U.S. Fish & Wildlife Service

Willapa National Wildlife Refuge

Draft Comprehensive Conservation Plan and Environmental Impact Statement

A Vision of Conservation

Within this beautiful coastal and bay setting, incoming tides mix with nutrient laden freshwaters to create one of the most pristine and productive estuarine environments along the Pacific coastline.

The distinctive habitats found within the Refuge include coastal dunes, salt marshes, mudflats, open water with eel grass beds, grasslands, and old growth western red cedar forest.

Visitors explore and enjoy a variety of wildlife from Roosevelt elk and the Pacific giant salamanders on Long Island to flocks of birds containing tens of thousands of shorebirds along the beach at Leadbetter Point.

Refuge management activities focus on protecting and restoring historic habitat conditions: second growth forests to healthy old growth forests, managed manmade freshwater wetlands to historic salt marsh habitat, threatened and endangered species to healthy sustained wildlife populations.

Success with these management activities is attained through partnerships with the Shoalwater Bay Tribe, local, state, and federal agencies, local organizations, communities, and individuals.

Community stewardship for these natural resources helps to sustain the healthy naturally functioning ecosystems of the Willapa Bay region for current and future generations to enjoy.

Comprehensive Conservation Plans provide long-term guidance for management decisions and set forth goals, objectives, and strategies needed to accomplish refuge purposes and identify the U.S. Fish and Wildlife Service's best estimates of future needs. These plans detail program planning levels that are sometimes substantially above current budget allocations, and as such, are primarily used for strategic planning and program prioritization purposes. The plans do not constitute a commitment for staffing increases, operational and maintenance increases, or funding for future land acquisition.

Dunlin and sanderlings / © Rudy Schuver

Willapa National Wildlife Refuge
Draft Comprehensive Conservation Plan and Environmental Impact Statement
Pacific County, Washington

Type of Action:	Administrative
Lead Agency:	U.S. Department of the Interior, Fish and Wildlife Service
Responsible Official:	Robyn Thorson, Regional Director
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Abstract: We developed alternatives, including preferred and no action alternatives, as required by National Environmental Policy Act regulations, for the Willapa National Wildlife Refuge. We addressed issues, opportunities, and Refuge management options in the alternatives. Summaries of the alternatives follow.

Alternative 1 (No Action). Under Alternative 1 we would maintain current Refuge management programs and where feasible, restore habitats, including implementing the forest management plan, enhancing wetland and beach dune habitats, and improving habitats for federally and State-listed threatened and endangered species. Hunting, fishing, wildlife observation, photography, interpretation, environmental education, boating, and camping, would continue. The Presidential Proclamation Boundary would remain closed to waterfowl hunting.

Alternative 2 (Preferred Alternative). Under Alternative 2 we would maintain current wildlife and habitat management, with the following improvements: The Refuge's managed pastures and impoundments would be restored to historic estuarine conditions, creating approximately 749 acres of open water, intertidal flats, and salt marsh habitats; an avian and mammalian predator management would be implemented on the Leadbetter Point Unit as necessary, to help meet Western snowy plover recovery goals; and grassland restoration of 15-33 acres would include establishing the early blue violet, a host plant that would serve the future reintroduction of the endangered Oregon silverspot butterfly. Managed freshwater wetlands would remain solely on the Tarlett Unit. An expanded approved Refuge boundary is proposed to include 6,803 acres in the Nemah, Naselle, South Bay, and East Hills areas. We would divest the Cape Shoalwater and Wheaton properties from the Refuge. Improvements to wildlife-dependent public uses would include: Developing a wildlife observation deck and interpretive trail along the South Bay connecting to the proposed Tarlett Unit visitor facility; expanding waterfowl hunting opportunities on approximately 6,058 acres of restored estuary; developing a cartop boat launch access point in the South Bay; conducting a special-permit elk hunt on Leadbetter Point Unit; and expanding elk/deer hunting on South Bay units.

Alternative 3. Under Alternative 3 we would maintain current wildlife and habitat management, with the following improvements: The Refuge's managed pastures and impoundments would be restored to historic estuarine conditions, creating approximately 429 acres of open water, intertidal flats, and salt marsh habitats. On the Leadbetter Point Unit avian predator management would be implemented as necessary, to help meet Western snowy plover recovery goals. Grassland restoration of 33 acres would include establishing the early blue violet, a host plant that would serve the future reintroduction of the endangered Oregon silverspot butterfly. Managed freshwater wetlands would remain on the Riekkola and Tarlatt units. An expanded approved Refuge boundary is proposed to include 4,895 acres in the South Bay and East Hills areas. We would divest the Cape Shoalwater and Wheaton properties from the Refuge. Improvements to wildlife-dependent public uses would include: Developing a wildlife observation deck and interpretive trail along the South Bay connecting to the proposed Tarlett Unit visitor facility; expanding waterfowl hunting opportunities on approximately 5,450 acres of restored estuary; conducting a special-permit elk hunt on Leadbetter Point Unit; and expanding elk/deer hunting on South Bay units.

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Draft Comprehensive Conservation Plan and Environmental Impact Statement

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November 2010

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Executive Summary

The Willapa National Wildlife Refuge (Refuge) is located on Willapa Bay along the southern Washington coastline. The Refuge was established in 1936 to protect migrating and wintering populations of brant, waterfowl, shorebirds, other migratory birds, and for other conservation purposes. It encompasses approximately 16,000 acres of tidelands, temperate rainforest, ocean beaches, sand dunes, rivers, and small streams. The Refuge also preserves several rare remnants of old growth coastal cedar forest, habitat for spawning wild salmon, hundreds of thousands of migrating shorebirds, and threatened and endangered species such as the Western snowy plover and Marbled murrelet. The U.S. Fish and Wildlife Service (Service) manages the Refuge as part of the National Wildlife Refuge System (Refuge System).

We developed this Draft Comprehensive Conservation Plan and Environmental Impact Statement (CCP/EIS) in coordination with our partners, for public review and comment. In Chapter 2, we describe three alternatives for future management of the Refuge, and analyze each alternative's potential effects on the biological, cultural, recreational, and economic environment. The alternatives are consistent with the principles of sound fish and wildlife management and relevant mandates, and address the issues we identified during public scoping.

We initiated public scoping on April 9, 2008, by publishing a Notice of Intent in the *Federal Register*, distributing Planning Update 1 and a press release, and announcing public meetings. The key issues we identified follow.

- Is tidal marsh restoration a desirable action? If so, which Refuge units should be considered, and which units if any should remain under current management practices?
- Should expansion of the Refuge boundary be considered, and if so, which properties and for what reasons should the Service consider expanding the approved Refuge boundary?
- What management actions should be implemented to protect Western snowy plovers from disturbance and predation while measures to protect and restore habitat are ongoing?
- What management actions should be implemented to alleviate threats to rare plants and animals caused by elk on the Leadbetter Unit?
- What forest management practices would restore forest complexity and biodiversity?
- Should the Refuge's wildlife-dependent recreational uses be expanded or modified? Which public uses are compatible with conserving wildlife resources?
- Should we consider a new visitor/administrative/maintenance facility

All three alternatives meet the Refuge's purposes and the Refuge System's mission. We identified Alternative 2 as our preferred alternative, because it would best achieve these benchmarks and allow for public uses as defined by the National Wildlife Refuge System Administration Act as amended. A summary of each draft alternative follows.

Alternative 1 (No Action Alternative). No changes to current Refuge management programs would occur under Alternative 1. The Refuge staff would continue programs and operations at current levels, based on funding and staffing levels. The Refuge would continue to maintain, and where feasible, restore forest, wetland, and beach dune habitats, and habitat for federally and State listed threatened and endangered species. We would continue to implement the forest management plan with our partners. Existing public uses—hunting, fishing, wildlife observation, photography, interpretation, environmental education, boating, and camping—would continue.

Alternative 2 (Preferred Alternative). Under Alternative 2 (our preferred alternative), current wildlife and habitat management programs would be maintained. In addition, of the three alternatives, the highest level of habitat improvements would occur under this alternative. The intensively managed pastures and impoundments would be restored to historic estuarine conditions, creating approximately 749 acres of open water, intertidal flats, and salt marsh habitats. We would continue to implement the forest management plan with our partners. On the Leadbetter Point Unit, a predator management program would be implemented as necessary, to control avian and mammalian predators and help meet Western snowy plover recovery goals. Grassland restoration on 15-33 acres would include establishing the early-blue violet, a host plant that would serve the future reintroduction of the endangered Oregon silverspot butterfly. Managed freshwater wetlands would remain on the Tarlett Unit. An expanded approved Refuge boundary is proposed to include 6,803 acres located in the Nemah and Naselle areas, South Bay, and the East Hills. The Cape Shoalwater and Wheaton properties would be divested from the Refuge.

Improvements to the wildlife-dependent public use program would include a new interpretive trail and wildlife observation deck along the South Bay. The new trail would tie into our proposed Tarlett Unit visitor/administrative/maintenance facility. The area where waterfowl hunting is conducted in accordance with the State's season would expand to include approximately 6,058 acres after the proposed estuarine restoration is completed. A cartop boat launch would be developed to access the South Bay. An expanded special permit elk hunt is proposed for the Leadbetter Point Unit. Elk and deer hunting would be expanded and conducted in South Bay Units in accordance with State seasons.

Alternative 3. Under Alternative 3, the Refuge's intensively managed pastures and impoundments would be restored to historic estuarine conditions, creating approximately 429 acres of open water, intertidal flats, and salt marsh habitats. The proposed estuarine restoration project would occur on the Lewis and Porter Point units only. On the Leadbetter Point Unit, predator management would be implemented as necessary, to control avian predators and help meet Western snowy plover recovery goals. Staff would continue to implement the forest management plan with partners. Grassland restoration on 15-33 acres would include establishing the early-blue violet, a host plant that would serve the future reintroduction of the endangered Oregon silverspot butterfly. Managed freshwater wetlands would remain on the Riekkola and Tarlett units. An expanded land acquisition boundary is proposed, to include 4,895 acres located in South Bay and the East Hills. The Cape Shoalwater and Wheaton properties would be divested from the Refuge.

Improvements to the wildlife-dependent public use program would include a new interpretive trail and wildlife observation deck along the South Bay that would tie into our proposed Tarlett Unit visitor/administrative/maintenance facility. The area where waterfowl hunting is conducted in accordance with the State's season would expand to include approximately 5,450 acres after the proposed estuarine restoration is completed. Hunting opportunities would expand at the Leadbetter Point Unit to include a permit-only regulated elk hunt. Elk and deer hunting opportunities would occur in the South Bay Units in accordance with the State seasons.

We encourage you to review and comment on the Draft CCP/EIS; comments will be addressed in the Final CCP/EIS. When the CCP is completed, it will provide guidance and direction for managing the Refuge for 15 years.

Chapter 1
Introduction and Background

Old growth forest
USFWS

Chapter 1. Introduction and Background

1.1 Introduction

The Willapa National Wildlife Refuge (Refuge) is located on Willapa Bay along the southern Washington coastline (Map 1). The Refuge was established in early 1937 by President Franklin Roosevelt in order to preserve and manage the important habitats and wildlife of Willapa Bay. The Refuge currently manages approximately 16,000 acres including sand dunes, sand beaches, intertidal mudflats, saltwater and freshwater marshes, grassland, open water, and forested lands.

The Refuge's wetland habitats support wintering populations of waterfowl such as black brant, trumpeter swans, Canada geese, scaup, canvasback, bufflehead, scoters, and American wigeon. The Refuge also hosts some of the largest concentrations of shorebirds on the Pacific Coast during their spring and fall migrations. These large concentrations of migrating shorebirds and the habitats that support them are now recognized as globally significant. The western snowy plover, listed as threatened under the Endangered Species Act, nests along the Refuge beaches. Marbled murrelet, black bear, black-tailed deer, Roosevelt elk, bats, bobcats, and grouse can be found in the forests and upland habitats. The cool, wet climate of the Willapa hills makes the area a "hotspot" of amphibian diversity; habitats on the Refuge support up to 13 of the 24 native amphibians that occur in Washington. Coastal rivers and streams on the Refuge provide habitat for western brook lamprey; western pearlshell mussels; Chinook, coho, and chum salmon; steelhead, and sea-run cutthroat trout.

1.2 Proposed Action

The U.S. Fish and Wildlife Service (USFWS or the Service) is proposing to adopt and implement a comprehensive conservation plan (CCP) and environmental impact statement (EIS) for the Willapa National Wildlife Refuge. This combined CCP/EIS will set forth management guidance for the Refuge for the next 15 years as required by the National Wildlife Refuge System (NWRS or the Refuge System) Administration Act of 1966, as amended (16 U.S. Code [U.S.C.] 688dd-688ee).

A CCP is required by the Refuge Administration Act to address "1) the purposes of the refuge; 2) the fish, wildlife and plant populations, their habitats, and the archaeological and cultural values found on the refuge; 3) significant problems that may adversely affect wildlife populations and habitats and ways to correct or mitigate those problems; 4) areas suitable for administrative sites or visitor facilities; and 5) opportunities for fish and wildlife-dependent recreation."

The Service has developed and analyzed the draft alternatives for future refuge management. The alternatives address the major issues and relevant mandates identified in the CCP process and are consistent with the principles of sound fish and wildlife management. The Service evaluated three draft alternatives for the Refuge and has identified Alternative 2 as the preferred alternative.

The Service selected the draft preferred alternative because it represents the best balanced approach for achieving the Refuge's purposes, vision, and goals; contributing to the NWRS mission; and addressing relevant issues and mandates consistent with sound principles of fish and wildlife management. However, the draft preferred alternative may be modified between the draft and final documents depending upon comments received from the public or other agencies and organizations. The Regional Director for the Service's Pacific Region will decide which alternative will be adopted for implementation. For details on the specific components and actions making up the range of alternatives, see Chapter 2.

1.3 Purpose and Need for the Comprehensive Conservation Plan

The purpose of the CCP is to provide the Service, the Refuge System, our partners, and the public with a long-term (15-year) management plan. This plan will integrate the goals, objectives and strategies (refuge management actions) set forth in this document. An approved CCP/EIS will ensure that the Service manages the Refuge to achieve the refuge purposes, vision, goals, and objectives to help fulfill the mission of the Refuge System. This CCP:

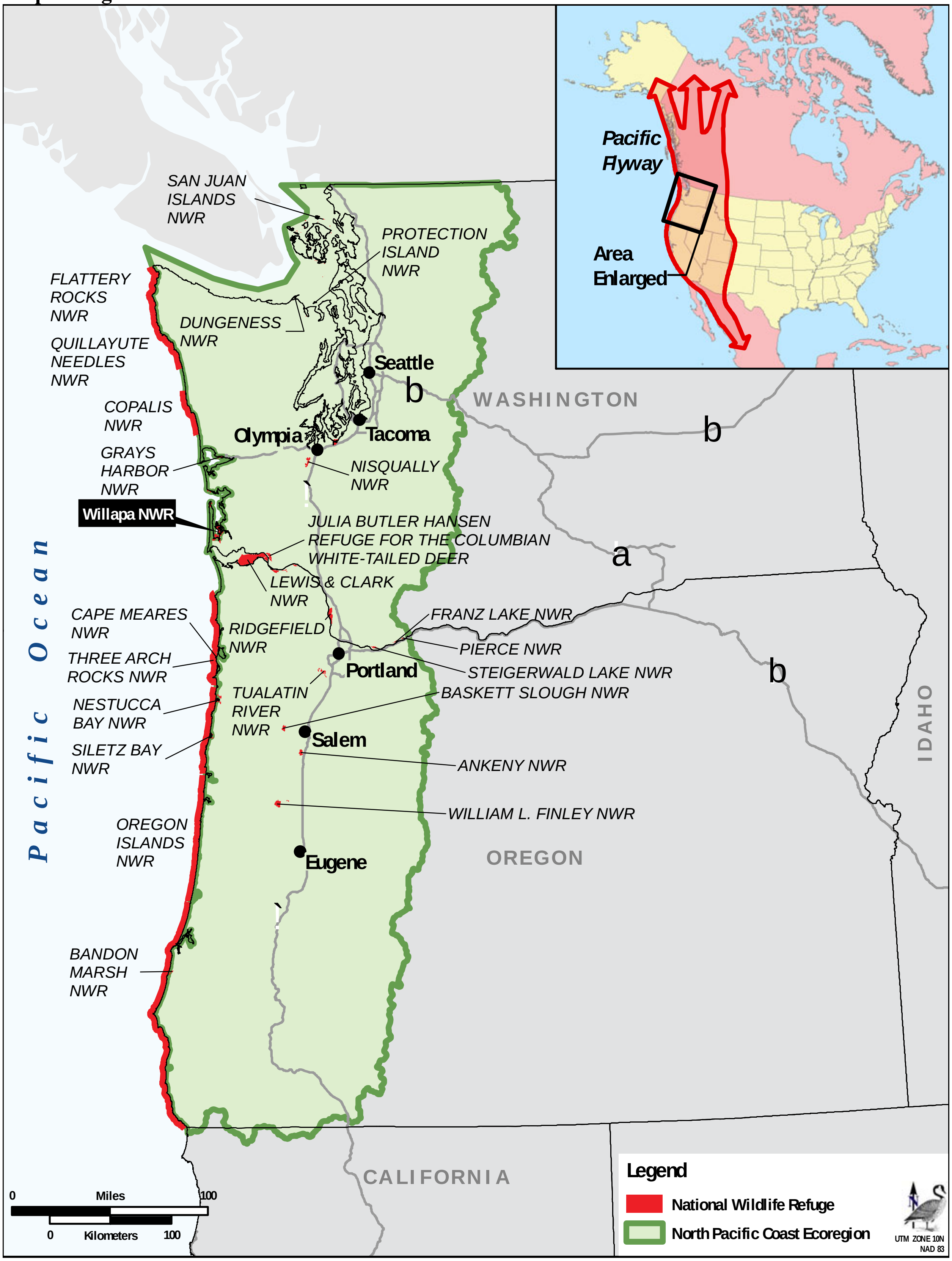
- Sets a long term vision for the Refuge;
- Establishes management goals, objectives, and strategies for the Refuge and its units;
- Provides the Refuge with a 15-year management plan for the conservation of fish, wildlife, and plant resources and their related habitats;
- Defines compatible public uses;
- Develops a plan that, when fully implemented, will achieve Refuge purposes, help fulfill the mission of the Refuge System, and maintain and, where appropriate, restore ecological integrity;
- Communicates the Service's management priorities for the Refuge; and
- Provides a basis for budget needs to support staffing, operations, maintenance, and capital improvements.

The plan was developed to provide reasonable, scientifically grounded guidance for improving the Refuge's habitats for the long-term conservation of native plants and wildlife species. It identifies appropriate actions for protecting and sustaining the cultural and biological features of the Refuge, and threatened, endangered, or rare species. Another purpose of the plan is to evaluate the priority public use programs on the Refuge, which may include hunting, fishing, wildlife observation, photography, environmental education, and interpretation.

The CCP/EIS is the needed to identify and set the long-term management priorities for the Refuge, which include:

- Improving Refuge habitat conditions through:
  - Management of young forest stands to create maximum trajectory toward establishing healthy old-growth stands;
  - Decommissioning and stabilization of old forest logging roads;
  - Removal of highly managed artificial freshwater wetlands by re-establishing the historic salt marsh habitat;
  - Restoration efforts for improving grasslands and dune habitats for the benefit of extirpated species, threatened wildlife, and other wildlife and plant species; and
  - Working with private land owners to improve habitat conditions on lands outside the refuge boundary.

Map 1. Regional Context.



Data Sources: Highways, State and Country Boundaries from ESRI; Cities from USGS; USFWS Ecoregions and Refuge Boundaries from USFWS/R1

The back sides of map pages are blank to facilitate map readability.

- Analyzing the Refuge's wildlife-dependent priority public uses, to determine what improvements or alterations could be made in the pursuit of higher quality programs for:
    - Continued and expanded quality hunting opportunities;
    - Improved environmental education and interpretation opportunities;
    - Expanded and improved wildlife observation opportunities with a new trail in the South Bay;
    - Expanded waterfowl hunting opportunities after habitat restoration activities in the South Bay; and
    - Maintenance of quality fishing opportunities.
- Constructing a visitor/administrative and maintenance replacement facility for the public and the Refuge staff and volunteers which would:
    - Improve visitor access to facilities and staff;
    - Expand environmental education and interpretation programs/opportunities;
    - Improve access to view wildlife of the bay with a new trail and car-top boat launch;
    - Consolidate Refuge maintenance facilities; and
    - Improve staff and volunteer office facilities, creating a healthy work site.
- Landscape habitat planning and for potential Refuge boundary expansion for:
    - Providing future opportunities to work with private landowners and nongovernmental organizations to acquire lands as funding and willing seller opportunities arise; and
    - Working with landowners to develop cooperative land management agreements.

1.4 Content and Scope of the Plan

This draft CCP provides guidance for management of Refuge habitats and wildlife and administration of public uses on Refuge lands and waters. Information included in the draft CCP includes:

- An overall vision for the Refuge, its role in the local ecosystem, and its relationship to other plans and the refuge purposes (Chapter 1).
- Goals and objectives for specific conservation targets and public use programs, as well as strategies for achieving the objectives (Chapter 2).
- A description of the physical environment (Chapter 3).
- A description of the conservation targets (habitats and wildlife), their condition and trends on the Refuge and within the local ecosystem, a presentation of the key desired ecological conditions for sustaining the targets, and a short analysis of the threats to each conservation target (Chapter 4).
- An overview of the Refuge's public use programs and current facilities, a list of desired future conditions for each program and proposed new facilities, and other management considerations (Chapters 2 and 5).
- An analysis of the effects of the proposed projects described in the plan (Chapter 6).
- Draft Land Protection Plan; strategies for acquisition boundary expansion (Appendix A)
- Evaluations of existing and proposed public and economic uses for appropriateness and compatibility (Appendices B and C).
- Draft Integrated Pest Management Plan (Appendix H).

- DraftForest Landscape Plan (Appendix K).
- Draft Predator Management Plan (Appendix L).
- Draft Hunt Plan (Appendix M).
- Draft Estuarine Restoration Plan (Appendix O).

1.5 U.S. Fish and Wildlife Service and National Wildlife Refuge System Laws and Directives

1.5.1 U.S. Fish and Wildlife Service Mission

The mission of the Service is "working with others, to conserve, protect and enhance fish and wildlife and their habitats for the continuing benefit of the American people."

National natural resources entrusted to the Service for conservation and protection include migratory birds, endangered and threatened species, inter-jurisdictional fish, wetlands, and certain marine mammals. The Service also manages national fish hatcheries, enforces Federal wildlife laws and international treaties regarding importing and exporting wildlife, assists with state fish and wildlife programs, and helps other countries develop wildlife conservation programs.

1.5.2 National Wildlife Refuge System

The National Wildlife Refuge System is the world's largest network of public lands and waters set aside specifically for conserving wildlife and protecting ecosystems. From its inception in 1903, the Refuge System has grown to encompass 550 National Wildlife Refuges in all 50 states, and waterfowl production areas in 10 states, covering more than 150 million acres of public lands. More than 40 million visitors annually fish, hunt, observe and photograph wildlife, or participate in environmental education and interpretive activities on National Wildlife Refuges.

1.5.3 National Wildlife Refuge System Administration Act

Of all the laws governing activities on National Wildlife Refuges, the Refuge Administration Act undoubtedly exerts the greatest influence. In 1997, the Refuge System Administration Act was amended by the National Wildlife Refuge System Improvement Act; it included a unifying mission for all National Wildlife Refuges as a system, a new process for determining compatible uses on refuges, and a requirement for each refuge to be managed under a CCP, developed in an open public process.

The Refuge Administration Act states that the Secretary shall provide for the conservation of fish, wildlife, and plants, and their habitats within the System as well as ensure that the biological integrity, diversity, and environmental health of the System are maintained. House Report 105-106 accompanying the Improvement Act states that "the fundamental mission of our System is wildlife conservation: wildlife and wildlife conservation must come first."

Biological integrity, diversity, and environmental health are critical components of wildlife conservation. As later made clear in the Biological Integrity, Diversity, and Environmental Health Policy (section 1.5B), "the highest measure of biological integrity, diversity, and environmental health is viewed as those intact and self-sustaining habitats and wildlife populations that existed during historic conditions."

Under the Refuge Administration Act, each refuge must be managed under an approved CCP to fulfill the Refuge System mission as well as the specific purposes for which it was established. The Refuge Administration Act requires the Service to monitor the status and trends of fish, wildlife, and plants on each refuge.

Additionally, the Refuge Administration Act identifies six priority wildlife-dependent recreational uses. These uses are hunting, fishing, wildlife observation and photography, and environmental education and interpretation. Under the Refuge Administration Act, the Service is to grant these six wildlife-dependent public uses special consideration during planning, managing, establishing, and expanding units of the Refuge System. The overarching goal is to enhance wildlife-dependent recreation opportunities and provide access to quality visitor experiences on refuges, while managing the refuge to conserve fish, wildlife, plants, and their habitats.

New and ongoing recreational uses should help visitors focus on wildlife and other natural resources. These uses should provide an opportunity to make visitors aware of resource issues, management plans, and how the refuge contributes to the Refuge System and Service's mission. When determined compatible on a refuge-specific basis, the six priority uses assume priority status among all uses of the refuge in question. The Service is to make extra efforts to facilitate priority wildlife-dependent public use opportunities.

When preparing a CCP, refuge managers must re-evaluate all general public, recreational, and economic uses (even those occurring to further refuge habitat management goals) proposed or occurring on a refuge for appropriateness and compatibility. No refuge use may be allowed or continued unless it is determined to be appropriate and compatible.

Generally, an appropriate use is one that contributes to fulfilling the refuge purpose(s), the Refuge System mission, or goals or objectives described in a refuge management plan. A compatible use is a use that, in the sound professional judgment of the refuge manager, will not materially interfere with or detract from the fulfillment of the mission of the Refuge System or the purposes of the refuge. Updated appropriate use and compatibility determinations for existing and proposed uses for the Willapa Refuge are in Appendices B and C.

A CCP must be developed with the participation of the public, as required by the Refuge Administration Act and other formally established guidance. Issues and concerns articulated by the public play a role in guiding alternatives considered during the development of the CCP, and together with the formal guidance, can play a role in selection of the preferred alternative. It is Service policy to develop CCP's in an open public process. The Service is committed to securing public input throughout the CCP planning process.

1.5.4 National Wildlife Refuge System Mission and Goals

The mission of the Refuge System is:

> to administer a national network of lands and waters for the conservation, management, and where appropriate, restoration of the fish, wildlife, and plant resources and their habitats within the United States for the benefit of present and future generations of Americans (NWRS Administration Act of 1966, as amended, 16 U.S.C. 668dd-668ee).

Wildlife conservation is the fundamental mission of the Refuge System. The goals of the National Wildlife Refuge System, as articulated in the Mission, Goals, and Purposes Policy (601 FW1) are:

- Conserve a diversity of fish, wildlife, and plants and their habitats, including species that are endangered or threatened with becoming endangered.
- Develop and maintain a network of habitats for migratory birds, anadromous and inter-jurisdictional fish, and marine mammal populations that is strategically distributed and carefully managed to meet important life history needs of these species across their ranges.
- Conserve those ecosystems, plant communities, wetlands of national or international significance and landscapes and seascapes that are unique, rare, declining, or underrepresented in existing protection efforts.
- Provide and enhance opportunities to participate in compatible wildlife-dependent recreation (hunting, fishing, wildlife observation and photography, and environmental education and interpretation).
- Foster understanding and instill appreciation of the diversity and interconnectedness of fish, wildlife, and plants and their habitats.

1.5.5 Planning and Management Guidance

Refuges are guided by various Federal laws, executive orders, Service policies, and international treaties. Fundamental to the management of every refuge are the mission and goals of the NWRS, and the designated purposes of the refuge unit as described in establishing legislation, executive orders, or other documents establishing, authorizing, or expanding a refuge.

Key concepts and guidance of the Refuge System are derived from the NWRS Act of 1966 as amended (16 U.S.C. 668dd-668ee), the Refuge Recreation Act of 1962 (16 U.S.C. 460k-460k-4), as amended, Title 50 of the Code of Federal Regulations (C.F.R.), and the Service Manual. The NWRS Administration Act is implemented through regulations covering the NWRS, published in Title 50, subchapter C of the C.F.R. and policies contained in the Service Manual. These regulations and policies govern general administration of units of the Refuge System.

1.5.6 Relationship to Previous and Future Refuge Plans

The final CCP will be revised every 15 years or sooner if monitoring and evaluation findings determine that changes are needed to achieve the Refuge's purposes, visions, goals, or objectives.

The CCP provides guidance in the form of goals, objectives, and strategies for refuge programs areas but may in some cases lack some of the specifics needed for implementation. Step-down management plans may, therefore, be developed for individual program areas as needed, following completion of the CCP. Step-down plans may require appropriate National Environmental Policy Act (NEPA) compliance.

Planning has been part of the Refuge's operations since it was established. Although not all past planning processes were carried out in a comprehensive fashion, with the level of public participation considered adequate today, a considerable number of plans have been completed over the years to guide refuge managers.

A list of various Refuge management plans and the year they were completed follows. Plans marked with an asterisk are covered through this CCP/EIS.

- Habitat and Public Use Management (Quarterly/Annual Action Summary)
- Station Safety Plan (updated annually)
- Continuity of Operations Plan (2006)
- Highly Pathogenic Avian Influenza Disease Contingency Plan (2006)
- Fire Management Plan (2004)
- Marsh and Water Management Plan (1990)*
- Refuge Habitat Management Plan (2005)*
- Public Use Management/Development Plan (1988)*
- Willapa Refuge Hunting Plan and Environmental Assessment (1986)*
- Refuge Management Plan (1986)*

1.6 Refuge Establishment and Refuge Purposes

The purpose for which a refuge was established or acquired is of major importance in refuge planning. Refuge purposes form the foundation for planning and management decisions. The purposes of a refuge are specified in or derived from the law, proclamation, executive order, agreement, public land order, donation document, or administrative memorandum establishing, authorizing, or expanding a refuge, refuge unit, or refuge subunit.

Unless the establishing law, order, or other document indicates otherwise, purposes dealing with the conservation, management, and restoration of fish, wildlife, and plants, and the habitats on which they depend, take precedence over other purposes in the management and administration of any Refuge System unit. Where a refuge has multiple purposes related to fish, wildlife, and plant conservation, the more specific purpose will take precedence in instances of conflict. When a new refuge unit is acquired under an authority different from the original refuge's establishing authority, the new unit takes on the purpose(s) of the original unit, but the original unit does not take on the purpose(s) of the new addition.

By law, refuges are to be managed to achieve their purposes. When a conflict exists between the Refuge System's mission and the purpose of an individual refuge, the refuge's purpose may supersede the Refuge System's mission.

Refuge purposes are also the driving force in the development of a refuge's vision statements, goals, and objectives in the CCP. The purposes are critical to determining the compatibility of all existing and proposed refuge uses.

1.6.1 Acquisition History and Purposes

The refuge purposes refer to the justification for the establishment of a Refuge within the NWRS as a place owned by the American people and cared for on their behalf. The following purposes form the foundation for management decisions and the planning process for the Willapa NWR, including the development of the goals and objectives.

With passage of the Migratory Bird Conservation Act in 1929, the Migratory Bird Conservation Commission (MBCC) was established to approve land acquisitions from the Migratory Bird Conservation Fund for the NWRS that are considered important to waterfowl. The commission was established largely in response to public concern over plummeting waterfowl populations during the Dust Bowl days of the 1920s and 1930s, reflecting the NWRS's early commitment to waterfowl protection. It was the MBCC that set the stage for the establishment and purchase of lands for the Willapa NWR.

The MBCC (acting under the authority of the Migratory Bird Conservation Act of 1929) on May 7, 1936, approved the acquisition of 24 tracts totaling 4,825 acres in Pacific County, Washington, authorizing the establishment of the Willapa Migratory Waterfowl Refuge. At that meeting, 1,642 acres were approved for purchase, which included 15 tracts. Specifically the MBCC meeting memorandum no. 16 also identified the tidal marsh around Long Island as:

> …one of the most important concentration points for migratory waterfowl on the Washington Coast. It has a fine supply of natural aquatic foods, especially eel-grass, and thereby has been for years one of the few suitable wintering grounds available for Black Brant.

The memo also states that Washington ranked fourth in the nation in duck stamp sales and further states that: "it is essential for the preservation of the Pacific flyway that the Restoration program provide adequate sanctuary facilities for migratory birds in that state."

The meeting minutes also note the management vision by Mr. Gabrielson (Department of Interior): "what we planned to do is to close by executive order the shallow water here where the birds feed. The mud flats are a concentration area."

On October 14, 1936, 196 acres were purchased establishing the Refuge and the refuge purposes were derived from the earlier MBCC meeting memorandum no. 16.

On January 12, 1937, three months after the first property was purchased, President Franklin Roosevelt signed Executive Order 7541, Establishing Public Domain lands. The refuge was called Willapa Harbor Migratory Bird Refuge. "as a refuge and breeding ground for migratory birds and other wildlife." These land tracts (1 and 1a) are currently known as the Shoalwater Bay Unit of Willapa NWR.

Later that year President Roosevelt issued Executive Order 7721, enlarging Willapa Harbor Migratory Bird Refuge "in order to effectuate further the purposes of the Migratory Bird Conservation Act (45 Stat. 1222)." The executive order states:

> The following lands and accretions, comprising approximately 5,000 acres either acquired or be acquired are reserved and set apart subject to existing rights for the use of the Dept. of Agriculture as an addition to the Willapa Harbor Migratory Bird Refuge established by EO 7541.
>
> Provided, that any private lands within the area described shall become a part of the refuge upon the acquisition of title thereto or lease thereof by the United States.

A few years later, in July 1940, a presidential proclamation was issued which changed the name from the Willapa Harbor Migratory Bird Refuge to Willapa National Wildlife Refuge.

Later that same year in a letter to the President from the Acting Secretary of Interior E.K. Burlew (dated October 22, 1940) introducing a request for an Executive Order he states: "after careful consideration of the exigencies of the migratory waterfowl and other migratory birds resident upon the and reporting to the Willapa National Wildlife Refuge, it has been determined that to allow the hunting, taking, capturing, or killing of such migratory birds on the lands and waters in Willapa Bay adjacent to or in the vicinity of the Refuge would defeat the protections sought to be extended to such migratory birds by the establishment of the Willapa refuge." The letter also states that this proposal is supported by local sportsmen and the Washington State Game Commission. It proceeds with the purpose for the proclamation, which is "to extend jurisdiction of the Department of Interior over these lands and waters by making them a closed area under the Migratory Bird Treaty Act of July 3, 1918 (40 Stat. 755)."

Later that year on November 7, 1940, the President issued another Proclamation (No. 2439): Regulation Designating As Closed Area under the Migratory Bird Treaty Act Certain Lands and Waters Adjacent to and in the Vicinity of the Willapa National Wildlife Refuge Washington.

- As lands were acquired into the refuge, with purposes derived from the earlier Executive Order it is also made clear in several MBCC Memoranda that "A Proclamation closes to hunting the water surrounding the island." That "island" refers to Long Island in south Willapa Bay. The Refuge maintains the Presidential Proclamation Boundary specifically prohibiting hunting around Long Island.

Throughout the 1940s and 1950s, the lands approved for purchase were under the purposes derived from Executive Order 7541.

- On April 7, 1967, in the Notice of Proposed Withdrawal and Reservation of Land, the purposes of the Leadbetter Point unit were described: "The applicant desires to use the land for the management of migratory birds and other wildlife as an extension of the Willapa National Wildlife Refuge." One year later (April 16, 1968), Leadbetter Point Unit was added to the refuge by Public Land Order 4403.

Beginning in 1978 through today, expansion of the Refuge identified specific habitat or wildlife attributes that were described in the environmental assessments (EAs) of those lands. In 1978, the EA for the acquisition of Long Island described its purposes:

- A grove of virgin western red cedars and western hemlock.
- Supports one of largest nesting colonies of great blue herons (150 nests on Burlington Northern land) in the Pacific NW.
- Five plants are listed as endangered by a Smithsonian report: *Aster chilensis hallii*, *Erythronium oregonum*, *Aster curtus*, *Arenaria paludicola*, and *Lasthenia minor maritime*.

An EA in 1983 derived the purposes for the Burlington Northern Land Exchange, Pacific County, Washington Tract: 12, Long Island Unit (92.2 acres): "1. To preserve and protect unique ecosystems associated with Willapa Bay. 2. To provide for maximum use and production by migratory birds other than wintering waterfowl, with special emphasis on bald eagles and marsh and wading birds." Land was exchanged for 175 acres on Little Pend Oreille NWR. Mineral rights were held by Burlington Northern Santa Fe.

In December 1999, the Willapa Addition EA/Land Protection Plan and Conceptual Management Plan describe the purposes for the future boundary expansion of 2,278 acres for the Bear River, Teal Slough, and Tarlatt Slough areas. The purposes follow.

- Protect habitat for old-growth dependent species including the threatened marbled murrelet and threatened northern spotted owl.
- Protect and restore upland forest and associated stream habitat in order to protect and enhance declining fish populations, including coastal cutthroat trout, and Chinook, coho, and chum salmon runs.
- Protect and restore coastal wetlands to provide a diversity of habitats for migratory waterfowl, shorebirds, wading birds, and songbirds.
- Protect the intertidal mudflats along Willapa Bay by consolidating spartina-infested lands for better management of control and eradication efforts on existing Refuge lands and on adjacent tidelands.
- Provide large scale habitat management through linking existing Refuge lands in a contiguous Refuge boundary.
- Provide wildlife-dependent public use opportunities compatible with Refuge purposes.

1.6.2 Summary of Purposes and Management Direction for the Willapa Refuge

The purposes for the Willapa NWR have been identified in historic legal documentation that established and added to Refuge lands. Because the Refuge was originally established to preserve an important wintering and foraging habitat for migratory waterfowl in the Pacific Flyway, preservation of this waterfowl habitat represents a priority for management to achieve the Refuge's purpose. In accordance with 601 FW1, all lands acquired since the original establishment of the Refuge retain this purpose.

... as a refuge and breeding ground for migratory birds and other wildlife: ... Executive Order 7541, dated Jan. 22, 1937

"... for use as an inviolate sanctuary, or for any other management purpose, for migratory birds." 16 U.S.C. § 715d (Migratory Bird Conservation Act)

"... suitable for— (1) incidental fish and wildlife-oriented recreational development, (2) the protection of natural resources, (3) the conservation of endangered species or threatened species ..." 16 U.S.C. § 460k-1

"... the Secretary ... may accept and use ... real ... property. Such acceptance may be accomplished under the terms and conditions of restrictive covenants imposed by donors ..." 16 U.S.C. § 460k-2 (Refuge Recreation Act (16 U.S.C. § 460k-460k-4), as amended).

"... for the development, advancement, management, conservation, and protection of fish and wildlife resources ..." 16 U.S.C. § 742f(a)(4)
"... for the benefit of the United States Fish and Wildlife Service, in performing its activities and services. Such acceptance may be subject to the terms of any restrictive or affirmative covenant, or condition of servitude ..." 16 U.S.C. § 742f(b)(1) (Fish and Wildlife Act of 1956)

In accordance with 601 FW1, all lands acquired since the original establishment of the Refuge retain this purpose.

Management priorities are further stated in subsequent land acquisition documents to preserve, protect, and restore newly acquired habitats and provide habitat for other migratory birds, plants, and wildlife with special emphasis for marbled murrelets, bald eagles, Aleutian Canada geese, shorebirds, marsh, wading birds, and water howellia (plant). Documentation for additional lands also identified the following habitats, wildlife, public opportunities, and management priorities to support a diverse assemblage of native fish, wildlife, and plants:

- Eelgrass beds
- Gravel bars
- Old-growth/mature forests
- Riverine habitats
- Intertidal mudflats
- Sand dune habitat
- Fish species: coho, Chinook, chum salmon, steelhead, sea-run cutthroat trout
- Amphibian diversity
- Compatible wildlife-dependent recreation
- Educational/research opportunities
- Cultural resource sites

1.6.3 Special Land Status

1.6.3.1 Research and Natural Areas (Washington State)

The refuge has three state-registered natural areas that are in the research natural area (RNA) category. These RNAs are owned and administered by the Service to 1) preserve examples of all significant natural ecosystems for comparison with those influenced by humans, 2) provide educational and research areas for ecological and environmental studies, and 3) preserve the genetic and behavioral diversity of native and endangered plants and animals. These areas consist of Diamond Point RNA (88 acres) and Cedar Grove RNA (264 acres), both of which are located on Long Island, and the Leadbetter RNA (1,705 acres). Detailed information regarding these areas can be found in Chapters 4 and 5.

1.6.4 Other Laws, Policies, and Orders

Many other laws apply to the USFWS and management of Refuge System lands. Examples include the Endangered Species Act of 1973, as amended, and the National Historic Preservation Act of 1966, as amended. A list and brief description of each can be found at http://laws.fws.gov.

In addition, over the last few years, the Service has developed or revised numerous policies and Director's Orders to reflect the mandates and intent of the NWRS Improvement Act. Some of these key policies include the Biological Integrity, Diversity, and Environmental Health Policy (601 FW3); the Compatibility Policy; the Refuge Planning Policy; Mission, Goals, and Purposes (602 FW 1), Appropriate Refuge Uses (603 FW 1); Wildlife-Dependent Public Uses (605 FW 1); and the Director's Order for Coordination and Cooperative Work with State Fish and Wildlife Agency Representatives on Management of the National Wildlife Refuge System. These policies and others in draft or under development can be found at http://refuges.fws.gov/policymakers/nwrpolicies.html.

In developing a CCP, refuges must consider these broader laws and policies as well as Refuge System and ecosystem goals and visions. The CCP must be consistent with these and also with the Refuge purpose.

1.7 CCP Relationship to Other Ecosystem Planning Efforts

One of the major purposes of this CCP is to ensure that refuge management is focused on achieving not only the Refuge's purposes, but also to analyze and determine the appropriate role of the Refuge in relationship to national, regional, state, watershed districts, in meeting various goals and objectives for conservation of natural resources. These goals are stated in various plans that pertain to individual wildlife species and the Pacific Northwest. A brief summary of the major plans considered during development of this CCP follows.

1.7.1 Applicable Recovery Plans

The Service has prepared recovery plans that are intended to serve as guidance documents for agencies, landowners, and the public. Each plan includes recommendations for actions considered necessary to satisfy the biological needs and ensure the recovery of the listed species. These plans also emphasize opportunities for improved management of listed species on Federal and State lands. Recommended actions generally include protection, enhancement, and restoration of those habitats deemed important for recovery, monitoring, research, and public outreach. Recovery plans for federally listed species that occur at Willapa include:

- Recovery Plan for the Marbled Murrelet (USFWS 1997)
- Revised Recovery Plan for the Oregon Silverspot Butterfly (USFWS 2001a)
- Recovery Plan for the Pacific Coast Population of the Western Snowy Plover (USFWS 2007a)
- Recovery Plan for the Northern Spotted Owl (USFWS 2008a)

The recommendations provided in the recovery plans for these listed species have been considered during the development of this CCP.

1.7.2 Migratory Bird Conservation

1.7.2.1 Birds of Management Concern (USFWS 2004c)

Birds of Management Concern (BMC) is a subset of all species protected by the Migratory Bird Treaty Act (50 C.F.R. 10.13) and includes those which pose special management challenges due to a variety of factors (e.g., too few, too many, conflicts with human interests, or societal demands). The BMC comprises both game birds below their desired condition and nongame birds. As indicated in its strategic plan (USFWS 2004c), the Migratory Bird Program places priority emphasis on these birds in its activities.

Willapa NWR provides breeding, wintering, and/or stopover habitat for some of the birds identified as BMC with primary importance in the region. Habitats for 12 focal species are supported on this Refuge. Those species consist of the brown pelican (*Pelecanus occidentalis*), dusky Canada goose (*Branta canadensis occidentalis*), brant (*Branta bernicla nigricans*), northern harrier (*Circus cyaneus*), western snowy plover (*Charadrius alexandrinus nivosus*), whimbrel (*Numenius phaeopus*), red knot (*Calidris canutus roselaari*), band-tailed pigeon

(*Columba fasciata*), Vaux's swift (*Chaetura vauxi*), olive-sided flycatcher (*Contopus cooperi*), American crow (*Corvus brachyrhynchos*), and red crossbill (*Loxia curvirostra*).

1.7.2.2 Birds of Conservation Concern (USFWS 2008b)

The 1988 amendment to the Fish and Wildlife Conservation Act mandates the USFWS to "identify species, subspecies, and populations of all migratory nongame birds that, without additional conservation actions, are likely to become candidates for listing under the Endangered Species Act (ESA) of 1973." The publication *Birds of Conservation Concern 2008* (BCC) is the most recent effort to carry out this mandate. The BCC identifies the migratory and non-migratory bird species, beyond those already designated as federally threatened or endangered, that represent the Service's highest conservation priorities. BCC species are a select group of birds appearing on the BMC list.

Thirteen BCC species within the U.S. portion of the Northern Pacific Forest, Bird Conservation Region regularly occur at Willapa NWR: northern goshawk (*Accipiter gentilis laingi*), bald eagle (*Haliaeetus leucocephalus*), peregrine falcon (*Falco peregrinus*), whimbrel, marbled godwit (*Limosa fedoa*), red knot, short-billed dowitcher (*Limnodromus griseus*), Caspian tern (*Sterna caspia*), rufous hummingbird (*Selasphorus rufus*), olive-sided flycatcher, willow flycatcher (*Empidonax traillii*), streaked horned lark (*Eremophila alpestris strigata*), and, purple finch (*Carpodacus purpureus*).

1.7.2.3 Partners in Flight, North American and State Landbird Conservation Plans

Partners in Flight (PIF) is an international coalition of government agencies, conservation groups, academic institutions, private organizations, and citizens dedicated to the long-term maintenance of healthy populations of native landbirds. The goal of PIF's landbird conservation plans is to focus resources on the improvement of monitoring and inventory, research, management, and education programs involving birds and their habitats. PIF's strategy is to stimulate cooperative public- and private-sector efforts in North America and the Neotropics to meet these goals.

Specific strategies for accomplishing the goals are contained in regional landbird conservation plans. These plans describe priority habitats and species and provide recommended management actions to conserve those habitats and species. The regional plans applicable to the Refuge are entitled *Conservation Strategy for Landbirds in Lowlands and Valleys of Western Oregon and Washington* (Altman 2000) and *Conservation Strategy for Landbirds in Coniferous Forests of Western Oregon and Washington* (Altman 1999). The lowlands and valleys plan identifies three priority habitats: grassland/savannah, oak woodland, and riparian. Two of these habitats, grassland/savannah and riparian, are found within the Refuge. All forest conditions identified in the coniferous forest plan, except the unique classifications, are found on the Refuge. In addition, over 40 focal species identified in the two plans occur on the Refuge.

1.7.2.4 Seabird Conservation Plan, Pacific Region (USFWS 2005a)

The California Current System is one of the most ecologically complex habitats. A diverse assemblage of organisms inhabits the California Current, including 60 species of seabirds, many of which breed or migrate through the coastal waters around Willapa NWR. The purpose of the Seabird Conservation Plan is to identify priorities for seabird management, monitoring research, outreach, planning and coordination (USFWS 2005a). The plan provides guidance and recommendations for conservation actions addressing a prioritized group of species occurring at a regional scale. Specific information on ecology, population, status, distribution, threats, and conservation needs is provided for species breeding in the region.

Although the Refuge does not manage habitats that provide for seabird breeding, many species of marine birds occur in the surrounding coastal waters.

1.7.2.5 USFWS Regional Marine Bird Policy (USFWS 1985)

This policy was enacted to recognize the significance of maintaining healthy, viable populations of marine birds in the Pacific. It is intended to guide the Service in implementing provisions of the Migratory Bird Treaty Act relative to marine birds. Specifically, the policy sets directives to 1) Utilize current programs and resources to maintain seabird populations at or above current levels, in a naturally diverse state and on native habitats throughout their range; 2) Achieve a goal of establishing and actively protecting colonies, roosts, loafing sites, and adjacent waters as sanctuaries; 3) Encourage the development of comprehensive management plans and appropriate regulations aimed at developing offshore petroleum and mineral resources and the safe transport of such resources that adequately protect marine birds and their habitats; 4) Promote research, survey, and monitoring programs focusing on seabirds and marine ecosystems, especially long-term monitoring that identifies declining species that may require future listing without immediate intervention; and 5) Remove non-native predators from seabird colonies on all National Wildlife Refuges, and encourage their removal from colonies on all other lands.

1.7.2.6 Northern Pacific Coast Region, Shorebird Conservation Plan (Drut and Buchanan 2000)

Willapa NWR is also located within the Northern Pacific Coast Region, as defined by the U.S. Shorebird Conservation Plan (Brown et al. 2000). The Northern Pacific Coast Region is an important wintering area for shorebirds that breed in the arctic and temperate zones, but it is also important during migration, particularly for arctic breeding species. There are also important breeding populations in the region. The major regional goal of the U.S. Shorebird Conservation Plan is "to ensure that adequate quantity and quality of habitat is identified and maintained to support the different shorebirds that breed in, winter in, and migrate through each region."

The Northern Pacific Coast Region Shorebird Conservation Plan (NPCRSCP) includes several conservation priorities that are relevant to Willapa NWR. These relevant priorities include increasing the breeding population of the highly imperiled western snowy plover to 250 breeding adults within the Oregon and Washington Recovery Unit; increasing and/or maintaining the breeding population of the western snowy plover and killdeer by restoring, enhancing, and creating nesting habitat; and increasing migratory and wintering populations of all key shorebird species in the region using various protection, restoration, enhancement, and management strategies. The NPCRSCP identifies tidal flats and sand beaches as important shorebird habitat within the coastal areas of Washington. Willapa Bay includes the largest remaining area of tidal mudflat habitat and the most coastal salt marsh habitat in southwestern Washington. Leadbetter Point has the greatest extent of mostly isolated, sparsely vegetated, sand beach on the entire southern Washington coast. Therefore, the NPCRSCP's habitat goals for tidal wetlands and coastal sand beaches are relevant to this Refuge. These goals include restoring tidal flats and estuarine marshes to benefit shorebirds; enhancing tidal action in existing wetlands through the removal and maintenance of introduced cordgrass; and managing a sufficient amount shallow open water habitat to support shorebird populations; and limiting human disturbance to shorebirds in all seasons. The NPCRSCP recommends restoration and enhancement of sparsely vegetated sand beach habitat by removing and controlling introduced beach grass. The NPCRSCP also includes goals for managed freshwater wetlands, which call for improving and maintaining the value of managed freshwater wetlands to benefit shorebirds.

In the NPCRSCP, Willapa Bay has been proposed as a site of international significance supporting more than 100,000 shorebirds, or 15% of the Pacific Flyway total (Drut and Buchanan 2000). The Refuge provides breeding, wintering, and/or stopover habitat for most of the shorebirds identified in the NPCRSCP as having primary importance within the region. Of the 20 species of highest concern for which coastal habitats in the Northern Pacific Coast Region are especially important, 11 species—the western snowy plover, black-bellied plover (*Pluvialis squatarola*), killdeer (*Charadrius vociferous*), greater yellowlegs (*Tringa melanoleuca*), whimbrel, marbled godwit, red knot, sanderling (*Calidris alpina*), dunlin (*Calidris alpina*), short-billed dowitcher, and western sandpiper (*Calidris mauri*)—are supported on this Refuge.

1.7.3 Waterbird Conservation Planning

1.7.3.1 North American Waterbird Conservation Plan (Kushlan et al. 2002)

An independent partnership was created to develop a plan that sustains or restores the distribution, diversity, and abundance of breeding, migratory, and non-breeding waterbirds of North and Central America and the Caribbean region (Kushlan et al. 2002). The primary goal of the council formed from this partnership was to develop and facilitate implementation of the North American Waterbird Conservation Plan (NAWCP). Completed in 2002, the NAWCP outlines a continental-scale conservation and management strategy for over 200 aquatic bird species of the Northwestern Hemisphere. The NAWCP identifies vulnerabilities and threats to species and their habitats. Habitat and site-based conservation actions throughout the Americas and the North Pacific are promoted by the NAWCP. Conservation priorities, information needs, resources, and infrastructure are identified at regional and local levels in a step-down process through regional working groups.

1.7.3.2 North American Waterfowl Management Plan

The North American Waterfowl Management Plan (NAWMP) is an international action plan to conserve migratory birds throughout the continent. The goal of the NAWMP is to return waterfowl populations to their levels in the 1970s by conserving wetland and upland habitat. Canada and the United States signed the NAWMP in 1986, in reaction to critically low numbers of waterfowl. Mexico joined in 1994, making it a truly continental effort. The NAWMP is a partnership of Federal, provincial, state and municipal governments, nongovernmental organizations, private companies, and many individuals, all working toward achieving better wetland habitat for the benefit of migratory birds, other wetland-associated species, and people.

Transforming the goals of the NAWMP into on-the-ground actions is accomplished through partnerships called joint ventures. Joint ventures are made up of individuals, corporations, conservation organizations, and local, state, provincial, and Federal agencies. There are currently 11 habitat joint ventures in the United States and four in Canada endorsed by the NAWMP committee. One of the habitat joint ventures has international status (Canada/United States). Partners from Canada and the United States also jointly support three species joint ventures. Habitat joint ventures restore and enhance wetlands and associated upland habitats. The species joint ventures address monitoring and research needs of black ducks, Arctic nesting geese, and seaducks.

The Pacific Joint Venture's (PJV) partners work within a planning framework that links local conservation priorities to the regional goals of the Pacific Coast and Intermountain West Joint Ventures. Focus areas are identified within the region. Within the Southern Washington Coast Focus Area, the Pacific Joint Venture is dedicated to ensure habitat objectives are met and sustained through the following recommended actions:

1) Key coastal wetlands are protected for the long term through means such as fee title acquisition, easements, conservation covenants, government land transfers, and management agreements.
2) Degraded or converted wetlands are restored to re-establish ecological relationships that more closely represent the site's original conditions. PJV partners frequently collaborate to restore former agricultural land, tidal marshes, and riparian communities. Examples of restoration projects include re-establishing riverine channels and riparian habitat; planting native vegetation; and, restoring tidal flow to diked agricultural areas.
3) Enhancement projects increase the wildlife values of specific habitats on secured lands. One way this is accomplished is through projects that control invasive and non-native plants.

1.7.3.3 Pacific Flyway Management Plan

The Pacific Flyway Council is an administrative body that forges cooperation among public wildlife agencies for the purpose of protecting and conserving migratory game birds in western North America. The council is generally composed of one member from the public wildlife agency in each state and province in the western United States, Canada, and Mexico.

Biologists from state, Federal, and provincial wildlife and land-management agencies, university students and faculty, and others develop management plans for the cooperative management of migratory game bird populations in the Pacific Flyway. Biologists from the Central Flyway, Canada, Mexico, and Russia contribute to these plans. The following management plans pertain to refuge habitats and associated waterfowl species.

1.7.3.4 Pacific Flyway Management Plan for the Pacific Population of Aleutian Cackling Goose

The goal of this plan is to identify needs and responsibilities necessary to cooperatively manage the number and distribution of Aleutian cackling geese, to provide for optimal aesthetic, educational, scientific, and hunting uses throughout their range (Pacific Flyway Council 1999a).

The refuge lies within the primary wintering area of cackling geese in northwestern Oregon and southwestern Washington. Willapa NWR and surrounding fields adjacent to Willapa Bay provide the principal migratory stopover habitat in Washington State (Kraege 2005). The Refuge typically supports several hundred wintering cackling geese. Refuge practices discussed in the CCP, including mowing of pasture, estuarine restoration, and freshwater wetland management, provide considerable goose foraging habitat. The Refuge also provides sanctuary from disturbance.

1.7.3.5 Pacific Flyway Management Plan for the Pacific Population of Brant

The Pacific brant subspecies breeds in the western Arctic of North America. In the early 1980s a dramatic decline and redistribution of Pacific brant occurred in western Alaska, a particularly important breeding region for this population. The three-year mean population estimate for Pacific brant is 88% of the Plan goal. The Pacific brant population is presently considered stable. A population objective of 12,000 wintering birds was established, and the 2008 population estimate based on an index derived from midwinter surveys totals 24,972.

1.7.3.6 Pacific Flyway Management Plan for the Pacific Population of Dusky Canada Goose

The goal of this management plan is to maintain and enhance the dusky Canada goose population. The objectives of the plan include 1) sustaining a population of between 10,000 to 20,000 geese, as measured by indices of geese on Copper River Delta and Middleton Island; 2) managing and improving breeding ground habitat conditions to achieve average annual production of 20% young, measured as the most recent 10-year average; and 3) maintaining and enhancing wintering and migration habitats in sufficient quantity and quality; and 4) managing wintering habitat to provide optimum food, water, and sanctuary conditions, and to provide optimum geographical distribution, with an emphasis on habitat objectives outlined in the Northwest Oregon/Southwest Washington Canada Goose Agricultural Depredation Control Plan (Pacific Flyway Council 1998).

1.7.3.7 Washington Natural Heritage Plan

The Washington Natural Heritage Plan is a product of the Washington Natural Heritage Program, whose mission is to conserve the full range of Washington's native plants, animals, and ecosystems through voluntary and cooperative action. The program uses science to identify high-quality and representative examples of native Washington habitats and species and works to protect these natural treasures through voluntary and cooperative habitat conservation agreements.

The Washington Natural Heritage Plan and Program:

- Describe the components of Washington's natural heritage and biodiversity;
- Identify natural areas of exceptional value for conservation;
- Provide opportunities for voluntary conservation on both public and private lands;
- Emphasize creating partnerships to enhance the capacity to have a positive conservation impact.

Areas of Critical Environmental Concern, Wilderness Areas, National Monuments, local preserves, and other public lands with management plans that adequately protect Washington's natural heritage are now included with RNAs and preserves as providing complete or partial protection for some ecosystems and species. For National Wildlife Refuges, the plan recommends that RNAs be established to protect natural areas of exceptional value (particularly those areas that are unique, and have no similar examples protected elsewhere). Leadbetter Point, Diamond Point, and the Cedar Grove are all designated RNA sites on the Refuge.

1.7.3.8 Washington Comprehensive Wildlife Conservation Strategy/Washington Wildlife Action Plan

In response to two Federal programs—the Wildlife Conservation and Restoration Program and the State Wildlife Grant Program—the Washington Department of Fish and Wildlife (WDFW) prepared a wildlife action plan (WAP) as part of the Comprehensive Wildlife Conservation Strategy. The WAP includes information on the distribution and abundance of priority wildlife and habitats; provides strategies for conserving and monitoring wildlife and habitat; and provides for coordination with Federal, state, Tribal, and local agencies, and the public. The WAP emphasizes proactive measures to conserve declining species and habitats, and to maintain the status of common species.

At least 32 species identified as "species of greatest conservation need" in the Washington Wildlife Action Plan (WDFW 2005) occur on the Refuge, including the streaked horned lark, western snowy plover, marbled murrelet, Dunn's salamander, Van Dyke's salamander, Columbia torrent salamander, and western pearlshell mussel.

1.7.3.9 South Willapa Bay Conservation Area—Forest Landscape Restoration Plan

In July 2003, The Nature Conservancy (TNC) and the Willapa NWR began a collaborative effort to design and develop a mutual forest management plan with goals and objectives on properties managed by both parties in Pacific County, Washington. The South Willapa Bay Forest Landscape Restoration Plan (Churchill et al. 2007) states the intent of management within the South Willapa Bay Conservation Area (SWBCA) is to restore self-sustaining, natural, ecological processes and healthy forest and stream systems, as opposed to engineering or manipulating habitats to meet specific structural or compositional targets.

Restoration actions, or active management, will primarily include:

1) Carefully designed density management (i.e., thinning) within young-managed forest stands (< 90 years old) to promote forest growth and the development of habitat complexity,
2) Removal, or repair of high risk forest roads, and
3) Improvement to the existing forest road network to minimize impacts to water quality.

Refuge goals related to forest management include:

1) To preserve and protect unique ecosystems associated with Willapa Bay.
2) To manage for the conservation and recovery of threatened and endangered animals in their natural ecosystems.

Under these goals the Refuge has developed specific objectives related to the forest management program.

1) Restore ecological function to Refuge forests by creating a natural distribution of stand structure, composition, and successional stages while promoting old-growth/late successional characteristics to benefit forest dependent wildlife—especially the marbled murrelet.
2) Decommission unnecessary forest roads to reduce/eliminate stream impacts and fragmentation of forest habitat.

3) Adopt forest management practices designed to change fire-prone thickets of western hemlock over a period of time to something that structurally resembles old-growth and reduces fuel loads.
4) Protect, and where appropriate, restore associated stream habitat to prevent further declines of anadromous fish stocks and enhance native amphibian populations and other stream-dependent wildlife species.
5) Reduce risk from insects and disease where epidemics are likely.

1.8 The Planning Process

A core planning team, consisting of a project leader, biologist, public use planner, the refuge manager, and a regional refuge conservation planner, began developing the CCP in 2008. An extended team assisted in development, particularly in providing comments at key milestones. The extended team consisted of various professionals from other agencies (WDFW, Washington Department of Natural Resources [WDNR]) and within Service. A list of the core team members and their experience is located in Appendix D.

Early in the planning process, the team identified the priority species, groups, and communities for this Refuge. These priorities were also called "conservation targets," and most of the biological emphasis of the CCP is focused on maintaining and restoring these targets.

Public use planning centered on developing goals, objectives, and strategies around the wildlife-dependent public uses. Other non-wildlife-dependent uses that currently occur were also addressed.

Public scoping began in March of 2008. Scoping meetings were held in South Bend and Ilwaco, Washington. Public commentary was also solicited through distribution of a planning update to the Refuge's CCP mailing list, refuge visitors, and other interested parties. A complete summary of public involvement can be found in Appendix E.

1.9 Issues, Concerns and Opportunities

Issues are defined as matters of controversy, dispute, or general concern over resource management activities, the environment, land uses or public use activities. Issues are important to the planning process because they identify topics to be addressed in the CCP, pinpoint the types of information to gather, and help to define alternatives for the CCP. Various issues, concerns, and opportunities were raised by the public as well, and all are addressed in some manner in the draft CCP.

It is the Service's responsibility to focus planning and EIS analysis on the major issues. Major issues typically suggest different actions or alternative solutions and are considered within the Refuge's jurisdiction. The major issues may have either a positive or negative effect on the resource. Major issues will influence the decisions proposed in the plan.

The core planning team discussed and presented preliminary issues to the public during public scoping. These preliminary issues were thought to be potential issues of concern for the public. Some of the preliminary issues presented to the public may have been revised or played a minor role or were eliminated from further consideration as a major issue.

Although CCPs are comprehensive plans, no single plan can cover all issues. One issue identified as being outside the current plan is *Spartina* eradication; the Service has implemented the *Spartina* Eradication Control Plan.

Presented below are a brief series of questions presented to the public, designed to open up discussion for each topic. Following the questions were brief descriptions of the major issues, concerns, and opportunities, some of which are presented below. These and other issues identified are later addressed in greater detail within this CCP/EIS.

1.9.1Wildlife and Habitat

1.9.1.1 Estuarine Restoration

Is estuarine (tidal marsh) restoration a desirable action? If it is, on which refuge units should restoration be considered? Which units, if any, should remain under current management practices?

Estuarine restoration is being considered as part of this CCP. This is being considered so that the Refuge can restore a more naturally functioning ecosystem to the bay. To date, we have restored tidal marshes at Headquarters, Bear River tributaries, and on Long Island. One of the larger refuge units, which consists of approximately 800 acres of former tideland located in the South Bay, is protected by dikes and tide gates. This area is managed primarily for waterfowl, and in some cases for salmonids and amphibians. In this draft CCP/EIS, the Refuge will be looking at the implications of restoring this area to a native salt marsh.

1.9.1.2 Western Snowy Plover Protection

What management actions would better protect western snowy plovers from disturbance and predation, while measures to protect and restore habitat are occurring?

The western snowy plover is threatened throughout its range by loss and disturbance of habitat and nesting sites. The primary threats to the snowy plover are habitat degradation caused by human disturbance, urban development, beach grass introduction, and predators. The plovers nesting on the Leadbetter Point Unit face direct losses of nests and fledglings due to predation, particularly by crows and ravens, resulting in poor hatching and fledging success rates for western snowy plovers.

1.9.1.3 Forest Management

What forest management practices should be implemented to restore forest complexity and biodiversity?

Forest lands in the Willapa Bay area, including the Refuge, are dominated by second- and/or third-growth forests, very little old-growth or late-successional forest exists. The quantity, distribution, and quality of the forest community has been significantly altered due to past timber harvest practices. These changes have invariably affected the structure of the wildlife community associated with this forest landscape. A variety of wildlife is dependent on these forest types, including the federally threatened marbled murrelet. The lack of late-successional/old-growth forest habitat is one reason for the disappearance of the spotted owl from the Refuge. Forest streams also provide habitat for anadromous fish such as Chinook, coho, and chum salmon, and sea-run cutthroat trout, making stream restoration a necessary part of forest management efforts. Due to the degraded nature of the Refuge's forests, and those in the surrounding areas, a major effort is needed to restore these forests to a semblance of their natural state.

1.9.2 Land Protection Planning

1.9.2.1 Refuge Boundary Expansion

Should expansion of the refuge boundary be considered, and if so, what lands and under what circumstances should the Service consider boundary expansion?

Willapa Refuge currently encompasses approximately 16,000 acres in fee title and includes easements located primarily in the South Bay and on the tip of Leadbetter Peninsula. In 1999, the Service expanded the Refuge's acquisition boundary by 2,200 acres. Since then we have acquired approximately 1,700 acres from willing sellers. A large increase in the amount of land acquired by nonprofit organizations for conservation purposes has occurred in Pacific County, and many groups have expressed interest in strategically expanding the Refuge's boundary to include sensitive habitats in need of protection.

1.9.3 Public Use and Access

1.9.3.1 Wildlife-dependent Recreational Uses

Should the Refuge's wildlife-dependent recreational uses be expanded or reduced? What opportunities are available that would satisfy public needs while conserving resources?

The refuge currently provides opportunities for high-quality, wildlife-dependent recreational uses that highlight the coastal dunes, open bay waters, salt marshes, mudflats, grasslands, and old-growth forests. The refuge is open to the public for a variety of uses, including hiking trails, hunting programs (waterfowl, deer, elk, and bear), wildlife observation, clamming, fishing, beach activities, and camping. An opportunity exists to expand and provide additional quality elk hunting opportunities by opening the Leadbetter Point Unit, South Bay Units, and other areas to be included in Washington State's elk hunting season. School groups enjoy environmental education programs both on and off the Refuge. Visitors are introduced to the Refuge's resources through various interpretive exhibits located on the Refuge. A proposed visitor/office and maintenance facility would allow for increased on-site interpretation and environmental education programs.

Chapter 2

Alternatives, Goals, Objectives, and Strategies

Western pearlshell mussel
USFWS

Chapter 2. Alternatives, Goals, Objectives, and Strategies

2.1 Considerations in Alternative Design

During development of the CCP alternatives presented in this chapter, the Service reviewed and considered a variety of resource, social, economic, and organizational aspects important for managing the Refuge. As is appropriate for a National Wildlife Refuge, resource considerations were fundamental in designing alternatives. House Report 105-106 accompanying the NWRS Improvement Act of 1997 (Public Law 105-57) states that "the fundamental mission of our System is wildlife conservation: wildlife and wildlife conservation must come first."

The Service planning team reviewed and used available scientific information (reports and studies) to better understand ecosystem trends and the latest scientific recommendations for species and habitats. The team also met with staff from local, state, and Federal agencies, and elected officials to ascertain priorities and problems as perceived by others. Refuge staff also met with refuge users, nonprofit groups, and community organizations to ensure their comments and ideas were considered during CCP development.

The details of public participation can be found in the Scoping Report (Appendix E). During development of the alternatives, the planning team considered the actions detailed below.

2.2 Draft Alternative Descriptions

Each alternative describes a combination of habitat and public use management prescriptions designed to achieve the Refuge's purpose, goals, and vision. These alternatives provide different ways to address and respond to major public issues, management concerns, and opportunities identified during the planning process. All of the major issues, activities, and management concerns were evaluated and addressed for each alternative and are shown in the corresponding maps found in this chapter. A summary of the key differences between the alternatives is presented in Table 2-1 at the end of this chapter.

2.2.1 Alternative 1: Continue Current Management Activities

This alternative assumes no change in current ongoing management programs and is considered the baseline (status quo) from which to compare other alternatives in this plan. Under this alternative, all refuge management programs consistent with available funding and staffing would continue. No significant changes would be initiated by the Service. Current refuge management programs are described throughout the draft CCP/EIS. Although the Refuge currently has no integrated plan to guide the management of all of its resources and programs, current management efforts on the Refuge focus on the protection of the Service's trust species (e.g., threatened and endangered species, migratory birds), the continued maintenance/enhancement of their habitats, and the management of wildlife-dependent recreational use of refuge lands. Current management of the Refuge is guided by the following existing plans:

1) Forest Management Plan (2007)
2) Water Management plan (annual)
3) Willapa National Wildlife Refuge Fire Management Plan (2006)

4) Willapa National Wildlife Refuge Management Plan
5) Habitat Management Plan (2005)
6) Refuge Hunt Plan
7) Refuge Safety Plan
8) Refuge Public Use Plan

In addition to the refuge plans listed above, other existing documents have provided management direction for the Refuge including the Recovery Plan for the Threatened Marbled Murrelet (USFWS 1997a), The Recovery Plan for the Pacific Coast Population of the Western Snowy Plover (USFWS 2007a), Range-wide Streaked Horned Lark Assessment and Preliminary Conservation Strategy (Pearson and Altman 2005), Conservation Strategy for Pink Sandverbena (Kaye 2003), Oregon Silverspot Butterfly revised Recovery Plan (USFWS 2001a), and other regional and state plans such as those used in Table 4-1.

2.2.1.1 Habitat and Wildlife

The Refuge maintains approximately 5 miles of constructed dikes in the south end of the bay. This area was constructed and has been extensively managed since the 1950s for freshwater wetlands to support migratory waterfowl. This area supports a regulated waterfowl hunting program, with approximately 500 hunter visits using these wetland areas during the waterfowl hunting season.

At 270 acres, the Long Island Unit has one of the largest remaining contiguous tracts of old-growth forest in southwest Washington. Most of the island forest was extensively logged prior to refuge ownership. Today, the refuge staff in partnership with TNC have developed and implemented a Forest Management Plan (Appendix K). The ongoing forest restoration efforts set the stage for enhancing the trajectory toward old-growth forest qualities for all the second- and third-growth forests currently on the Refuge and adjoining TNC lands. Forest road decommissioning is also a large part of this restoration plan.

The western snowy plover (a federally threatened species) uses local beaches and refuge lands for migrating overwintering and for nesting habitat in the summer months. In recent years, the Refuge has restored and maintained over 200 acres of coastal dunes that has increased the available nesting habitat for these birds. Refuge staff have maintained nest exclosures (a type of wire cage with openings for western snowy plover) to reduce predation from avian and mammalian predators. In Washington, the Refuge supports the greatest nesting population of western snowy plover but the fledgling success rate is likely low primarily due to predation issues (Pearson et al. 2009; USFWS 2007a). Other impacts to the nesting success of these birds are identified and described in detail in Chapter 4. An added benefit to the restoration of the dune habitat was the discovery of pink sandverbena (threatened plant species) formerly thought to be extirpated from the state of Washington and now is found throughout this restoration site.

2.2.1.2 Visitor/Administrative and Maintenance Facilities

Under the No Action Alternative, a replacement headquarters facility would not be constructed, and the Willapa Refuge would continue to operate with deficient and inadequate facilities at its current location. Local water supplies would continue to be undrinkable and purchased drinking water would be provided for staff use. Visitor restrooms would continue to be located in the parking area with a vault system that requires daily maintenance and routine pumping. Since the current office facility is a 1930s home, many of the building systems are deteriorated, inefficient and extremely difficult to upgrade. Funds will be expended to make the office minimally acceptable; however, the current site does not justify a large investment of funds because of potential impacts to marbled murrelet habitat and the adjacent stream. The existing headquarters facility would continue to deteriorate over time and be prone to violating health and other state environmental regulations.

Willapa Refuge staff would continue to experience space limitations, and the inefficiencies associated with working in a crowded, inadequate office environment. Vehicular traffic safety issues associated with the headquarters location on U.S. Highway 101 across from a public boat launch would continue to be of concern. Maintenance facilities and storage would continue to be located in three different sites on the Refuge which is inefficient and challenging for staff and for security. The Service has determined that this alternative does not meet the long-range facility requirements, or the Service's mission and environmental goals related to conservation and management of wildlife habitat.

2.2.1.3 Public Use and Recreation

The Leadbetter Point Unit currently offers opportunities for public access to the ocean beach through several trails from the refuge parking lot. Visitors are introduced to the unit and its resources with an informational kiosk and refuge brochures. The cutthroat trout trail and salmon art trails along with trails on Long Island are described further in Chapter 5. The refuge currently supports wildlife-dependent public uses such as waterfowl and big game hunting programs; details of the current programs can be found in Chapter 5.

2.2.1.4 Acquisition Boundary

The Refuge's current acquisition boundary (Map 2) encompasses approximately 16,000 acres, and there are approximately 750 acres within the Refuge's acquisition boundary that are privately held lands. The Refuge will continue to pursue acquisition of these lands, if and when they are available and funding is available to purchase them.

The Shoalwater Bay Unit was one of the first large units set aside in 1937. At the time, the habitat of this unit was upland and beach habitat located in the far north portion of the bay on the mainland. This area of the Refuge has since eroded away due to ocean and bay wave action over the past 73 years; it is now for the most part submerged under water. No management activities occur here. The Wheaton Unit (132 acres) was given to the Refuge through the Farmers Home Administration and was at one time a privately held farm; it is located approximately 42 miles from the Refuge. Currently there is a contract agreement to maintain the pastures on the Wheaton Unit through a grazing permit with a private farmer.

2.2.2 Alternative 2: Healthy Wildlife Habitats, Endangered Species and Biodiversity Gains, Focused Refuge Expansion, and Expanded Public Use

Alternative 2 has been selected as the preferred alternative. This alternative would expand upon Alternative 1 (current management activities) by implementing these additional programs and activities.

2.2.2.1 Habitat and Wildlife

Alternative 2 would restore approximately 749 acres of historic estuarine habitats (open water, intertidal flats, and salt marsh) on refuge lands, by removal of all or strategic portions of the dike system in the Lewis, Porter Point, and Riekkola Units. Short-grass fields at the Riekkola Unit (212 acres) would be restored to estuarine habitat and the remaining managed freshwater wetlands would be located solely at the Tarlatt Unit.

The Refuge currently maintains and protects 33 acres of grassland habitat on the Tarlatt Unit; this alternative proposes 15-33 acres of grassland restoration for the benefit of the Oregon silverspot butterfly. Restoration activities would require establishment of a thriving self-sustaining population of the native, host plant species (i.e., early blue violet, tufted hairgrass, red fescue) on the Tarlatt Unit (future potential acreage at the Leadbetter Point Unit may be considered). Reintroduction of adult butterflies and larva would be initiated only when sufficient quality habitat has been restored and successfully established (based on expert knowledge).

Under this alternative, predator management would be implemented annually for the protection of western snowy plovers, particularly nests and fledglings on Leadbetter Point. Initiating a predator management program would likely increase the fledgling success rate and adult survival of the federally threatened, state endangered species as described in detail in Appendix L, Predator Management Plan.

In this alternative, avian and mammalian predators (i.e., crows, ravens, skunks, raccoons) present on Leadbetter Point Unit during nesting season March through August would be removed by (refuge staff, Wildlife Services) using lethal control methods. Current protection efforts and techniques including nest exclosures would also be used. Other benefiting species would include the Federal candidate, state endangered streaked-horned lark, which is a ground-nesting bird subject to the same predation threats as the western snowy plover (Pearson and Hopey 2005). A proposed increase in refuge law enforcement presence, educational outreach information, and boundary fencing and signage would be implemented to inform the public of the necessity to keep clear of and protect the bird nesting areas.

Inventories, monitoring, research, and studies in support of refuge management decisions would receive greater emphasis. Staff would work to recruit students from universities (when feasible) to assist with necessary research and monitoring activities; research would be designed to support refuge resource management activities.

2.2.2.2 Visitor/Administrative and Maintenance Facilities

The preferred alternative proposes the construction and operation of a replacement headquarters complex, including a new Visitor/Administrative Building and a Maintenance Area, consisting of four shop and/or equipment storage buildings (see Draft Site Plan in Appendix P). It will serve as the new headquarters for the Willapa Refuge Complex to better manage the refuges that are part of the complex and provide increased accessibility for the visiting public.

The proposed replacement headquarters facility would be located on a parcel owned by the Service on the Long Island Peninsula in Pacific County near the City of Long Beach, Washington (Map 3). The site is located within the Tarlett Unit along Sandridge Road south of the intersection with 95th Street. The site has approximately 1,250 linear feet of frontage along Sandridge Road and approximately 2,000 linear feet of frontage along 95th Street.

Approximately 29 acres of land area exists at the proposed replacement headquarters site which would be adequate for the relocated facilities proposed. The proposed site currently consists of grassland, emergent wetlands, estuarine wetlands associated with Tarlett Slough, and patches of native remnant woodland vegetation. Tarlett Slough winds through the property, generally flowing in a northerly direction, and makes a bend to the east within the property. It is a major stormwater drainage channel for Pacific County, draining the southeastern portions of the Long Beach Peninsula into Willapa Bay. It is anticipated that the total development zone would be approximately 5 acres.

The alternative proposes to construct a new Visitor/Administrative Building. Based upon the USFWS's Standard Suite of Facilities prototypes for a Small Visitor Facility and a Medium Two-story Administration Building, the new building size would be approximately 11,000 square feet. This facility would become the Willapa Refuge's permanent administrative office with staff offices for up to 21 Service staff, not including interns. In addition, volunteers who are involved in day-to-day activities would be provided space in the building. The Visitor Center will house a gift shop, a substantial lobby area, and an orientation multi-purpose room for interpretive exhibits or events. The new facility would also be available to host community and environmental education events.

It is anticipated that site development for the visitor/administrative building would require approximately 2 acres and would include the following supporting elements:

- Entrance/welcome plaza space
- Delivery/service/garbage area
- Outdoor space for staff (near employee entrance)
- Outdoor group gathering space with overhead shelter for up to 60 people
- Outdoor nature play area
- Five or six smaller breakout outdoor gathering spaces for smaller groups
- Outdoor area to set up event tents
- Outdoor interpretive display areas integrated with natural environment
- Wildlife observation platform
- Pedestrian bridge over Tarlett Slough
- Paths and trails to connect to South Bay overlook and Dike System Trail
- Entrance driveway and site circulation pavement
- Vehicular circulation to accommodate up to a straight body truck
- Staff parking area for approximately 10 cars
- Visitor parking area for up to 55 cars
- Three bus/RV parking spaces

A new trail would be constructed from the new Visitor/Administration Building approximately 1 mile to a new South Bay overlook, offering enhanced opportunities for wildlife observation, photography, and interpretive/hiking trails in the South Bay. An additional parking lot and new boat launch (car-top boats only) would be located on 67th Street at Doman Creek for South Bay access.

Construction of a new and consolidated Maintenance Area would require additional land development area of approximately 2.3 acres at the Sandridge Road site, including a bone yard area of approximately 5,800 square feet. Seven new buildings are proposed for the Maintenance

Area. Building 1 is proposed to be a new Shop Building of approximately 4,800 square feet. This building would provide space for vehicle maintenance, a wood shop, and general Willapa Refuge maintenance functions, and would include two pull-through bays and one single access bay. Building 1 includes an open office component with four work stations and a conference room. Buildings 2 and 3 are proposed to be Equipment Storage Buildings of approximately 4,900 square feet of space each. Building 4 is proposed to provide Boat Storage at approximately 5,670 square feet. Building 5 is proposed to provide additional Small Equipment Storage at approximately 1,260 square feet. Building 6 would be a carport utilized for fleet vehicles (2,600 square feet), and Building 7, at approximately 150 square feet, is proposed to house hazardous materials.

Associated site development for the Maintenance Area would also include the following supporting elements:

- Vehicular circulation to accommodate up to a conventional semi trailer
- Site circulation pavement
- Separate driveway entrance
- Fleet parking for up to 20 vehicles
- Staff parking for up to 15 vehicles
- Equipment washing area (associated with Shop Building)
- Fuel pumps: one with 550 gallons of gasoline and one with 1,000 gallons of off-road diesel

A new headquarters would provide a more central location for Willapa Refuge management activities. Willapa Refuge management would benefit by consolidating the multiple maintenance facilities (shops, storage, warehouses) located in three areas of the Refuge. Having the equipment and staff centrally located would cut down on extensive building maintenance and utility expenses. The Sandridge Road site would provide safer highway access for large refuge vehicles as compared to the current headquarters site along U.S. Highway 101. The intersection of Sandridge Road and 95th Street would be improved to provide sufficient turning radii for large vehicles.

Other potential off-site improvements would include a southbound left-turn lane and a northbound right-turn lane at required driveway access points onto Sandridge Road. A northbound right-turn taper on Sandridge Road at 95th Street may also be required.

All of the replacement headquarters buildings would meet health and safety standards/ regulations providing for staff and visitor necessities (drinking water, sewer system, power, telecommunications, and data service). With a Pacific County Public Utilities District (PUD) substation and office bordering the site to the north, providing power to the site will be easily accomplished. Water can likely be obtained through rainwater harvesting and underground well(s), or through the extension of the water main along Sandridge Road. There are no public sewer mains in this region. Neighboring and surrounding properties use on-site septic systems to dispose of sanitary waste. The replacement headquarters project will be required to build a new septic system for the new building sewer services. Most likely a sanitary sewage treatment system with a sand mound drain field will be required. Stormwater runoff from the proposed development will need to be separated from sanitary flows. Stormwater management facilities for detention and water quality will likely be required for this type of development and are easily facilitated on the site.

Buildings at the replacement headquarters facility are proposed to be designed and constructed to meet or exceed energy efficiency standards for the Leadership in Energy and Environmental Design (LEED) Green Building Rating System. Site design will strive to incorporate sustainable site design concepts such as integrating aboveground stormwater management facilities with site grading, minimizing overall site grading, and incorporating native or climate-adaptive (low water consumptive) plant materials into facility landscaping. Buildings and landscape will be designed to reflect the rural, coastal vernacular. Site design will include the enhancement of wetland buffer zones by revegetation with native plant materials, the relocation and mitigation of one site drainage feature, and the restoration of local woodland, shrub, and wetland plant communities on the site. This landscape and entry sequence through a restored natural environment will create a compelling setting for future visitor experiences at the Refuge.

It is anticipated that the new headquarters at this site would attract a greater number of visitors due to the location in proximity to various peninsula communities and the main access road (Sandridge Road) to the Leadbetter State Park and the Refuge's Leadbetter Point Unit. The Refuge anticipates an increase in visitors from approximately 60,000 to an estimated 150,000 annually due to the increased visibility of the Refuge headquarters and future site use programs. In addition, site development would accommodate a pedestrian/bicycle connection on the site to the City of Long Beach most likely via Pioneer Street at the south end of the property.

Prior to development, the Wetlands Reserve Program designation would be removed from the proposed headquarters complex land area.

Upon completion of the replacement headquarters development, the existing headquarters complex would be deconstructed, decommissioned, and the site restored for wildlife habitat. The Salmon Art Trail at the headquarters site will remain.

2.2.2.3 Public Use and Recreation

The Refuge currently provides 2,894 acres available for waterfowl hunting on Leadbetter Point and the South Bay Units. Under this alternative, in the South Bay only, waterfowl hunting (geese included) would be expanded to 6,058 acres once the proposed estuarine restoration project is completed.

The Refuge currently has 8,020 acres available for big game hunting. Under this alternative, Long Island would continue as currently opened to archery only for the take of grouse, bear, deer, and elk. All mainland properties and existing open portions of the Headquarters Unit and Bear River Unit would also continue as they are now open to the take of bear, deer, and elk in accordance with WDFW regulations. Expansion of elk and deer hunting opportunities on the Refuge under this alternative (see Appendix M) would include approximately 1,700 acres on the Leadbetter Point Unit (permit only muzzleloader hunt and as necessary an expanded permit only elk hunt); South Bay Units and East Hills Units would include elk and deer hunting as refuge expansion opportunities occur. All new hunting opportunities would be developed and implemented in coordination with WDFW.

Under Alternative 2, the exisiting camping opportunities on Long Island would be maintained to facilitate archery hunting, photography, and other wildlife-dependent recreation experiences.

2.2.2.4 Acquisition Boundary

Under this alternative, the land acquisition boundary would be adjusted to include 1,909 acres in the Nemah and Naselle areas and 561 acres in South Bay and 4,334 acres in the East Hills (Appendix A). This acreage is designed to provide maximum protection of the watershed and habitat adjacent to Willapa Bay and current refuge boundary. This expansion effort would maximize the opportunities for forest restoration efforts in a holistic landscape and ecosystem manner.

The Shoalwater Bay Unit and Wheaton Unit would be divested from the Refuge.

2.2.3 Alternative 3: Partial Restoration of Habitats, Endangered Species Recovery, Limited Refuge Expansion, Moderate Public Use

This alternative would be the same as Alternative 1 (current management activities) with the following additional activities and programs.

2.2.3.1 Habitat and Wildlife

Under this alternative the Refuge would pursue estuarine (open water, intertidal and salt marsh) restoration at a reduced level of 429 acres, to benefit salmonids, Pacific brant and other waterfowl, shorebirds, and a diverse assemblage of other native species. The proposed restoration efforts, which consist of breaching or removing dikes, would occur on the Lewis and Porter Point units only.

The refuge currently has 878 acres of open water and channel habitat. Under this alternative, open water and channel habitat and 4,180 acres of intertidal flats within the Refuge would not change. Salt marsh habitat within the Refuge (1,636 acres) would be increased on the Refuge by 429 acres by removing the dikes in the Lewis and Porter Point units only.

By breaching or removing the dikes in the Lewis and Porter Point units, the remaining 25 acres of seasonal, managed freshwater wetlands would be located on the Riekkola and Tarlatt units.

At the Leadbetter Point Unit in the coastal dune habitat, predator management would be initiated to increase the fledgling and adult survival of the federally threatened, state endangered western snowy plover and enhance survival of the streaked horned lark, a Federal candidate species and state endangered species. Only methods to manage avian predators would be used in this alternative. Use of predator exclosures would continue but could be reduced if other predator management actions are implemented (see Appendix L, Predator Management Plan).

The Refuge currently has 33 acres of grassland habitat. Under this alternative, grassland restoration actions for enhancing the Oregon silverspot butterfly habitat would occur and would include habitat restoration at the Tarlatt Unit (10-33 acres) and potential additional acreage at the Leadbetter Point Unit. Reintroduction (see Section 2.4.6.2) of adult butterflies and larva would be initiated when sufficient quality habitat (see Section 2.4.5.2) has been established (based on expert knowledge).

2.2.3.2 Visitor/Administrative and Maintenance Facilities

Under this alternative, construction and operation of a replacement headquarters complex would be the same as described in Alternative 2, the preferred alternative.

2.2.3.3 Public Use and Recreation

The refuge currently has 2,894 acres available for waterfowl hunting at the Leadbetter and South Bay units. Under this alternative, waterfowl hunting would be expanded to 5,450 acres through estuarine restoration (Lewis and Porter Point units). The area within the Presidential Proclamation Boundary would remain closed to waterfowl hunting.

The refuge currently has 8,020 acres available for big game hunting. Under this alternative, Long Island would remain archery only and continue to be open to bear, deer, and elk hunting. The Teal Slough Unit and existing open portions of the Headquarters Unit and Bear River Unit would be open to bear, deer, and elk hunting in accordance with state regulations. Expansion of elk hunting opportunities would occur at the Leadbetter Point Unit (approximately 1,700 acres) to include a regulated permit elk hunt, the same as under Alternative 2. Camping on Long Island would continue similar to the the other alternatives.

2.2.3.4 Acquisition Boundary

Under this alternative, within the approved land acquisition boundary, 561 acres would be acquired in the South Bay and 4,334 acres in the East Hills (Map 4). This acreage would protect the watershed and habitat adjacent to Willapa Bay. Opportunities for increased big game hunting would occur with future refuge additions in the East Hills and South Bay units. Under this alternative, the Shoalwater Bay and Wheaton units would also be divested from the Refuge.

2.3 Features Common to All Alternatives

All of the alternatives contain some common features. To reduce the length and redundancy of the individual alternative descriptions, common features are presented below.

2.3.1 Implementation Subject to Funding Availability

Under each alternative, actions would be implemented over a period of 15 years as funding becomes available. It is the intent of the planning team that annual priorities would follow the final CCP guidelines, although funding initiatives, unforeseeable management issues, and budgets, may vary from year to year. The CCP will be reviewed every five years and updated as necessary throughout its life.

2.3.2 Refuge Revenue Sharing Payment

Under the Uniform Relocation Assistance and Real Property Acquisition Policies Act, as amended, landowners who sell their property to the Service are eligible for certain benefits and payments including: reimbursement of reasonable moving and related expenses or certain substitute payments; replacement housing payments under certain conditions; relocation assistance services to help locate replacement housing, farmland, or business property; and reimbursement of certain necessary and reasonable expenses incurred in selling real property to the Federal government.

Under provisions of the Refuge Revenue Sharing Act (Public Law 95-469), the Service would annually reimburse Pacific County for tax revenue which is lost as a result of the Services acquisition of private property. This law states that the Secretary of the Interior (Secretary) shall pay to each county in which any area acquired in fee title is situated, the greater of the following amounts:

- An amount equal to the product of 75 cents multiplied by the total acreage of that portion of the fee area that is located within such county.
- An amount equal to three-fourths of one percent of the fair market value, as determined by the Secretary, for that portion of the fee area that is located within such county.
- An amount equal to 25 percent of the net receipts collected by the Secretary in connection with the operation and management of such fee area during such fiscal year. If a fee area is located in two or more counties, however, the amount for each county shall be apportioned in relationship to the acreage in that county.

Some payments to the counties have been less than the legislated amounts because of governmental funding deficits. Congress may appropriate, through the budget process, supplemental funds to compensate local governments for any shortfall in revenue sharing payments. The Refuge Revenue Sharing Act requires Service lands be reappraised every five years to ensure that payments to local governments remain equitable. Payments under this Act would be made only on lands that the Service acquires in fee title. On lands where the Service acquires only partial interest through easement, all taxes would remain the responsibility of the individual landowner.

2.3.3 Western Snowy Plover Recovery Plan

On March 5, 1993, the Pacific coast population of the western snowy plover was listed as threatened under provisions of the Endangered Species Act of 1973, as amended (16 U.S.C. 1531 *et seq.*) The Pacific coast population is defined as those individuals that nest within 50 miles of the Pacific Ocean on the mainland coast, peninsulas, offshore islands, bays, estuaries, or rivers of the United States and Baja California, Mexico (USFWS 2007a). Of the six Washington locations identified in the recovery plan as breeding areas, only two are currently occupied. The largest is located at the Leadbetter Point Unit of Willapa NWR. Recommendations and recovery actions identified in the western snowy plover recovery plan were considered in the development of this CCP and are described in further detail in Sections 2.5.6.1 and 4.9.2, and protection efforts are outlined in Appendix L.

2.3.4 Oregon Silverspot Recovery Plan

The federally threatened Oregon silverspot butterfly (*Speyeria zerene hippolyta*) previously inhabited coastal habitat from northern California to southern Washington. It is now extirpated from Washington State and is state listed as endangered. It is found on only a few sites in California and Oregon. No Oregon silverspot butterflies have been documented on the Long Beach Peninsula since 1990 (USFWS 2001a). The Service will work toward establishing one or more healthy sustainable populations of Oregon silverspot butterfly, in accordance with recovery goals described in the revised recovery plan (USFWS 2001a).

2.3.5 Recovery Plan for the Marbled Murrelet (Washington, Oregon, and California Populations)

The Washington, Oregon, and California population segment of the marbled murrelet (*Brachyramphus marmoratus*) was federally listed as threatened on September 28, 1992 (USFWS 1992a) due to the high rate of nesting habitat loss and fragmentation, and mortality associated with net fisheries and oil spills. The marbled murrelet is state listed as threatened in Washington. The Federal marbled murrelet recovery plan identifies southwest Washington as a significant gap in suitable nesting habitat along the Pacific Northwest Coast (USFWS 1997a). Increasing available habitat in this area is critical to expanding the geographic distribution of the murrelet within its threatened range (Raphael et al. 2008). Unlike most other regions within the range of the murrelet, this area has limited forested Federal ownership with large blocks of intact habitat. Therefore, improving both Federal and non-Federal forests in southwest Washington is critical to marbled murrelet recovery (Raphael et al. 2008).

2.3.6 Forest Landscape Restoration Plan

TNC and the Service have developed a forest landscape restoration plan in partnership, to restore young-managed forestlands at a landscape scale across TNC's Ellsworth Creek Preserve and the neighboring Willapa National Wildlife Refuge. The plan is discussed in this CCP/EIS and is located in Appendix K.

2.3.7 Willapa NWR Fire Management Plan

The 2003 Willapa National Wildlife Refuge Fire Management Plan details how the Refuge will respond to the threat of wildfire and determine what circumstances the refuge staff is to use fire as a tool on refuge lands.

2.3.8 Tribal Coordination

Regular communication with Native American Tribes that have an interest in the Refuge would be common to all alternatives. The Shoalwater Bay Tribe and the Refuge will coordinate and consult on a regular basis regarding issues of shared interest. The Service will also seek assistance from the Tribe as necessary for issues related to both the Native American Graves Protection and Repatriation Act and National Historic Preservation Act (NHPA).

2.3.9 Wilderness Review

The Service's CCP policy requires that a wilderness review be completed for all CCPs. If it is determined that the potential for wilderness designation is found, the process moves on to the wilderness study phase. As part of the process for this draft CCP/EIS, the planning team completed an initial wilderness review (Appendix G) and found that currently there are no lands on the Refuge that meet the basic wilderness criteria.

2.3.10 Integrated Pest Management (IPM)

In accordance with 517 DM 1 and 7 RM 14, an integrated pest management (IPM) approach would be used, where practicable, to eradicate, control, or contain pest and invasive species (herein collectively referred to as pests) on the Refuge. IPM would involve using methods based upon effectiveness, cost, and minimal ecological disruption, which considers minimum potential effects to non-target species and the refuge environment. Pesticides may be used where physical, cultural, and biological methods or combinations thereof, are impractical or incapable of providing adequate control, eradication, or containment. If a pesticide would be needed on refuge lands, the most specific (selective) chemical available for the target species would be used unless considerations of persistence or other environmental and/or biotic hazards would preclude it. In accordance with 517 DM 1, pesticide usage would be further restricted because only pesticides registered with the U.S. Environmental Protection Agency (USEPA) in full compliance with the Federal Insecticide, Fungicide, and Rodenticide Act and as provided in regulations, orders, or permits issued by USEPA may be applied on lands and waters under refuge jurisdiction.

Environmental harm by pest species would refer to a biologically substantial decrease in environmental quality as indicated by a variety of potential factors including declines in native species populations or communities, degraded habitat quality or long-term habitat loss, and/or altered ecological processes. Environmental harm may be a result of direct effects of pests on native species including preying and feeding on them; causing or vectoring diseases; preventing them from reproducing or killing their young; out-competing them for food, nutrients, light, nest sites, or other vital resources; or hybridizing with them so frequently that within a few generations, few if any truly native individuals remain. In contrast, environmental harm can be the result of an indirect effect of pest species. For example, decreased waterfowl use may result from invasive plant infestations reducing the availability and/or abundance of native wetland plants that provide forage during the winter.

Environmental harm may also include detrimental changes in ecological processes. For example, cheatgrass infestations in shrub steppe greatly can alter fire return intervals displacing native species and communities of bunch grasses, forbs, and shrubs. Environmental harm may also cause or be associated with economic losses and damage to human, plant, and animal health. For example, invasions by fire-promoting grasses that alter entire plant and animal communities eliminating or sharply reducing populations of many native plant and animal species can also greatly increase fire-fighting costs.

For the Refuge's IPM program documentation to manage pests for this CCP/EIS, see Appendix H. Along with a more detailed discussion of IPM techniques, this documentation describes the selective use of pesticides for pest management on these refuges, where necessary. Throughout the life of the CCP, proposed pesticide uses on these refuges would be evaluated for potential effects to biological resources and environmental quality. Pesticide uses with appropriate and practical best management practices (BMPs) for habitat management as well as cropland/ facilities maintenance would be approved for use on these refuges where there likely would be only minor, temporary, and localized effects to species and environmental quality based upon non-exceedance of threshold values in chemical profiles. However, pesticides may be used on a refuge where substantial effects to species and the environment are possible (exceed threshold values) in order to protect human health and safety (e.g., mosquito-borne disease).

2.3.11 Monitor the Effects of Public Use Programs on Wildlife

Monitoring to ensure acceptable levels of effects for compatible public uses on refuge habitat and wildlife would be conducted contingent upon availability of resources. Areas and/or timing of public use will be modified, if necessary, to provide secure and adequately sized sanctuary areas for western snowy plover, Oregon silverspot butterfly, pink sandverbena, and other sensitive plant and animal species.

2.3.12 Regulatory Compliance

All activities in all alternatives requiring review, permits and clearances (Section 106 of the NHPA, Section 7 endangered species consultation, 401 water quality permit, etc.) and will undergo appropriate review and obtain necessary permits and/or clearances as needed (Appendix I).

2.3.13 Maintaining/Upgrading Existing Facilities

Periodic maintenance and upgrading of the refuge buildings and facilities will be necessary regardless of the alternative selected. Periodic maintenance and upgrading of facilities is necessary for safety and accessibility and to support staff and management needs.

2.3.14 State Coordination

Under all alternatives, the Service will continue to maintain regular discussions and partnership with the State of Washington, Washington State Parks, and WDFW. Current topics for discussion continue to be the Western Snowy Plover Recovery Plan and its continued implementation on Willapa NWR and the surrounding private and public lands, Pacific Flyway Management Plan for the Dusky Canada Goose (Pacific Flyway Council 2007), wildlife monitoring, hunting and fishing seasons and regulations, and listed species management.

2.3.15 Volunteer Opportunities

Volunteer opportunities occur in all alternatives. These are recognized as components of the successful management of public lands and may become vital to the implementation of refuge programs, plans, and projects, especially in times of declining budgets. Currently the Refuge has a formal and successful volunteer program, despite the rural nature of this Refuge, a small staff, and a large land base to manage. There are currently 20 volunteers.

2.3.16 Adaptive Management

Based upon 522 DM 1 (Adaptive Management Implementation Policy), refuge staffs shall use adaptive management (AM) for conserving, protecting, and, where appropriate, restoring lands and resources. Within 43 C.F.R. 46.30, AM is defined as a system of management practices based upon clearly identified outcomes, where monitoring evaluates whether management actions are achieving desired results (objectives). In the recently published DOI Adaptive Management Technical Guide*,* AM is defined as a decision process that “promotes flexible decision making that can be adjusted in the face of uncertainties as outcomes from management actions and other events become better understood”. Adaptive management accounts for the fact that complete knowledge about fish, wildlife, plants, habitats, and the ecological processes supporting them may be lacking. The role of natural variability contributing to ecological resilience also is recognized as an important principle for AM. It is not a “trial and error” process; rather, AM emphasizes learning while doing based upon available scientific information and best professional judgment considering site-specific biotic and abiotic factors on refuge lands.

2.3.17 Participation in Planning and Review of Regional Development Activities

The Service will actively participate in environmental planning, protection and studies for ongoing and future development projects including regional land protection planning partnerships, identifying threats to natural resources, and other potential concerns that may adversely affect refuge wildlife resources, habitats, and/or environmental quality. The Service will actively cultivate partnerships with nongovernmental organizations; private landowners; Tribes; and county, state, and Federal agencies to stay abreast of current and potential developments, land protection opportunities and will use outreach and education techniques when necessary to raise awareness of each of the Refuge's resources and dependence on the local environment.

2.3.18 Reintroduction and Augmentation of Flora and Fauna

The Service policy for Biological Integrity, Diversity and Environmental Health (601 FW 3) allows for the reintroduction of native flora and fauna to their historic range. Throughout the life of this CCP, the Service may consider plant and animal reintroductions for the purpose of restoring species to areas where historic use has occurred or areas which are appropriate. As an example, the Refuge has introduced freshwater mussels to refuge streams to actively restore and expand freshwater mussels within their historic range.

Guidelines exist that provide a scientific basis for planning, conducting, and monitoring reintroductions, which range from being nonspecific for taxa under consideration for reintroduction (IUCN 1998) as well as specifically for a group of taxa (e.g., freshwater fish, see George et al. 2009) or a species (e.g., bull trout, see Dunham and Gallo 2008). These guidelines are intended to assist in evaluating the feasibility of reintroductions, improving the success of management, and applying sound adaptive management, which confer conservation benefits to extirpated or depauperate populations. The Service will consider the appropriate guidelines and policies for reintroductions and augmentation of native flora and fauna in their historic range consistent with policies identified in the Refuge Manual 7, Section 12, Propagation and Stocking, and other appropriate policies and guidelines.

Re-establishment or enhancement of native species in their historical habitat may occur in some instances where native populations are extirpated or depauperate. Emphasis will be placed on restoring native fauna to suitable habitats on the Refuge where, in some cases, previous detrimental land use practices have impacted or extirpated species, such as native mussels, lamprey, Oregon silverspot butterflies, pink sandverbena, and salmonids.

2.3.19 Presidential Proclamation Boundary

The Presidential Proclamation Boundary was established in 1937 Executive Order 7721for protection of all migratory birds within the designated area. As stated in the Federal Register (Volume 5, Number 221), "the hunting, taking, capturing, or killing of migratory waterfowl or other migratory birds, or the attempt to hunt, capture, or kill such waterfowl or other birds, or the taking of their nests or eggs therein or thereon, is not permitted." Waterfowl hunting is prohibited within this area and is common to all alternatives within this plan.

2.4 Goals, Objectives, and Strategies

Goals and objectives are the unifying elements of successful refuge management. They identify and focus management priorities, resolve issues, and link to refuge purposes, Service policy, and the Refuge System Mission.

A CCP describes management actions that help bring a refuge closer to its vision. A vision broadly reflects the refuge purposes, the Refuge System mission and goals, other statutory requirements, and larger-scale plans as appropriate. Goals then define general targets in support of the vision, followed by objectives that direct effort into incremental and measurable steps toward achieving those goals. Finally, strategies identify specific tools and actions to accomplish objectives.

In the development of this CCP, the Service has prepared an EIS. The EIS evaluates alternative sets of management actions derived from a variety of management goals, objectives and implementation strategies.

The goals for the Willapa NWR to be implemented over the next 15 years under the CCP/EIS are presented on the following pages. Each goal is followed by the objectives that pertain to that goal. Some objectives pertain to multiple goals and have simply been placed in the most reasonable spot. Similarly, some strategies pertain to multiple objectives.

The goal order does not imply any priority in this CCP. The Implementation Plan articulates the current refuge priorities (Appendix F).

Readers, please note the following:

1) The objective statement indicates specific items that vary in the alternatives. How those items vary is displayed in the short table under each objective statement; as applicable.
2) If an objective is not in a particular alternative, a blank box indicates that this objective is not addressed in that alternative.

Finally, below each objective statement are the strategies that could be employed in order to accomplish the objectives. Again, note the following:

1) Check marks alongside each strategy show which alternatives include that strategy.
2) If a column for a particular alternative does not include a check mark for a listed strategy, it means that strategy would not be used in that alternative.

A summary of the alternatives is found at the end of this chapter (Table 2-1).

2.4.1 Goal 1. Protect, maintain, and restore ecologically functional late-successional forest habitats (mature and old-growth forest) characteristic of the low-elevation temperate forests in the southwest Washington coastal region for the benefit of endangered and threatened species, migratory and resident birds, and a diverse assemblage of other native species.

Objective 2.4.1.1 Protect and Maintain Late-successional Sitka Spruce Zone Forest

Protect and maintain 557 acres of existing late-successional Sitka spruce zone forest representative of the unmanaged, forested landscape for the benefit of marbled murrelets, spotted owls (currently extirpated from the Refuge), bald eagles, other migratory and resident birds, bats, and a diverse assemblage of other forest-dependent native species. Late-successional Sitka spruce zone forest is characterized by the following:

1) <80% canopy closure.
2) Multi-aged, multi-layered, multi-species canopy: Sitka spruce, western red cedar and western hemlock.
3) Dominant (old-growth and mature) trees 100-200+ years; average tree diameters >21 inches; largest tree diameters ranging from 32 to >39 inches.
4) Prevalence of large fallen trees and snags.
5) A shrub layer composed of native species such as evergreen huckleberry, salal, and red huckleberry.
6) Heavy ground cover composed of native herbaceous species such as oxalis, sword fern, deer fern, mosses, and lichens.

Old-growth west of Cascade crest: Stands of at least two tree species, forming a multi-layered canopy with occasional small openings; with at least eight trees per acre >32 inches diameter at breast height (dbh) or > 200 years of age; and more than four snags per acre over 20 inches in diameter and 15 feet tall; with numerous downed logs, including four logs per acre >24 inches in diameter and > 50 feet long (WDFW 2008b).

Mature forests: Stands with average diameters exceeding 21 inches dbh; crown cover may be less than 100%; decay, decadence, numbers of snags, and quantity of large downed material is generally less than that found in old-growth; 80-200 years old west of the Cascade Crest. (WDFW 2008b)

Late-successional Sitka spruce zone forest will be protected and maintained to aid in the recovery of the marbled murrelet, a federally threatened species. Attributes of marbled murrelet nesting habitat include:

- Large diameter trees (western hemlock, Sitka spruce, western red cedar, Douglas fir) 32 to >39 inches.
- Large flat moss-covered branches >7 inches in diameter.
- Branches at least 50 feet above the ground.
- Mean nest branch height equal to 120 feet.
- High canopy closure over nest branches.

Alternatives	Alt. 1	Alt. 2	Alt. 3
Acres to Achieve the Objective	557	557	557
Strategies for Achieving the Objective			

A. Use appropriate IPM techniques including mechanical, physical, biological, and chemical methods (see Appendix H) to control invasive or undesirable plant species.	✓	✓	✓
B. Protect and promote natural processes to drive vegetative changes.	✓	✓	✓
C. Use fire suppression techniques (including use of fire-lines, hand tools, backpack and slip-on water pumps) to prevent catastrophic wildfire in forests.	✓	✓	✓
D. Maintain partnerships (e.g., TNC, State) to foster ecosystem/landscape approach to protect habitats.	✓	✓	✓
E. Within new approved refuge boundary, acquire lands/habitats from willing sellers as funds become available.	✓	✓	✓
F. Monitor presence/absence of marbled murrelets through protocol surveys.	✓	✓	✓

Rationale:

Forestlands in the Willapa Bay area are dominated by commercial timberlands. In fact, most of the forested acreage within either the Refuge or Willapa Bay watersheds is second- or third-growth timber. Very little late-successional forest exists. One estimate states that <1% of the original coastal old-growth remains in the 700,000-acre Willapa Bay watershed. The largest old-growth parcel in the Refuge is the 274-acre Cedar Grove located on Long Island (Maps 5-7). This habitat type is important and a priority for maintaining biological integrity, diversity, and environmental health.

These forests are a high priority due to their limited availability and high vulnerability to habitat alteration (WDFW 2006).

A variety of wildlife use late successional forests including black bear, black-tailed deer, Roosevelt elk, salamanders, forest-dwelling bats and other small mammals, marbled murrelets, pileated woodpeckers and other forest birds, and a host of fungi and gastropods.

Lack of late-successional/old-growth forest habitat is one reason for the disappearance of the spotted owl from the Refuge. Spotted owls use regenerated forest but depend on old-growth for nesting and prey species.

According to the Recovery Plan for the Marbled Murrelet (USFWS 1997a), the major factors contributing to the threatened status of murrelets include loss of nesting habitats, and poor reproductive success in the habitat that does remain. Loss of high-quality nesting habitat and increased forest fragmentation are the main causes cited in the reduction of marbled murrelet populations and continue to threaten their recovery (Raphael et al. 2008; USFWS 1997a). The Federal marbled murrelet recovery plan identifies southwest Washington as a significant gap in suitable nesting habitat along the Pacific Northwest Coast (USFWS 1997a). Increasing available habitat in this area is critical to expanding the geographic distribution of the murrelet within its threatened range (Raphael et al. 2008). Unlike most other regions within the range of the murrelet, this area has limited forested Federal ownership with large blocks of intact habitat. Therefore, improving both Federal and non-Federal forests in southwest Washington is critical to marbled murrelet recovery (Raphael et al. 2008). With less than 1% of the original old-growth forest remaining, restoration is essential to increasing the viability and resilience of marbled murrelet populations in this area (Davis et al. 2009).

Habitat fragmentation has also reduced nesting success for murrelets within the remaining habitat by reducing microhabitat quality and increasing rates of predation, especially near artificial edges (Malt 2007). It is thought that these effects should decline as adjacent forests mature. Large core landscapes dedicated to murrelet protection should help reduce the amount of fragmentation over time. Buffering of existing habitat by actively managing young adjacent forests will be an important strategy to improve microhabitat conditions within these core murrelet emphasis areas (Davis et al. 2009).

The Washington, Oregon, and California population segment of the marbled murrelet was federally listed as threatened on September 28, 1992 (USFWS 1992) due to the high rate of nesting habitat loss and fragmentation, and mortality associated with net fisheries and oil spills. The marbled murrelet is state listed as threatened in Washington.

The strategies outlined to achieve this objective are consistent with the goals of the Recovery Plan for the Marbled Murrelet (USFWS 1997a).

The objective of the recovery plan is "to stabilize population size at or near current levels by (1) maintaining and/or increasing productivity of the population as reflected by changes in total population size, the adult: juvenile ratio, and nesting success by maintaining and/or increasing marine and terrestrial habitat and by (2) removing and/or minimizing threats to survivorship, including mortality from gill-net fisheries and oil spills" (USFWS 1997a).

The marbled murrelet is listed as a resource of concern under the following documents:

Endangered and threatened wildlife and plants (USFWS 1992); Policy on maintaining the biological integrity, diversity and environmental health of the national wildlife refuge system (USFWS 2001b), Birds of Conservation Concern (USFWS 2002a), The U.S. Fish and Wildlife Service's focal species strategy for migratory birds. Division of Migratory Bird Management (USFWS 2005b), Recovery Plan for the Marbled Murrelet (Washington, Oregon, and California Populations) (USFWS 1997a), North American Waterbird Conservation Plan (Kushlan et al. 2002), Seabird Conservation Plan (USFWS 2005a), Washington's comprehensive wildlife conservation strategy (WDFW 2005), State of Washington Natural Heritage Plan 2005 Update (WDNR 2005), and State of Washington Natural Heritage Program Information Systems (WDNR 2007).

Objective 2.4.1.2 Restore Late-successional Sitka Spruce Zone Forest

Initiate restoration activities to create a trajectory toward late successional Sitka spruce zone forest within portions of the 6,178 acres of this habitat type for the benefit of marbled murrelets, spotted owls (currently extirpated from the Refuge), bald eagles, migratory and resident birds, bats, and other native species. The following attributes characterize a late-successional Sitka spruce zone forest:

1) <80% canopy closure.
2) Multi-aged, multi-layered, multi-species canopy: Sitka spruce, western red cedar and western hemlock.
3) Dominant trees 100-200+ years; average tree diameters >21 inches; largest tree diameters ranging from 32 to >39 inches.
4) Prevalence of large fallen trees and snags.
5) Shrub layer composed of native species such as evergreen huckleberry, salal, and red huckleberry.

6) Heavy ground cover composed of native herbaceous species such as oxalis, sword fern, deer fern, mosses, and lichens.

Attributes of marbled murrelet nesting habitat found within the late-successional forest includes these characteristics:

1) Large diameter trees (western hemlock, Sitka spruce, western red cedar, Douglas fir) 32 to >39 inches.
2) Large, flat moss-covered branches >7 inches in diameter.
3) Branches at least 50 feet above the ground.
4) Mean nest branch height equal to 120 feet.
5) High canopy closure over nest branches.

Alternatives	**Alt. 1**	**Alt. 2**	**Alt. 3**
Acres to Achieve the Objective	**6,178**	**6,178**	**6,178**
Strategies for Achieving the Objective			
A. Use appropriate forest management techniques (e.g., thinning, planting) to drive desired vegetative changes (Appendix K).	✓	✓	✓
B. Protect and promote natural processes to drive vegetative changes.	✓	✓	✓
C. Use appropriate IPM techniques including mechanical, physical, biological, and chemical methods (see Appendix H) to control invasive or undesirable plant species.	✓	✓	✓
D. Use fire suppression techniques (including use of fire-lines, hand tools, backpack and slip-on water pumps) to prevent catastrophic wildfire in forests.	✓	✓	✓
E. Decommission roads and facilities to reduce fragmentation of forested habitat and maximize stream integrity and water quality.	✓	✓	✓
F. Maintain partnerships (e.g., TNC, State) to foster ecosystem/landscape approach to protect habitats.	✓	✓	✓
G. Within new approved refuge boundary acquire lands from willing sellers as funds become available.	✓	✓	✓
H. Monitor presence/absence of murrelets through protocol surveys, especially in restored habitats.	✓	✓	✓

Rationale:

Forestlands in the Willapa Bay area are dominated by commercial timberlands. In fact, most of the forested acreage within either the Refuge or Willapa Bay watershed is second- or third-growth timber. Very little late-successional forest exists. One estimate states that less than <1% of the original coastal old-growth remains in the 700,000-acre Willapa Bay watershed. The Refuge's largest old-growth parcel is the 274-acre Cedar Grove located on Long Island.

To describe the characteristics of late-successional forest above the team used several criteria from the WDFW Priority Habitats and Species List:

Old-growth west of Cascade crest:

- Stands of at least two tree species, forming a multi-layered canopy with occasional small openings, with at least eight trees per acre >32 inches dbh or >200 years of age;
- More than four snags per acre over 20 inches in diameter and 15 feet tall; and

- Numerous downed logs, including four logs per acre >24 inches in diameter and >50 feet long.

Mature forests:

- Stands with average diameters exceeding 21 inches dbh;
- Crown cover may be less than 100%;
- Decay, decadence, numbers of snags, and quantity of large downed material is generally less than that found in old-growth; and
- 80-200 years old west of the Cascade Crest.

These forests are a high priority due to their limited availability and high vulnerability to habitat alteration (WDFW 2006). Due to the degraded nature of the refuge forests and those in the surrounding areas, a major effort is needed to restore these forests to their natural state. A variety of wildlife use late successional forests including black bear, black-tailed deer, Roosevelt elk, salamanders, forest-dwelling bats and other small mammals, marbled murrelets, pileated woodpeckers, other forest birds, and a host of fungi and gastropods.

The lack of late-successional/old-growth forest habitat is one reason the spotted owl has disappeared from the Refuge. Spotted owls use regenerated forest but depend on old-growth for nesting and prey species.

Late-successional Sitka spruce zone forest will be restored to aid recovery efforts for the marbled murrelet, a federally threatened species. According to the marbled murrelet Recovery Plan (USFWS 1997a), the major factors contributing to the threatened status of murrelets are: Loss of nesting habitats and poor reproductive success in the habitat that does remain.

Loss of high-quality nesting habitat and increased forest fragmentation are the main causes cited in the reduction of marbled murrelet populations and continue to threaten their recovery (Raphael et al. 2008; USFWS 1997a). The Federal marbled murrelet recovery plan identifies southwest Washington as a significant gap in suitable nesting habitat along the Pacific Northwest Coast (USFWS 1997a). Increasing available habitat in this area is critical to expanding the geographic distribution of the murrelet within its threatened range (Raphael et al. 2008). Unlike most other regions within the range of the murrelet, this area has limited forested Federal ownership with large blocks of intact habitat. Therefore, improving both Federal and non-Federal forests in southwest Washington is critical to marbled murrelet recovery (Raphael et al. 2008). With less than 1% of the original old-growth forest remaining, restoration is essential to increasing the viability and resilience of marbled murrelet populations in this area (Davis et al. 2009).

The marbled murrelet recovery plan states that “silvicultural techniques may be appropriate to increase the area of suitable nesting stands and the rate at which they develop” within young-managed forests (USFWS 1997a). Given the lack of suitable habitat in this region, exploring forest restoration strategies intended to increase the amount of marbled murrelet nesting habitat is of particular importance. Habitat fragmentation has also reduced nesting success for murrelets within the remaining habitat by reducing microhabitat quality and increasing rates of predation, especially near artificial edges (Malt 2007). It is thought that these effects should decline as adjacent forests mature. Large core landscapes dedicated to murrelet protection should help reduce the amount of fragmentation over time. Buffering of existing habitat by actively managing young adjacent forests will be an important strategy to improve microhabitat conditions within these core murrelet emphasis areas. Road decommissioning can also be accomplished to further address habitat fragmentation and re-establish large areas of intact forest.

Thinning can be an important first step in speeding the development of suitable murrelet nesting habitat. If thinning is not conducted in dense coastal stands at this early stage, many stands will lose cedar and spruce cohorts to hemlock competition, diameter growth will be significantly slower, and tree crowns will begin to lift, often leaving stands susceptible to windthrow. Left untreated, development of suitable nesting habitat in these stands can be greatly delayed or may never occur (Davis et al. 2009).

Recent scientific research concludes that it is possible to accelerate forest complexity and habitat development through the application of carefully applied silvicultural practices. Techniques such as variable density thinning, under planting, and the creation of large woody debris (snags and downed logs) have been shown to accelerate the development of complex habitat conditions in young managed stands. Habitat manipulation around isolated legacy trees that remain in young managed forest stands also enhances the forest canopy structure required by murrelets for nesting. Such techniques can be used to promote the development of trees with nesting platforms and canopy characteristics preferred by the murrelet while also benefitting other species of concern. Access to current legacy trees suitable for nesting may also be opened up through these techniques (Davis et al. 2009).

The Washington, Oregon, and California population segment of the marbled murrelet was federally listed as threatened on September 28, 1992 (USFWS 1992) due to the high rate of nesting habitat loss and fragmentation, and mortality associated with net fisheries and oil spills. The marbled murrelet is state listed as threatened in Washington. The strategies outlined to achieve this objective are consistent with the goals of the Recovery Plan for the Marbled Murrelet (USFWS 1997a).

The objective of the recovery plan is "to stabilize population size at or near current levels by (1) maintaining and/or increasing productivity of the population as reflected by changes in total population size, the adult: juvenile ratio, and nesting success by maintaining and/or increasing marine and terrestrial habitat and by (2) removing and/or minimizing threats to survivorship, including mortality from gill-net fisheries and oil spills" (USFWS 1997a).

The marbled murrelet is listed as a resource of concern under the following documents: Endangered and threatened wildlife and plants (USFWS 1992a); Policy on maintaining the biological integrity, diversity and environmental health of the national wildlife refuge system (USFWS 2001b); Birds of Conservation Concern (USFWS 2002a); Service's focal species strategy for migratory birds (USFWS 2005b); Recovery Plan for the Marbled Murrelet (Washington, Oregon, and California Populations) (USFWS 1997a); North American Waterbird Conservation Plan (Kushlan et al. 2002); Seabird Conservation Plan (USFWS 2005a); Washington's comprehensive wildlife conservation strategy (WDFW 2005); State of Washington Natural Heritage Plan 2005 Update (WDNR 2005); and State of Washington Natural Heritage Program Information Systems (WDNR 2007).

2.4.2 Goal 2. Protect, maintain, and restore estuarine habitats historically characteristic of the southwest Washington coastal region for the benefit of salmonids, Pacific brant, other waterfowl, shorebirds, seabirds, and a diverse assemblage of other native species.

Objective 2.4.2.1 Open Water Maintenance			
Annually protect and maintain 878 acres of open water and channel habitat within the refuge portion of Willapa Bay for the benefit of salmonids, Pacific brant, other waterfowl, and other native species. Open water and channel habitats are characterized by the following: 1) Subtidal habitats that are continuously submerged. 2) Substrates are typically sand and/or mud. 3) Vegetated (e.g., eelgrasses) or Unvegetated. 4) Minimal human disturbance.			
Alternatives	**Alt. 1**	**Alt. 2**	**Alt. 3**
Acres to Achieve the Objective	**878**	**878**	**878**
Strategies for Achieving the Objective			
A. Use appropriate IPM techniques including mechanical, physical, biological, and chemical methods (see Appendix H) to control invasive or undesirable plant species.	✓	✓	✓
B. Monitor water quality as warranted.	✓	✓	✓
C. Protect and promote natural processes that create and maintain aquatic habitats	✓	✓	✓
D. Maintain partnerships to protect ecological integrity of Willapa Bay and its wildlife resources.	✓	✓	✓

Rationale:

The open water channels and sloughs of Willapa Bay are habitat for fish and a variety of invertebrate animals and aquatic plants. These aquatic areas serve as pathways and foraging areas for adult salmon, eulachon, lamprey, sea-run cutthroat trout, and steelhead migrating upriver to spawn, and for juveniles moving downstream to the ocean. Sturgeon forage in the deeper channels and holes. Clams, oysters, mussels, aquatic worms, amphipods, and other small organisms are found living along the bottom of this habitat and serve as a valuable food source for many species. The large expanse of open water provides necessary resting and foraging habitat for waterfowl, shorebirds, and marsh and wading birds.

Through an active role in local, state, and Federal partnerships, the refuge staff will work to maintain the ecological integrity and water quality of the Willapa Bay estuary. As with other natural estuarine habitats, this area is subject to natural processes, therefore, little if any physical management actions are appropriate for existing open water areas. A portion of the open water habitat of the Willapa Bay estuary is within the designated boundaries of the Refuge. The refuge staff will work in concert with the community and sister agencies to provide the necessary monitoring, protection, resources, and educational information, to maintain the Willapa Bay ecosystem in a healthy sustainable manner.

Willapa Bay is a valuable habitat for migratory birds, juvenile fishes, eelgrass, and clams (Proctor et al. 1980). Estuarine areas on the Refuge have annually provided important habitat for over 20,000 migrating ducks, tens of thousands of shorebirds, and 3,000 migrating geese at a time. Refuge open water habitat is essential to sustaining the estimated 2.2 million duck, 400,000 Canada goose, 200,000 brant, and over 2 million shorebird use-days associated with the southern half of Willapa Bay (USFWS 1997b).

Willapa Bay's subtidal system of three main channels and associated complex of smaller drainage channels deliver oceanic nutrients and plankton to feeding areas on the tide flats. The side channels provide fish a route to access the mudflats as well as cover from large predators during low tides (Coastal Resources Alliance 2007).

Objective 2.4.2.2 Open Water Restoration

Restore 0.2 acre and annually protect and maintain open water and channel habitat within the refuge portion of Willapa Bay for the benefit of salmonids, Pacific brant, other waterfowl, and other native species. Open water and channel habitats are characterized by the following:

1) Subtidal habitats that are continuously submerged.
2) Substrates are typically sand and/or mud.
3) Vegetated or unvegetated.
4) Minimal human disturbance.

Alternatives	**Alt. 1**	**Alt. 2**	**Alt. 3**
Acres to Achieve the Alternative	**0**	**0.2**	**0**
Strategies for Achieving the Objective			
A. Breach or remove dikes.		✓	✓
B. Reconnect tidal channels.		✓	✓
C. Protect sanctuary of new open water habitat.		✓	✓
D. Use appropriate IPM techniques including mechanical, physical, biological, and chemical methods (see Appendix H) to control invasive or undesirable plant species.	✓	✓	✓
E. Monitor water quality as warranted.		✓	✓
F. Maintain partnerships to protect ecological integrity of Willapa Bay and its wildlife resources.	✓	✓	✓

Rationale:

The open water channels and sloughs of Willapa Bay are habitat for fish and a variety of invertebrate animals and aquatic plants. These aquatic areas serve as pathways and foraging areas for adult salmon, eulachon, lamprey, sea-run cutthroat trout, and steelhead migrating upriver to spawn, and for juveniles moving downstream to the ocean. Sturgeon forage in the deeper channels and holes. Clams, oysters, mussels, aquatic worms, amphipods, and other small organisms are found living along the bottom of this habitat and serve as a valuable food source for many species. The large expanse of open water provides necessary resting and foraging habitat for waterfowl, shorebirds, and marsh and wading birds.

Willapa Bay is a valuable habitat for migratory birds, juvenile fishes, eelgrass, and clams (Proctor et al. 1980). Estuarine areas on the Refuge have annually provided important habitat for over 20,000 migrating ducks, tens of thousands of shorebirds, and 3,000 migrating geese at a time. Refuge open water habitat are essential to sustaining the estimated 2.2 million duck, 400,000 Canada goose, 200,000 brant, and over 2 million shorebird use-days associated with the southern half of Willapa Bay (USFWS 1997b).

Willapa Bay's subtidal system of three main channels and associated complex of smaller drainage channels deliver oceanic nutrients and plankton to feeding areas on the tide flats. The side channels provide fish a route to access the mudflats as well as cover from large predators during low tides (Coastal Resources Alliance 2007).

The most reliable method of estuarine restoration is dike removal or breaching. Once saltwater influence has been restored to diked wetlands, natural processes are initiated that eventually lead to enhanced habitat value (Coastal Resources Alliance 2007). Key ecosystem processes are changed when saltwater influence is restored, including tidal hydrology, cycling of organic matter, and sediment movements. New off-channel habitat will be available to fish. Organic nutrients will be added. New plant communities will grow and make organic matter and prey items available (Coastal Resources Alliance 2007). Breaching or removing the dikes would lead to reclamation of a portion of historical open water, maximizing the availability of this valuable habitat for wildlife resources.

Objective 2.4.2.3 Intertidal Flats Maintenance

Annually protect and maintain at least 4,178 acres of intertidal flats within the refuge portion of Willapa Bay for the benefit of Pacific brant and other waterfowl, shorebirds, marine mammals, salmonids, and a variety of native, estuarine species. Intertidal flat habitats are characterized by the following:

1) Exposed mud to sandy substrate interspersed with eelgrass (*Zostera* spp.) beds.
2) Sand bars provide roost sites for brown pelicans and haul-outs for marine mammals.
3) No *Spartina.*

Alternatives	Alt. 1	Alt. 2	Alt. 3
Acres to Achieve the Objective	**4,178**	**4,189**	**4,180**
Strategies for Achieving the Objective			
A. Use appropriate IPM techniques including mechanical, physical, biological, and chemical methods (see Appendix H) to control invasive or undesirable plant species.	✓	✓	✓
B. Allow natural processes to revegetate flats.	✓	✓	✓

Rationale:

The expansive intertidal mudflats of Willapa Bay are among its most differentiating and defining features. They are also the basis for its unusual productivity for human communities. The intertidal zone supports a variety of habitats including mud and sand flats, oyster reefs, salt marsh habitat, and eelgrass meadows. Its oyster beds are currently the most productive growing grounds in the United States. Its mudflats are among the 10 most important fueling areas for migratory birds along the Pacific Flyway (Coastal Resources Alliance 2007).

Intertidal mudflats are particularly valuable habitat for migratory birds, juvenile fishes, eelgrass, and clams (Proctor et al. 1980). Such areas on the Refuge have annually provided important feeding habitat for over 20,000 migrating ducks, tens of thousands of shorebird,s and 3,000 migrating geese at a time. Refuge tidelands are essential to sustaining the estimated 2.2 million duck, 400,000 Canada goose, 200,000 brant, and over 2 million shorebird use-days associated with the southern half of Willapa Bay (USFWS 1997b). Extensive eelgrass (*Zostera* spp.) beds on intertidal mudflats are an important food source for Pacific brant as well as habitat for juvenile salmonids and invertebrates.

In the Pacific Northwest, a large portion of estuarine habitat has been lost to diking, channelization, dredging, and filling. Washington is estimated to have lost between 45% and 62% of its pre-settlement estuarine habitat (Aitkin 1998).

Objective 2.4.2.4 Intertidal Flats Restoration

Restore ≤11 acres of intertidal flats within the refuge portion of Willapa Bay for the needs of Pacific brant and other waterfowl, seabirds, shorebirds, marine mammals, salmonids, and a variety of other benefiting species. Intertidal flat habitats are characterized by the following:

1) Exposed mud to sandy substrate interspersed with eelgrass (*Zostera* spp.) beds.
2) Sand bars provide roost sites for brown pelicans and haul-outs for marine mammals.
3) No *Spartina.*

Alternatives	**Alt. 1**	**Alt. 2**	**Alt. 3**
Acres to Achieve the Objective	**0**	**11**	**2**
Strategies for Achieving the Objective			
A. Breach or remove dikes using heavy equipment.		✓	✓
B. Reconnect tidal channels.		✓	✓
C. Use appropriate IPM techniques including mechanical, physical, biological, and chemical methods (see Appendix H) to control invasive or undesirable plant species.		✓	✓

Rationale:
The expansive intertidal mudflats of Willapa Bay are among its most differentiating and defining features. They are also the basis for its unusual productivity for human communities. The intertidal zone supports a variety of habitats including mud and sand flats, oyster reefs, salt marsh habitat, and eelgrass meadows. Its oysterbeds are currently the most productive growing grounds in the United States. Its mudflats are among the 10 most important fueling areas for migratory birds along the Pacific Flyway (Coastal Resources Alliance 2007).

Intertidal mudflats are particularly valuable habitat for migratory birds, juvenile fishes, eelgrass, and clams (Proctor et al. 1980). Such areas on the Refuge have annually provided important feeding habitat for over 20,000 migrating ducks, tens of thousands of shorebirds, and 3,000 migrating geese at a time. Refuge tidelands are essential to sustaining the estimated 2.2 million duck, 400,000 Canada goose, 200,000 brant, and over 2 million shorebird use-days associated with the southern half of Willapa Bay (USFWS 1997b). Extensive eelgrass (*Zostera* spp.) beds on intertidal mudflats are an important food source for Pacific brant as well as habitat for juvenile salmonids and invertebrates.

In the Pacific Northwest a large portion of estuarine habitat has been lost to diking, channelization, dredging, and filling. Washington is estimated to have lost between 45% and 62% of its pre-settlement estuarine habitat (Aitkin 1998).

The most reliable method of estuarine restoration is dike removal or breaching. Once saltwater influence has been restored to diked wetlands, natural processes are initiated that eventually lead to enhanced habitat value (Coastal Resources Alliance 2007).

Key ecosystem processes are changed when saltwater influence is restored including tidal hydrology, cycling of organic matter, and sediment movements. New off-channel habitat will be available to fish. Organic nutrients will be added. New plant communities will grow and make organic matter and prey items available (Coastal Resources Alliance 2007). Breaching or removing the dikes would lead to reclamation of a portion of the historical intertidal mudflats, maximizing the availability of this valuable habitat for wildlife resources.

Objective 2.4.2.5 Maintain Salt Marsh Habitat

Annually protect and maintain 1,636 acres of salt marsh within the refuge portion of Willapa Bay for the benefit of waterfowl, salmonids, wading birds, shorebirds and other native species. Salt marsh habitats are characterized by the following:

1) Vegetation usually occurring within tidal range of 9 to 11 feet NGVD (National Geodetic Vertical Datum) dominated primarily by pickleweed (*Salicornia* spp.), tufted hairgrass, seashore salt grass, seacoast angelica, gumweed, jaumea, seaside plantain, small spikerush, seaside arrowgrass, and Lyngbye's sedge.
2) Infrequently inundated except on highest high tides.
3) Interspersion of tidal sloughs.
4) No *Spartina.*

Alternatives	Alt. 1	Alt. 2	Alt. 3
Acres to Achieve the Objective	**1,636**	**1,636**	**1,636**
Strategies for Achieving the Objective			
A. Use appropriate IPM techniques including mechanical, physical, biological, and chemical methods (see Appendix H) to control invasive or undesirable plant species.	✓	✓	✓
B. Protect and promote natural processes to drive vegetative changes.	✓	✓	✓

Rationale:

The tidal salt marshes on the Refuge provide habitat for a diverse array of species which include waterfowl and other waterbirds, fish, and invertebrates. Salt marshes provide a major source of nutrients for aquatic and terrestrial wildlife. They also provide forage for waterfowl and hunting grounds for bald eagles, northern harriers, peregrine falcons, and other raptors. The management strategies identified for this habitat are focused on protection and restoration. Because about 30% of the original wetlands of Willapa Bay have been lost by diking and filling (Hedgpeth and Obrebski 1981), the existing salt marshes should be protected and maintained. In the Pacific Northwest, a large portion of estuarine habitat has been lost to diking, channelization, dredging, and filling. Washington is estimated to have lost between 45% and 62% of its pre-settlement estuarine habitat (Aitkin 1998).

In a recent comparative goose survey, use within two types of habitats—salt marsh (Porter Point Unit) and pasture lands (Riekkola Unit)—the migratory goose utilization of these areas as foraging habitat revealed a greater use by geese on the salt marsh to that of the adjacent managed pastures protected by dikes. Goose use of the salt marsh occurred regardless of the level of water coverage by the tides. Survey data suggests that migrating geese utilize salt marsh on average 8.6 times more than on the Riekkola Unit pastures (Patten et al. 2008).

This salt marsh habitat is subject to natural processes and currently there is little physical management activity occurring outside the dikes. Control of invasive species would provide the best opportunity to improve habitat in the naturally occurring emergent tidal salt marsh.

Objective 2.4.2.6 Salt Marsh Restoration			
Restore and then protect and maintain 429-749 acres of salt marsh within the refuge portion of Willapa Bay for the benefit of waterfowl, salmonids, wading birds, shorebirds, and other native species. Salt marsh habitats are characterized by the following: 1) Vegetation usually occurring within tidal range of 9 to 11 feet NGVD (National Geodetic Vertical Datum) dominated primarily by pickleweed, tufted hairgrass, seashore salt grass, seacoast angelica, gumweed, seaside plantain, small spikerush, seaside arrowgrass, and Lyngbye's sedge. 2) Infrequently inundated except on highest high tides. 3) Interspersion of tidal sloughs. 4) No *Spartina.*			
Alternatives	**Alt. 1**	**Alt. 2**	**Alt. 3**
Acres to Achieve the Objective	**0**	**749**	**429**
Strategies for Achieving the Objective			
A. Breach or remove dikes.		✓	✓
B. Reconnect tidal channels.		✓	✓
C. Use appropriate IPM techniques including mechanical, physical, biological, and chemical methods (see Appendix H) to control invasive or undesirable plant species.		✓	✓

Rationale:

The tidal salt marshes on the Refuge provide habitat for a diverse array of species which include waterfowl and other waterbirds, fish, and invertebrates. Salt marshes provide a major source of nutrients for aquatic and terrestrial wildlife. They also provide forage for waterfowl and hunting grounds for bald eagles, northern harriers, peregrine falcons, and other raptors.

The management strategies identified for this habitat are focused on protection and restoration. A portion of refuge salt marsh habitat was eliminated by diking in the late 1940s and early 1950s to create pasture lands and freshwater wetlands, believed to enhance overall waterfowl use of the Refuge and increase land available for agricultural production. About 30% of the original wetlands of Willapa Bay have been reclaimed by diking and filling (Hedgpeth and Obrebski 1981).

In the Pacific Northwest, a large portion of estuarine habitat has been lost to diking, channelization, dredging, and filling. Washington is estimated to have lost between 45% and 62% of its pre-settlement estuarine habitat (Aitkin 1998).

Loss of saltwater wetlands habitat is considered one of the most common limiting factors blamed for the decline of nearshore or estuarine salmon habitat. Wetland loss occurs when a dike is built isolating areas from the reach of tidal waters.

According to Olympic Natural Resources Center (ONRC) calculations, Willapa Bay originally contained approximately 14,620 acres of saltwater wetlands. Now there are 5,277 acres. This represents a 64% loss of estuarine wetlands (Coastal Resources Alliance 2007).

In a recent comparative goose survey, use within two types of habitats; salt marsh (Porter Point Unit) and pasture lands (Riekkola Unit) the migratory goose utilization of these areas as foraging habitat revealed a greater use by geese on the salt marsh to that of the adjacent managed pastures protected by dikes. Goose use of the salt marsh occurred regardless of the level of water coverage by the tides. Survey data suggests that migrating geese utilize salt marsh on average 8.6 times more than on the Riekkola Unit pastures (Patten et al. 2008).

The most reliable method of estuarine restoration is dike removal or breaching. Once saltwater influence has been restored to diked wetlands, natural processes are initiated that eventually lead to enhanced habitat value (Coastal Resources Alliance 2007).

Key ecosystem processes are changed when saltwater influence is restored including tidal hydrology, cycling of organic matter, and sediment movements. New off-channel habitat will be available to fish. Organic nutrients will be added. New plant communities will grow and make organic matter and prey items available (Coastal Resources Alliance 2007).

Breaching or removing dikes would restore valuable salt marsh habitat which is considered one of the most productive ecosystems in the world.

Willapa NWR has previously pursued tidal restoration on other refuge properties (Headquarters, areas near the Bear River, and Long Island). The Refuge has approximately 638.1 acres of former tideland located in the South Bay, which is cut off from the bay by dikes and tide gates. These areas can be returned to estuarine habitat and improve the Refuge's value to waterfowl and native wildlife species. Restoring tidal influence would allow a recovery that will reflect the historical salt marsh habitat. Plan outlined in Appendix O.

2.4.3 Goal 3. Protect, maintain, and restore freshwater habitats historically characteristic of the southwest Washington coastal region for the benefit of migratory birds, salmonids, amphibians, mussels, lamprey, and a diverse assemblage of other native species.

Objective 2.4.3.1 Protect and Maintain Riverine Habitats

Protect and maintain 27 miles of riverine habitats containing characteristics that represent the historical landscape. A riverine system includes all wetlands and deepwater habitats contained within a channel, with two exceptions: 1) wetlands dominated by trees, shrubs, persistent emergents, emergent mosses, or lichens, and 2) habitats with water containing ocean-derived salts in excess of 0.5% (Cowardin et al. 1979). Riverine systems containing salmonid habitat are characterized by (Knutson and Naef 1997; Kondolf and Wolman 1993; Laufle et al. 1986; USFWS 2004a):

1) Periodic flooding with flooding energy variable depending on location of stream/river in landscape.
2) Perennial water flows.
3) Barrier-free passage for fish.
4) At least one piece of large woody debris per channel width.
5) Pool-to-riffle ratio of 1:1.
6) Abundance of spawning gravel (6-128 mm) for salmonids.
7) Low amounts of fine sediments.
8) Cool temperatures (<73˚F) with preferred temperature range (40˚F-58˚F).
9) Dissolved oxygen levels >5 parts per million.
10) Intact riparian corridor providing stream surface shade of 60%-80%.

Alternatives	Alt. 1	Alt. 2	Alt. 3
Miles to Achieve the Objective	**27**	**27**	**27**
Strategies for Achieving the Objective			
A. Use appropriate IPM techniques including mechanical, physical, biological, and chemical methods (see Appendix H) to control invasive or undesirable plant species.	✓	✓	✓
B. Protect and promote natural processes that create and maintain aquatic habitats.	✓	✓	✓

Rationale:
An estimated 50%-90% of streams in the state of Washington are in a degraded state (Knutson and Naef 1997).

Rivers and streams in the Willapa NWR support runs of anadromous fish such as chum, coho and Chinook salmon, and cutthroat trout. River and stream channels provide migration pathways for adult anadromous fish traveling to spawning grounds and juveniles traveling to the estuary and/or Pacific Ocean.

Land use activities have impacted wildlife habitat values in and along rivers and streams in the Willapa Bay watershed. Historical stream processes in many areas have been altered. There has been a loss of connectivity to the estuary due to highway and dike construction. Hydrological regimes have been altered, fish passage barriers exist, there are water quality issues, and exotic species are present. There is a need to protect and maintain ecological processes and functions in streams and associated habitat. Positive effects of healthy streams include enhanced nutrient production and cycling, improved water quality, and support of a diverse riparian and estuarine plant and wildlife community. Optimal stream habitat provides protective cover, improved forage, and structural diversity that results in formation of in-stream riffles and pools for anadromous fish but will also benefit other stream-dependent wildlife species, including rare amphibian species and invertebrates, such as mollusks, and a large variety of aquatic insects (USFWS 2003a).

Objective 2.4.3.2 Restore Riverine Habitats

Conduct restoration activities within various reaches of the 27 miles of riverine habitat that mimic or promote natural processes that create and maintain aquatic habitat conditions representative of the historical landscape. Riverine systems containing salmonid habitat are characterized by:

1) Periodic flooding with flooding energy variable depending on location of stream/river in landscape.
2) Perennial water flows.
3) Barrier-free passage for fish.
4) At least one piece of large woody debris per channel width.
5) Pool-to-riffle ratio of 1:1.
6) Abundance of spawning gravel (6-128 mm) for salmonids.
7) Low amounts of fine sediments.
8) Cool temperatures (<73˚F) with preferred temperature range (40˚F-58˚F).
9) Well-oxygenated water, with dissolved oxygen levels >5 parts per million.
10) Intact riparian corridor providing stream surface shade of 60%-80%.

Restoration may include re-establishment or enhancement of native stream-dependent species in their historical habitat. This may occur in some instances where native populations are extirpated or depauperate.			
Alternatives	**Alt. 1**	**Alt. 2**	**Alt. 3**
Stream Miles Restored and Maintained.	**27**	**27**	**27**
Strategies for Achieving the Objective			
A. Use appropriate IPM techniques including mechanical, physical, biological, and chemical methods (see Appendix H) to control invasive or undesirable plant species.	✓	✓	✓
B. Compile watershed assessments.	✓	✓	✓
C. Re-establish large woody debris to mimic historical stream complexities.	✓	✓	✓
D. Removal of fish passage barriers.	✓	✓	✓
E. Use of stream restoration techniques (reconnect historic channels, riparian plantings, placement of large woody debris, etc.) as appropriate to improve stream conditions.	✓	✓	✓

Rationale:

Stream restoration techniques will be used to maximize healthy stream characteristics. Because an estimated 50%-90% of streams in the state of Washington are in a degraded state, stream restoration is appropriate (Knutson and Naef 1997).

Rivers and streams in the Willapa NWR support declining runs of anadromous fish such as chum, coho and Chinook salmon, and cutthroat trout. Barriers to fish passage and previous land management practices throughout the Willapa area have contributed to the decline of fish runs in Willapa Bay.

Land use activities have also impacted other wildlife habitat values along refuge streams. Historical stream processes in many areas of the Refuge have been altered. Wood in many of the streams has previously been removed by early logging practices and "stream cleaning" efforts. In addition, the important components of gravel beds suitable for anadromous fish spawning as well as riparian vegetation have previously been compromised. In some areas, fish passage barriers are present. There is a need to restore historic ecological processes and functions in refuge streams and associated habitat. Positive effects of restoration efforts would include enhanced nutrient production and cycling, improved water quality and support of a diverse riparian and estuarine plant and wildlife community. Restored stream habitats would provide protective cover, improved forage, and structural diversity that results in formation of in-stream riffles and pools for anadromous fish but would also benefit other stream-dependent wildlife species, including rare amphibian species and invertebrates such as mollusks and a large variety of aquatic insects (USFWS 2003a).

Re-establishment or enhancement of native stream-dependent species in their historical habitat may occur in some instances where native populations are extirpated or depauperate. Emphasis will be placed on restoring all native fauna to suitable habitat in refuge streams where previous detrimental land use practices have impacted or extirpated healthy salmonid runs as well as had impacts on other stream-dependent species, such as native mussels and lamprey.

Objective 2.4.3.3 Seasonal, Managed Freshwater Wetlands

Annually protect and maintain 17-317 acres of seasonal, managed freshwater wetland habitats for the benefit of waterbirds, native fish, and native amphibians. These seasonally managed wetlands will have the following attributes:

1) >40% cover of desirable and native wetland plants and short emergent vegetation (e.g., bur-reed, spike rush, water pennywort, smartweed).
2) <5% cover of invasive plant species (e.g., bog loosestrife, tussock).
3) <40% cover of reed canarygrass and undesirable rushes.
4) No bullfrogs.
5) Variable water levels (6 inches to >4 feet).

Alternatives	**Alt. 1**	**Alt. 2**	**Alt. 3**
Acres to Achieve the Objective	**317**	**17**	**25**
Strategies for Achieving the Objective			
A. Soil disturbance (e.g., disking) to control undesirable plant species.	✓	✓	✓
B. Use and maintain infrastructure (e.g., water control structures, dikes) to maintain appropriate water levels and dewater.	✓	✓	✓
C. Water draw-downs by mid-June or July to promote germination of native aquatic and desirable moist soil plants and to control bullfrogs.	✓	✓	✓
D. Prolonged flood-up (>1 year) on an annual rotational basis on both large and small impoundments for habitat management.	✓	✓	✓
E. Use appropriate IPM techniques including mechanical, physical, biological, and chemical methods (see Appendix H) to control invasive or undesirable plant species.	✓	✓	✓
F. Remove non-native plant and animal populations as necessary.	✓		✓

Rationale:

Freshwater wetlands are important habitat for a variety of migratory and wintering waterfowl, wading birds, and shorebird species, as well as fish and native amphibians.

Active management (which includes draw-downs and mechanical/chemical methods) ensures that these areas do not become dominated by invasive plants such as reed canarygrass and common rush (tussock). Desirable wetland plant species such as spike rush, smartweed and bur-reed are maintained by proper application and timing of draw-downs and flood-ups.

Managed wetlands provide breeding habitat for native amphibians such as red-legged frogs, Pacific chorus (tree) frogs, and a variety of native salamanders. Proper timing of draw-downs also allows control of non-native bullfrog populations.

Managed freshwater wetlands currently occur on the Tarlatt, Riekkola, Porter Point, and Lewis units. Under Objectives 2.4.2.2., 2.4.2.4., 2.4.2.6 the acreage of managed freshwater wetlands in the Porter Point, Lewis, and Riekkola units would be reduced due to restoration of estuarine open water, intertidal mudflat, and salt marsh habitat which represent the historical condition of these areas. Due to reduction in the amount of managed freshwater wetlands under Alternatives 2 and 3, problem non-native species such as reed canarygrass, bullfrogs, and nutria would be naturally reduced/eliminated due to loss of habitat in the conversion of managed freshwater wetlands to estuarine habitat. Managed freshwater wetlands would remain at the Tarlatt Unit.

<table>
<tr><th colspan="4">Objective 2.4.3.4 Permanent/Semi-permanent Natural Freshwater Wetlands (Includes Beaver Ponds and Interdunal Wetlands)</th></tr>
<tr><td colspan="4">Annually protect and maintain 610 acres of permanent and semi-permanent, naturally occurring freshwater wetlands (includes beaver ponds and interdunal wetlands) for the benefit of beaver, salmonids (beaver ponds), waterfowl, other waterbirds, landbirds, raptors, and native amphibians. These naturally occurring wetlands are characterized by the following plant communities:
1) Submergents (e.g., pondweeds) in open water (beaver ponds).
2) Desirable and native wetland plants and emergent vegetation (e.g., bur-reed, spike rush, water pennywort, slough sedge, creeping spearwort, cinquefoil and smartweed).
3) Willow shrubs.</td></tr>
<tr><td>Alternatives</td><td>Alt. 1</td><td>Alt. 2</td><td>Alt. 3</td></tr>
<tr><td>Acres to Achieve the Objective</td><td>610</td><td>610</td><td>610</td></tr>
<tr><td>Strategies for Achieving the Objective</td><td></td><td></td><td></td></tr>
<tr><td>A. Use appropriate IPM techniques including mechanical, physical, biological, and chemical methods (see Appendix H) to control invasive or undesirable plant species.</td><td>✓</td><td>✓</td><td>✓</td></tr>
<tr><td>B. Protect and promote natural processes to maintain wetlands.</td><td>✓</td><td>✓</td><td>✓</td></tr>
<tr><td colspan="4">Rationale:
Permanent and semi-permanent natural freshwater wetlands are important habitat for a variety of wildlife.

Beaver ponds often contain snags standing in open water. These snags are important nesting habitat for wood ducks, tree swallows, and woodpeckers. They are also used as hunting perches by a variety of raptors.

Cutthroat trout make extensive use of beaver ponds for overwintering and feeding (Johnson et.al. 1999), and coho often use these areas as winter habitat (Narver 1978 in McMahon 1983). Beaver ponds on Willapa NWR streams provide winter habitat for both juvenile cutthroat and coho. Maintaining beaver ponds on these streams should benefit cutthroat and coho by providing winter habitat as well as rearing and feeding areas (USFWS 2004a).

At Leadbetter Point the deflation plain and dune trough communities containing semi-permanent natural wetlands are of relatively high ecological integrity when compared to what remains of these habitats in Washington. Pockets of native plants in these areas are considered significant (Caicco 1989). Waterfowl, waterbirds, songbirds, and native amphibians use these wetlands.</td></tr>
</table>

2.4.4 Goal 4. Protect, maintain, and restore coastal beach and dune habitats historically characteristic of the southwest Washington coastal region for the benefit of the western snowy plover, streaked horned lark, pink sandverbena, Oregon silverspot butterfly, and a diverse assemblage of other native species.

Objective 2.4.4.1 Protect and Maintain Coastal Dune Ecosystem

Protect and maintain 1,581 acres of coastal dune habitat (Leadbetter Point Unit excluding wetlands). Coastal dune habitat will be maintained where appropriate for the western snowy plover, streaked horned lark, and pink sandverbena. Coastal dune habitat suitable for these species will be characterized by the following attributes:

1) Sparsely vegetated habitat with a ground layer dominated by sand.
2) Large areas of open sand with native beach plants, and shell patches/tidal debris suitable for plover nesting and chick fledging.
3) Presence of native beach plants including pink sandverbena (*Abronia umbellate brevifloria*), beach morning glory (*Convolvulus soldanella*), gray beach pea (*Lathyrus japonicus*), and a native dune grass (*Leymus mollis*).
4) Beach or dune habitat free of introduced beach grasses (*Ammophila* spp.)

Alternatives	Alt. 1	Alt. 2	Alt. 3
Acres to Achieve the Objective	**1,581**	**1,581**	**1,581**
Strategies for Achieving the Objective			
A. Use appropriate IPM techniques including mechanical, physical, biological, and chemical methods (see Appendix H) to control invasive or undesirable plant species.	✓	✓	✓
B. Protect and promote natural processes.	✓	✓	✓
C. Propagation and planting/broadcast seeding native plant species.	✓	✓	✓

Rationale:

Within approximately 1,581 acres of the coastal dune ecosystem, the Refuge has currently restored and maintained 121 acres. Up to an additional 229 acres of coastal dune habitat would be restored for plover nesting. Extensive areas (throughout the Pacific coastline and the Refuge) of formerly open or sparsely vegetated coastal dune habitat continue to be invaded by exotic beach grasses including introduced American beachgrass (*Ammophila breviligulata*) and European beachgrass (*Ammophila arenaria*). These grasses out-compete native vegetation, alter the dune ecosystem and form dense stands that reduce the amount and quality of nesting habitat for native wildlife, including the western snowy plover and streaked horned lark. The invasion of *Ammophila* has caused a dramatic reduction of coastal native plants and is a primary threat to pink sandverbena.

The western snowy plover relies heavily on coastal beaches from southern Washington to Baja California for food, shelter, and raising its young. The Pacific Coast populations of this species have been declining dramatically because of substantial habitat loss related to industrial, urban and recreational development, human disturbance, and encroachment of invasive plants. The coastal population of western snowy plover was listed as threatened by the USFWS in 1993 (USFWS 1993). It is listed as endangered by the State of Washington.

The Leadbetter Point Unit is one of the northernmost breeding sites for the western snowy plover on the Pacific Coast and is the largest and most significant snowy plover nesting area in Washington. The western snowy plover is listed as a resource of concern (see section 2.4.6.1) under the following documents: Northern Pacific coast regional shorebird management plan—U.S. Shorebird Conservation Plan (Drut and Buchanan 2000), Endangered and threatened wildlife and plants; determination of threatened status for the Pacific Coast populations of the western snowy plover (USFWS 1993), Policy on maintaining the biological integrity, diversity and environmental health of the national wildlife refuge system (USFWS 2001b), The U.S. Fish and Wildlife Service's focal species strategy for migratory birds (USFWS 2005b), Recovery Plan for the Pacific Coast Population of the Western Snowy Plover (*Charadrius alexandrinus nivosus*) (USFWS 2007a), Washington state recovery plan for the snowy plover (WDFW 1995), Washington's comprehensive wildlife conservation strategy (WDFW 2005), State of Washington Natural Heritage Plan 2005 Update (WDNR 2005), and State of Washington Natural Heritage Program Information Systems (WDNR 2007).

The streaked horned lark is a candidate species for Federal listing under the ESA, an endangered species in Washington State under the Washington Endangered Species Act, and a priority species for conservation by Oregon-Washington Partners in Flight. Lark nesting habitat is low, sparse vegetation with an abundance of bare ground. The Range-wide Streaked Horned Lark (*Eremophila alpestris strigata*) Assessment and Preliminary Conservation Strategy (Pearson et al. 2005) prioritizes control of invasive beach grasses at coastal breeding sites. The streaked horned lark is likely to become extinct in Washington unless additional nesting areas are established and protected (WDFW 2005).

The streaked horned lark is listed as a resource of concern under the following documents: Conservation strategy for landbirds in lowlands and valleys of western Oregon and Washington. Oregon-Washington Partners in Flight (Altman 2000), Policy on maintaining the biological integrity, diversity and environmental health of the national wildlife refuge system (USFWS 2001b), Birds of conservation concern (USFWS 2002a), Washington's comprehensive wildlife conservation strategy (WDFW 2005), Range-wide Streaked Horned Lark Assessment and Preliminary Conservation Strategy (Pearson et al. 2005), State of Washington Natural Heritage Plan 2005 Update (WDNR 2005), and State of Washington Natural Heritage Program Information Systems (WDNR 2007).

A habitat restoration area to create nesting habitat for the western snowy plover was initiated in 2002 and currently supports the only known population of pink sandverbena in Washington State. This plant species was thought to be extirpated in the state (Federal species of concern, Washington State endangered species).

The pink sandverbena is listed as a resource of concern under the following documents: Policy on maintaining the biological integrity, diversity and environmental health of the national wildlife refuge system (USFWS 2001b), State of Washington Natural Heritage Plan 2005 Update (WDNR 2005), and State of Washington Natural Heritage Program Information Systems (WDNR 2007).

A long-term goal is to protect and maintain the native coastal dune ecosystem at Leadbetter Point. Recovery needs of the western snowy plover, streaked horned lark, and pink sandverbena are all directly supported by protecting and maintaining coastal dune habitat.

Objective 2.4.4.2 Restore Coastal Dune Ecosystem			
Restore up to 229 acres of coastal dune habitat and the native species it supports, especially for the western snowy plover, streaked horned lark, and pink sandverbena. Historically, coastal dunes were characterized by: 1) Sparsely vegetated habitat with a ground layer dominated by sand. 2) Large areas of open sand with native beach plants, and shell patches/tidal debris suitable for plover nesting and chick fledging. 3) Native beach plants including pink sandverbena, beach morning glory, gray beach pea, and a native dune grass. 4) Beach or dune habitat free of introduced beach grasses (*Ammophila* spp.)			
Alternatives	**Alt. 1**	**Alt. 2**	**Alt. 3**
Acres of Dune Habitat Restored and Maintained	**121**	**229**	**229**
Strategies for Achieving the Objective			
A. Use appropriate IPM techniques including mechanical, physical, biological, and chemical methods (see Appendix H) to control invasive or undesirable plant species.	✓	✓	✓
B. Protect and promote natural processes.	✓	✓	✓
C. Use fire suppression techniques (including use of fire-lines, hand tools, backpack and slip-on water pumps) to prevent catastrophic wildfire.	✓	✓	✓
D. Seeds will be collected for conservation insurance and placed in long-term seed storage.	✓	✓	✓
E. Propagation and planting/broadcast seeding of native plant species.	✓	✓	✓
Rationale: Within approximately 1,581 acres of the coastal dune ecosystem, the Refuge has currently restored and maintained 121 acres. Up to an additional 229 acres of coastal dune habitat will be restored for plover nesting. Extensive areas (throughout the Pacific coastline and the Refuge) of formerly open or sparsely vegetated coastal dune habitat continue to be invaded by exotic beach grasses including introduced American beachgrass and European beachgrass. These grasses out-compete native vegetation, alter the dune ecosystem, and form dense stands that reduce the amount and quality of nesting habitat for native wildlife, including the western snowy plover and streaked horned lark. The invasion of *Ammophila* has caused a dramatic reduction of coastal native plants and is a primary threat to pink sandverbena. Western snowy plover numbers have declined along the U.S. Pacific coast due to habitat degradation and expanding predator populations. One of the most significant causes of habitat loss for coastal breeding snowy plovers has been the encroachment of introduced beach grasses. Habitat restoration by removal of beachgrass is recommended in both the Federal (USFWS 2007a) and Washington State (WDFW 1995) recovery plans for the western snowy plover. The U.S. National Shorebird Conservation Plan: Northern Pacific Coast Working Group Regional Management Plan (Drut and Buchanan 2000) also calls for the removal of *Ammophila*.			

The western snowy plover relies heavily on coastal beaches from southern Washington to Baja California for food, shelter, and raising its young. The Pacific Coast populations of this species have been declining dramatically because of substantial habitat loss related to industrial, urban and recreational development, human disturbance, and encroachment of exotic vegetation. On March 5, 1993, the Pacific Coast population of the western snowy plover was listed as threatened under provisions of the Endangered Species Act of 1973 (16 U.S.C. 1531-1544), as amended (USFWS 1993). It is listed as endangered by the State of Washington.

The Leadbetter Point Unit of Willapa NWR is one of the northern-most breeding sites for the western snowy plover on the Pacific Coast. Leadbetter Point is the largest and most significant snowy plover nesting area in Washington. If Willapa NWR implements predator management and the plover population increases, then restored suitable habitat at Leadbetter Point would likely be needed by the growing population.

The western snowy plover is listed as a resource of concern under the following documents: Northern Pacific coast regional shorebird management plan - U.S. Shorebird Conservation Plan (Drut and Buchanan 2000), Endangered and threatened wildlife and plants; determination of threatened status for the Pacific Coast populations of the western snowy plover (USFWS 1993), Policy on maintaining the biological integrity, diversity and environmental health of the national wildlife refuge system (USFWS 2001b), The U.S. Fish and Wildlife Service's focal species strategy for migratory birds. Division of Migratory Bird Management (USFWS 2005b), Recovery Plan for the Pacific Coast Population of the Western Snowy Plover (USFWS 2007a), Washington state recovery plan for the snowy plover (WDFW 1995), Washington's comprehensive wildlife conservation strategy (WDFW 2005), State of Washington Natural Heritage Plan 2005 Update (WDNR 2005), and State of Washington Natural Heritage Program Information Systems (WDNR 2007).

(For the snowy plover, see also Section 2.4.6.1.)

The streaked horned lark is a candidate species for Federal listing under the ESA, an endangered species in Washington State under the Washington Endangered Species Act, anda priority species for conservation by Oregon-Washington Partners in Flight. Lark nesting habitat is low, sparse vegetation with an abundance of bare ground. The Range-wide Streaked Horned Lark Assessment and Preliminary Conservation Strategy (Pearson et al. 2005) prioritizes control of invasive beach grasses at coastal breeding sites. The streaked horned lark is likely to become extinct in Washington unless additional nesting areas are established and protected (WDFW 2005).

The streaked horned lark is listed as a resource of concern under the following documents: Conservation strategy for landbirds in lowlands and valleys of western Oregon and Washington. Oregon-Washington Partners in Flight (Altman 2000), Policy on maintaining the biological integrity, diversity and environmental health of the national wildlife refuge system (USFWS 2001b), Birds of conservation concern (USFWS 2002a), Washington's comprehensive wildlife conservation strategy (WDFW 2005), Range-wide Streaked Horned Lark Assessment and Preliminary Conservation Strategy (Pearson et al. 2005), State of Washington Natural Heritage Plan 2005 Update (WDNR 2005), and State of Washington Natural Heritage Program Information Systems (WDNR 2007).

The Leadbetter habitat restoration area supports the only known population of pink sandverbena in Washington State. This plant species was thought to be extirpated in the state (Federal species of concern, Washington State endangered species). In 2006, it was able to re-establish itself, from a long-term seed bank, because beachgrass had been removed from the site. In addition to removing *Ammophila*, further recovery actions for pink sandverbena include direct augmentation of the population by collecting seed, propagating individuals in a greenhouse, and transplanting those individuals back to the restoration area at Leadbetter or by broadcasting seed. The ultimate goal is to create a self-sustaining verbena population.

The pink sandverbena is listed as a resource of concern under the following documents: Policy on maintaining the biological integrity, diversity and environmental health of the national wildlife refuge system (USFWS 2001b), State of Washington Natural Heritage Plan 2005 Update (WDNR 2005), and State of Washington Natural Heritage Program Information Systems (WDNR 2007).

A long-term goal is to restore additional native coastal dune habitat at Leadbetter Point and then protect and maintain this habitat. Predation risks to plovers and larks are also expected to be somewhat alleviated by this action, thus reducing the detection of nests by predators that may be hunting the edges.

Recovery needs of the western snowy plover, streaked horned lark, and pink sandverbena are all directly supported by restoring coastal dune habitat.

The current habitat restoration area at Leadbetter Point is approximately 121 acres. Additional restoration efforts would take place along the fore dunes and outer beach.

2.4.5 Goal 5. Provide short-grass fields (improved pastures) and grasslands for the benefit of Canada geese, Pacific jumping mouse, and other grassland-dependent species and restore grasslands for the Oregon silverspot butterfly.

Objective 2.4.5.1 Maintain Short-grass Fields (Improved Pastures)

Annually maintain 33-250 acres of improved short-grass fields (pastures) on the Tarlatt Unit, providing quality foraging habitat for Canada geese and meeting the life history needs of other grassland-dependent wildlife. Short-grass fields will be characterized by the following:

1) Short grasses (<4 inch) by October 1.
2) Desirable mix of grasses and grass/legumes (e.g., orchard grass, rye grass, clover, birdsfoot trefoil, and native forbs).
3) <50% cover of non-palatable/invasive plant species (e.g., reed canarygrass, thistle, tussock, tall fescue).

Alternatives	Alt. 1	Alt. 2	Alt. 3
Acres to Achieve the Objective	**250**	**33**	**250**
Strategies for Achieving the Objective			
A. Mow fields (when grazing livestock is not present) to a height of 4 to 6 inches at least twice per year if feasible. Early mowing in May is desirable (if fields are dry enough), as is mowing in late September.	✓	✓	✓

B. Graze livestock in fenced fields from mid-April to early October. Use rotational grazing to maintain a vegetation height of 4 to 6 inches.	✓		✓
C. Conduct soil testing. Apply fertilizer and lime as needed to the fields from May to October (at a time not impacting the grazing livestock with minimal disturbance to migratory birds).	✓		✓
D. Aerate fields, as needed (approximately every five years).	✓		✓
E. Use appropriate IPM techniques including mechanical, physical, biological, and chemical methods (see Appendix H) to control invasive or undesirable plant species.	✓	✓	✓
F. As needed (1-5 years), inter-seed grass with desirable grass/pasture mix.	✓		✓

Rationale:
Canada geese (i.e., dusky, westerns, cackling) use the Refuge and forage exclusively in short-grass fields and marshes. It is important to maintain grass in a short, immature growth form by repeated mowing or livestock grazing during the growing season prior to arrival of migrating waterfowl. Once grass matures, it becomes coarse, much less digestible, and has less protein.

Mammals (elk, deer, bear, coyote, etc.) use the short-grass fields as foraging areas and/or travel routes to adjacent lands. Smaller mammals (voles, mice, etc.) thrive in short-grass fields. These smaller mammals serve as prey for raptors such as red-tailed hawks, northern harriers, American kestrels, and various species of owls, all of which use the short-grass fields as foraging grounds. Other songbird and shorebird species will use short-grass fields.

Objective 2.4.5.2 Restore Grasslands

Restore up to 33 acres of grassland habitat especially for the federally threatened Oregon silverspot butterfly and for a variety of other grassland-dependent species. Grassland habitat for the Oregon silverspot butterfly has the following attributes:

Dominant plant species:
1) red fescue
2) tufted hairgrass
3) early blue violet (host plant for the Oregon silverspot butterfly caterpillar) in patches of 25-35 violets per square meter

Five native nectar plants at a density of no fewer than five flowering stems per square meter. Species include: pearly everlasting, yarrow, California aster, dune goldenrod, and dune thistle.

Alternatives	**Alt. 1**	**Alt. 2**	**Alt. 3**
Acres to Achieve the Objective	**0**	**33**	**33**
Strategies for Achieving the Objective			
A. Utilize appropriate IPM techniques including mechanical, physical, biological, and chemical methods (see Appendix H) to control invasive or undesirable plant species.		✓	✓
B. Use nurseries to raise plant stock.		✓	✓
C. Transplant native grasses and forbs.		✓	✓

D. Direct seeding of native grasses and forbs.		✓	✓
E. Maintain partnerships to restore habitat suitable for the Oregon silverspot butterfly.		✓	✓
F. Private lands biologist position will assist private landowners interested in pursuing management actions that support resources in this objective.		✓	✓

Rationale:

Suitable areas on the Refuge would serve as the focal point for restoration projects to create habitat for the Oregon silverspot butterfly (currently extirpated in Washington state). These areas would be managed long-term to maintain native, early successional grassland communities. The habitat needs of both larval and adult Oregon silverspot butterflies would be met. Habitat management and restoration efforts would provide early blue violet (larval host plant) and promote abundance, provide a minimum of five native nectar species dispersed abundantly throughout the habitat, flowering throughout the entire flight period, and reduce the abundance of invasive non-native plant species (USFWS 2001a). Creation of an appropriate number of acres of high quality habitat would allow reintroduction of this species to occur on the Refuge.

Mammals (elk, deer, bear, coyote, etc.) use grasslands as foraging areas and/or travel routes to adjacent lands. Smaller mammals (voles, mice, etc.) thrive in grasslands. These smaller mammals serve as prey for raptors such as red-tailed hawks, northern harriers, American kestrels, and various species of owls, all of which ue grasslands as foraging grounds. Other songbird and shorebird species will use grasslands.

For the Oregon silverspot butterfly, invasion by exotic species, natural succession, fire suppression, and land development have resulted in loss and modification of the species' habitat. Land use practices have altered disturbance regimes needed to maintain existing habitats and create new habitats for species expansion. (For the Oregon silverspot butterfly, see also Section 2.4.6.2.)

2.4.6 Goal 6. Promote the recovery of federally threatened and endangered as well as Federal candidate and state-listed species.

Objective 2.4.6.1 Western Snowy Plover (Threatened)

Contribute to the recovery of the western snowy plover by protecting and maintaining a five-year average population of 40 breeding pairs of western snowy plovers producing >1.0 fledged chick per male on the Refuge at Leadbetter Point Unit. Ensure long-term protection and management of breeding, wintering, and migration areas to maintain the subpopulation sizes and average productivity; see also Section 2.4.4.1 (Protect and Maintain Coastal Dune Ecosystem) and Section 2.4.4.2 (Restore Coastal Dunes).

Alternatives	**Alt. 1**	**Alt. 2**	**Alt. 3**
Strategies Applied to Achieve Objective			
A. Monitor western snowy plover breeding and wintering populations.	✓	✓	✓
B. Monitor western snowy plover breeding productivity.	✓	✓	✓

C. Research actions as needed.	✓	✓	✓
D. Seasonal beach closures and symbolic fencing.	✓	✓	✓
E. Install predator exclosures (type of cage) for nest protection from predators.	✓	✓	✓
F. As necessary, manage specific avian and/or mammalian predators on a seasonal basis during nesting season.		Avian and mammalian predator control	Avian predator control only
G. In cooperation with WDFW, manage disturbance to nesting western snowy plover, and implement a regulated permit-only elk hunt for the Leadbetter Unit.		✓	✓
H. Annually coordinate western snowy plover monitoring with Leadbetter State Park management.	✓	✓	✓
I. Limit and manage human disturbance to nesting western snowy plover by providing a law enforcement presence and educational resources.	✓	✓	✓

Rationale:
The western snowy plover relies heavily on coastal beaches from southern Washington to Baja California, Mexico for food, shelter, and raising its young. The Pacific Coast populations of this species have been declining dramatically because of substantial habitat loss related to industrial, urban and recreational development, human disturbance, encroachment of exotic vegetation, and the expansion of predator populations. On March 5, 1993, the Pacific Coast population of the western snowy plover was listed as threatened under provisions of the Endangered Species Act of 1973 (1 6U.S.C. 1531-1544), as amended (USFWS 1993). Recovery plans were developed by state and Federal governments to protect this population and its habitat with the ultimate goal of full recovery of the species.

The strategies outlined to achieve this objective are consistent with the goals of the Recovery Plan for Western Snowy Plover, Pacific Coast Population (USFWS 2007a) and the Washington State Recovery Plan for the Snowy Plover (WDFW 1995).

Federal recovery plan recovery criteria for Washington and Oregon (recovery unit): 1) 250 breeding adults, 2) A yearly average of productivity of at least one fledged chick per male has been maintained in each recovery unit in the last five years prior to delisting, 3) Mechanisms have been developed and implemented to ensure long-term protection and management of breeding, wintering and migration areas to maintain the subpopulation sizes and average productivity specific in 1) and 2) (USFWS 2007a).

State recovery plan recovery criteria for the state of Washington: The snowy plover will be considered for down-listing to threatened status when the state supports a four-year average of at least 25 pairs, fledging at least one young per pair per year, at two or more nesting areas with secure habitat. Delisting will be considered when the average population reaches 40 breeding pairs at three or more secure nesting areas (WDFW 1995).

The states of Washington and Oregon are considered a combined recovery unit for the purposes of recovery planning. The Leadbetter Point Unit (see Maps 5-7) is one of the northern-most breeding sites for the western snowy plover on the Pacific Coast. Leadbetter Point is the largest and most significant western snowy plover nesting area in Washington.

The Refuge has recently restored and maintained 121 acres of degraded dune habitat with the primary purpose to enhance the opportunity for the nesting success of these birds. This habitat restoration project for the western snowy plover is discussed in Section 4.9.2 and is further supported in Section 2.4.4.1 (Protect and Maintain Coastal Dune Ecosystem) and Section 2.4.4.2 (Restore Coastal Dunes). During the past four years the Refuge has annually supported approximately 30 breeding adults (95% Confidence Interval = 11-49). The resulting statewide estimated fledgling success rate is 0.71 young fledged per adult male. Further details can be found in Section 4.9.2.

The primary threats to the snowy plover population on the Refuge at Leadbetter Point are habitat degradation caused by human disturbance, introduced non-native beachgrass (*Ammophila* spp.), and predators (USFWS 2007a). Additional disturbance and threats to the Western snowy plover nesting habitat and potentially individual nests on the Refuge includes an expanding elk population; herds of elk frequently feed on native and non-native plants and grasses within the dune habitat that supports the western snowy plover nesting. Elk have been observed to flush plovers from their nests and cause nest abandonment, and they have damaged exclosures (nest cages) that refuge staff place around the eggs/nests to protect them from predators. However, the most direct losses of nests and chicks are due to predation, particularly by crows and ravens, resulting in poor hatching and fledging success on the Refuge.

The Western Snowy Plover is listed as a resource of concern under the following documents: Northern Pacific Coast Regional Shorebird Management Plan - U.S. Shorebird Conservation Plan (Drut and Buchanan 2000), Endangered and threatened wildlife and plants; determination of threatened status for the Pacific Coast populations of the western snowy plover (USFWS 1993), Policy on maintaining the biological integrity, diversity and environmental health of the national wildlife refuge system (USFWS 2001b), The U.S. Fish and Wildlife Service's focal species strategy for migratory birds. Division of Migratory Bird Management (USFWS 2005b), Recovery Plan for the Pacific Coast Population of the Western Snowy Plover (USFWS 2007a), Washington state recovery plan for the snowy plover (WDFW 1995), Washington's comprehensive wildlife conservation strategy (WDFW 2005), State of Washington Natural Heritage Plan 2005 Update (WDNR 2005), and State of Washington Natural Heritage Program Information Systems (WDNR 2007.

In Oregon, lethal predator control has occurred for many years with impressive results in increasing snowy plover productivity. The Refuge would pursue the feasibility of a predator control program targeting specific avian and mammalian predators (see Appendix L, Predator Management Plan).

Objective 2.4.6.2 Oregon Silverspot Butterfly (Threatened; Extirpated from Washington State)

Establish one or more healthy, sustainable populations of the Oregon silverspot butterfly.

- 200 to 500 butterflies for at least 10 years.

Alternatives	Alt. 1	Alt. 2	Alt. 3
Strategies for Achieving the Objective			
A. Implement strategies under Objective 2.4.5.3 to improve grassland habitat, expanding as needed to meet recovery population goals.	✓	✓	✓

B. Partner with various entities as appropriate (i.e., Oregon Zoo, WDFW, Leadbetter State Park, Xerces Society, USFWS Ecological Services, and Willapa Refuge Friends) to establish larval host plant/adult nectar plant populations and reintroduce butterfly populations.	✓	✓	✓
C. Release larvae and/or adult butterflies when an appropriate amount of high-quality habitat has been established.		✓	✓

Rationale:
The federally threatened Oregon silverspot butterfly previously inhabited coastal habitat from northern California to southern Washington. It is now extirpated from Washington State and found only on a few sites in California and Oregon. No Oregon silverspot butterflies have been documented on the Long Beach Peninsula since 1990 (USFWS 2001a). The Oregon silverspot butterfly is state listed as endangered in Washington.

For the Oregon silverspot butterfly, invasion by exotic species, natural succession, fire suppression, and land development have resulted in loss and modification of the species' habitat. The Oregon silverspot inhabits a few areas south of the Refuge located in coastal areas of Oregon.

The Willapa Refuge would identify the appropriate sites within the Refuge and work with partners to establish sustainable populations of the larval host plant, early blue violet (*Viola adunca*), and adult nectaring plants. Maintaining partnerships is critically important to build and maintain a successful long lasting effort for the reintroduction of this species to Washington State.

The Refuge would establish high-quality butterfly habitat, meeting the needs of both larval and adult butterflies, to support a reintroduction effort. Prior to any reintroduction efforts of the butterfly suitable grassland habitat as described in Section.2.4.5.2 would be fully restored.

Recovery criteria (local area only): Delisting can be considered when all of the following conditions have been met:

1) At least one viable Oregon silverspot butterfly population exists in protected habitat in the following areas: Long Beach Peninsula, Washington, and Clatsop Plains, Oregon.
2) Habitats are managed long-term to maintain and restore native, early successional grassland plant communities.
3) This includes developing a management plan.
4) Each population site supports a minimum viable population of 200 to 500 butterflies for at least ten consecutive years.

The refuge will work toward establishing one or more healthy sustainable populations of Oregon silverspot butterfly by meeting recovery goals as outlined in the Federal recovery plan (USFWS 2001a).

The Oregon silverspot butterfly is listed as a resource of concern under the following documents: Policy on maintaining the biological integrity, diversity and environmental health of the national wildlife refuge system (USFWS 2001b), Washington's comprehensive wildlife conservation strategy (WDFW 2005), Olympic-Willapa Hills Wildlife Area Management Plan (WDFW 2006), State of Washington Natural Heritage Plan 2005 Update (WDNR 2005), and State of Washington Natural Heritage Program Information Systems (WDNR 2007).

2.4.7 Goal 7. Gather scientific information (inventories, monitoring, research, assessments, and studies) in support of adaptive management decisions on the Refuge under Goals 1 through 6.

Objective 2.4.7.1 Scientific Information

Conduct high-priority inventory and monitoring (survey) activities as well as research, assessments, and studies to enhance endangered and threatened species protection and recovery as well as habitat management and restoration activities. The gathering of scientific information will assist in evaluating resource management and public use activities to facilitate adaptive management and contribute to the enhancement, protection, use, preservation and management of wildlife populations and their habitats on and off refuge lands. Specifically, they can be used to evaluate achievement of resource management objectives identified under Goals 1 through 6 in the CCP. These activities have the following attributes:

- Data collection techniques would likely have minimal animal mortality or disturbance and minimal habitat destruction.
- Minimum number of samples (e.g., water, soils, vegetative litter, plants, macroinvertebrates, vertebrates) to meet statistical analysis requirements would be collected for identification and/or experimentation in order to minimize long-term or cumulative impacts.
- Proper cleaning of investigator equipment and clothing as well as quarantine methods, where necessary, would minimize the spread or introduction of invasive species.
- Projects will adhere to scientifically defensible protocols for data collection, where available and applicable.

Alternatives	Alt. 1	Alt. 2	Alt. 3
Strategies for Achieving the Objective			
A. Maintain both a full-time wildlife biologist and a career seasonal wildlife biologist at the Refuge to ensure biological information is gathered and analyzed for species recovery, management actions and regional/national data needs.	✓	✓	✓
B. Monitor the status of western snowy plover, marbled murrelet, streaked horned lark, and pink sandverbena, as well as fish, mammal and priority amphibian and invertebrate species on the Refuge.	✓	✓	✓
C. Continue restoration, maintenance, and monitoring of habitat for western snowy plover, streaked-horned lark, pink sandverbena, and marbled murrelet, as well as fish and priority amphibian and invertebrate species.	✓	✓	✓
D. Monitor priority vegetative habitats on the Refuge.	✓	✓	✓
E. Conduct watershed assessments as needed.	✓	✓	✓
F. Continue to partner with local universities, nongovernmental organizations, state and local agencies, and others to conduct research and monitoring activities that will advance the science of habitat management on refuge lands.	✓	✓	✓
G. Assist state and other Federal efforts as feasible (e.g., range-wide snowy plover breeding and winter window surveys, mid-winter brant surveys).	✓	✓	✓

Rationale:
The NWRS Administration Act of 1966, as amended (16 U.S.C. 668dd-ee) requires that the Service "monitor the status and trends of fish, wildlife, and plants in each refuge." Surveys would be used primarily to evaluate resource response to assess progress toward achieving refuge management objectives (under Goals 1 through 6 in this CCP) derived from the NWRS mission, refuge purpose(s), and maintenance of biological integrity, diversity, and environmental health (601 FW 3). Determining resource status and evaluating progress toward achieving objectives is essential to implementing adaptive management on Department of Interior lands as required by policy (522 DM 1). Specifically, results of surveys would be used to refine management strategies, where necessary, over time in order to achieve resource objectives. Surveys would provide the best available scientific information to promote transparent decision-making processes for resource management over time on refuge lands.

Inventories, monitoring, research, assessments, and studies are essential to high-quality habitat and population management. Conducting population surveys for the western snowy plover and compiling data are critical to evaluate population status and measure progress toward goals stated in the Recovery Plan. Similarly, other wildlife populations, habitat conditions, and habitat management practices, including restoration efforts, must be monitored to evaluate their status and effectiveness. Population trends can be used to evaluate habitat effectiveness and guide management actions

Refuges must collect site-specific information and conduct defensible research to provide information for devising, guiding, and adapting management practices. Monitoring habitat conditions provides valuable support and sound decision-making as applied to refuge resource management and also contributes to the Service's ability to modify management practices (adaptive management). Applied research on the Refuge will help address management issues and questions, in theory, would result in improved management decisions for the Refuge and the region. The Refuge has always maintained a close working relationship with several state, Tribal, and local agencies and universities in order to advance the knowledge base of a variety of habitats and plant and wildlife species.

Research is valuable for protecting and understanding refuge resources, determining natural resource components and their interactions, and understanding the consequences of management actions on the parts and the whole. Research is also necessary for the overall advancement of science and scientific inquiry. The Refuge and the surrounding area in conjunction with TNC have been recognized as a premier location to conduct forest restoration research due to the character of the forest environment.

Applied research by universities and other entities will be encouraged and would help address management issues and answer questions, allowing an opportunity to improve management decisions.

Invasive species are a major threat to high quality wildlife habitat, and poses a major problem in the restoration and recovery of rare and listed species. Efforts would be made to work with partners as much as possible in a combined effort to pinpoint infestations and plan and coordinate control efforts both on and off the Refuge.

2.4.8 Goal 8. Foster a connection between refuge visitors and nature. Visitors will have the opportunity to participate in safe, quality, wildlife-dependent recreation activities located throughout Willapa NWR. These activities and programs include wildlife observation, hunting, fishing, environmental education, interpretation, and photography.

Objective 2.4.8.1 Wildlife Observation and Photography

Provide visitors with the opportunity for self-guided wildlife observation and photography on the Leadbetter, Long Island, and Mainland units while limiting the impacts of noise and human activity to sensitive species and their habitats.

1) Focusing on the major wildlife species and groups of wildlife species, including wintering waterfowl (ducks, geese, and swans); other migratory birds such as wading birds; raptors including bald eagles, and neotropical songbirds; elk, deer, bear, etc.
2) Incorporating most of the habitat types found on the Refuge.
3) Emphasize opportunities on Long Island, Tarlatt, Riekkola, and the original Headquarters Unit on a year-round basis.
4) Directly link opportunities to the environmental education and interpretation programs.

Alternatives	Alt. 1	Alt. 2	Alt. 3
Strategies for Achieving the Objective			
A. Enhance and maintain opportunities for self-guided wildlife observation and photography on the Leadbetter, Long Island, and Mainland Units.	✓	✓	✓
B. Conduct wildlife observation and photography workshops/tours with Friends group, volunteers, and staff.	✓	✓	✓
C. Maintain one photo observation blind.	✓	✓	✓
D. Work with various partner groups, e.g., Friends and Audubon Society, and use the Youth Conservation Corps and volunteers to improve and maintain existing trails.	✓	✓	✓
E. Create a new trail based on the restoration along South Bay and new office/visitor information center design.		✓	✓
F. Create one new wildlife observation site.		✓	

Rationale:

Wildlife observation is the primary visitor activity that occurs on the Refuge. Wildlife/nature photography promotes public understanding and appreciation for natural resources. The Refuge will continue to provide high-quality wildlife/nature viewing and photography opportunities. The program is designed to provide a diversity of wildlife viewing opportunities in a manner that minimizes disturbance to wildlife and their habitat. Developing a new trail and observation structure would enhance educational opportunities (associated with the restoration) highlighting the importance of salt marsh habitat in the South Bay, regionally and nationally. Wildlife observation opportunities will continue to be provided on the Refuge by maintaining existing trails and observation sites (Maps 8-10). In addition to the observation boardwalk (Salmon Art Trail), the Refuge offers visitors a photography blind (Tarlatt Unit) that may be used on a first-come, first-served basis. Visitors and school groups may request guided hikes to enhance learning and wildlife/nature observation opportunities on the Refuge.

Objective 2.4.8.2 Interpretive Trails			
Provide up to 3 miles of interpretive trails on the Refuge located on the Headquarters, Leadbetter Point, and Tarlatt units.			
Alternatives	**Alt. 1**	**Alt. 2**	**Alt. 3**
Miles of Trail to Achieve the Objective	**3**	**4**	**4**
Strategies for Achieving the Objective			
A. Establish a 1-mile, year-round trail and observation point on the Tarlatt Unit in conjunction with the office and visitor contact center.		+ 1 mile	+ 1 mile
B. Work with various partner groups, e.g., Friends and Audubon Society, and use the Youth Conservation Corps and volunteers to improve existing and develop new trails.	✓	✓	✓
C. Enhance and maintain 11-12 miles of hiking trails.	✓	✓	✓
D. Develop partnerships (hiking groups, friends, volunteers) to maintain trails.	✓	✓	✓

Rationale:
Interpretive trails are a popular component to the overall public use program on the Refuge. Trails provide visitors with a designated route of travel to view and learn about the Refuge's natural resources, as well as providing protection for sensitive resources through proper routing and construction techniques. Through publications and signage, visitors would be encouraged to stay on the trail, and the interpretive messages will educate them as to why. A new interpretive trail accessing the South Bay in conjunction with the development of a new office/visitor contact station would highlight the salt marsh habitat and its wildlife. The new interpretive trail would be designed to be easily traversed by all age groups.

While hiking is not a priority public use of the NWRS, it does support uses such as wildlife observation, photography, environmental education, and interpretation. Hiking is a popular public use activity on the Refuge. Refuge units with trails include Long Island, Leadbetter Point, East Hills (at Teal Slough and Headquarters), and Tarlatt (Maps 8-10).Carefully planned hiking routes and/or hiking areas, together with use stipulations, can minimize impacts to wildlife while providing high-quality opportunities to experience and learn about the Refuge. Identifying parameters for hiking, such as–resource protection needs, seasonal restrictions, group size limitations, facilities, and visitor information needs–would be an important component of the trails design/route.

Objective 2.4.8.3 Waterfowl Hunting

Waterfowl hunters of all abilities will have the opportunity to participate in a quality, safe waterfowl hunt program that provides a variety of waterfowl hunting experiences that:

1) Poses minimal conflict with wildlife/habitat objectives.
2) Poses minimal conflict with other wildlife-dependent recreation activities.
3) Poses minimal conflict with neighboring lands.
4) Is accessible to a broad spectrum of visitors.
5) Promotes stewardship and conservation.
6) Promotes understanding and appreciation of natural resources and USFWS role.
7) Provides reliable/reasonable opportunity to experience wildlife.
8) Uses accessible facilities that blend into landscape.
9) Uses visitor satisfaction to define and evaluate programs.

Alternatives	**Alt. 1**	**Alt. 2**	**Alt. 3**
Acres available to Waterfowl Hunting	**2,894**	**6,058**	**5,450**
Strategies for Achieving the Objective			
A. Maintain Presidential Proclamation closure to hunting.	✓	✓	✓
B. Retain limited regulated goose hunting on the managed pastures of the Riekkola and Tarlatt units (currently two days per week).	✓		✓
C. Maintain limited access hunting in areas of the south Willapa Bay, Leadbetter Point, Stanley Point, and Porter Point to waterfowl hunting in accordance with state regulations.	✓		✓
D. Limited expansion of hunting in areas of the south Willapa Bay to waterfowl hunting in accordance with state regulations (excluding the Presidential Proclamation Boundary area) and concurrently with tidal restoration.			✓
E. Open all areas of the south Willapa Bay to waterfowl and goose hunting in accordance with state regulations (excluding the Presidential Proclamation Boundary area).		✓	
F. Construct car-top canoe/boat put-in to access to South Bay from Riekkola Unit.		✓	
G. Create and enhance signage for changes in hunt programs.		✓	

Rationale:

Hunting is identified as a priority public use by the NWRS Improvement Act, when it is compatible with National Wildlife Refuge purposes. Public input during the CCP/EIS scoping period identified waterfowl hunting-related issues that included access, facilities, weapon and species restrictions, and the quality of information available on waterfowl and general hunting opportunities.

Through participation in the waterfowl hunt program, hunters would have an opportunity to learn about and understand the Refuge's purpose and resource management activities. Providing opportunities for youth is an important initiative in the USFWS and helps address a public desire to see more hunting opportunities for youth.

Currently, within the state waterfowl hunting season, the Refuge provides waterfowl hunting three days per week and goose hunting two days per week. With the completion of the south Willapa Bay estuarine habitat restoration, the restored salt marsh would be open for waterfowl and goose hunting opportunities (in accordance with state regulations) eliminating the upland hunt restrictions.

The Presidential Proclamation Boundary was established in 1937 to set aside a waterfowl and migratory bird sanctuary in Willapa Bay. This area will remain closed to all waterfowl and migratory bird hunting activity (Maps 8-10).

All hunting occurring on Willapa National Wildlife Refuge is in accordance with Washington State regulations.

Objective 2.4.8.4 Big Game Hunting			
Hunters will have the opportunity to participate in a quality, safe big game hunt (elk, deer, bear) program that provides a variety of hunting experiences. The big game hunt program will: 1) Pose minimal conflict with wildlife/habitat objectives. 2) Pose minimal conflict with other wildlife-dependent recreation activities. 3) Pose minimal conflict with neighboring lands. 4) Be accessible to a broad spectrum of visitors. 5) Promote stewardship and conservation. 6) Promote understanding and appreciation of natural resources and USFWS role. 7) Provide reliable/reasonable opportunity to experience wildlife. 8) Use accessible facilities that blend into landscape. 9) Use visitor satisfaction to define and evaluate programs.			
Alternatives	**Alt. 1**	**Alt. 2**	**Alt. 3**
Acres Available to Big Game Hunting	**6,999**	**11,380**	**10,326**
Strategies for Achieving the Objective			
A. Expand potential hunting opportunities as lands are acquired from willing sellers as outlined in the Land Protection Plan (Appendix A).		✓	✓
B. Expand elk hunting opportunities (permit only) to include a muzzleloader only hunt on the Leadbetter Point Unit.		✓	✓
C. Maintain big game hunt program (elk, deer, bear) on Long Island and the East Hills Units (Maps 8-10).	✓	✓	✓
D. Create and enhance signage for changes in hunt programs.		✓	✓

Rationale:

Recreational hunting (a wildlife-dependent activity) has been identified in the National Wildlife Refuge System Administration Act, as amended, as a priority public use, provided it is compatible with the purpose for which the Refuge was established. The Act declares that compatible wildlife-dependent recreational uses are legitimate and appropriate priority general public uses of the Refuge System. The six wildlife-dependent recreational uses–hunting, fishing, wildlife observation and photography, and environmental education and interpretation–are to receive enhanced consideration in planning and management over all other general public uses of the Refuge System. When compatible, these wildlife-dependent recreational uses are to be strongly encouraged. Public input during the CCP/EIS scoping period identified hunting-related issues that included access, facilities, weapon and species restrictions, and the quality of information available regarding general hunting opportunities. Across Washington, elk and deer are increasingly causing damage to private and commercial property including orchards and landscaping. As a result, there are few, if any places remaining in the state which are willing to accept relocated elk or deer. In addition, relocation has proven a costly option and funding is not available for a long-term solution.

Willapa Refuge currently offers existing elk and deer hunting opportunities in the Long Island Unit and designated portions of the East Hills Units from the Bear River to Teal Slough (Map 8). Proposed elk and deer hunting areas include the upland areas in the South Bay (Lewis, Porter Point, and Riekkola units and a portion of the Tarlatt Unit); and a proposed regulated (permit only) elk hunt on the Leadbetter Point Unit; and any additional lands acquired, would be open to elk and deer hunting (Maps 9 and 10).

Maintaining and/or expanding existing hunting opportunities on the East Hills Units, the South Bay Units and the Leadbetter Point Unit to hunting would complement state-permitted hunting activities locally. Specific species/numbers to be taken and hunting periods would be set by WDFW to reflect the adjacent areas open to elk and deer hunting. This would resolve potential problems over the exact position of the refuge boundary that would exist with an elk/deer hunt closure, and the associated enforcement of relevant laws and regulations.

Objective 2.4.8.5 Fishing

Anglers will have the opportunity to participate for salmon, steelhead, sturgeon, and shellfish fishing in accordance with state seasons, while minimizing disturbance and impacts to other resources.

Alternatives	Alt. 1	Alt. 2	Alt. 3
Strategies for Achieving the Objective			
A. Provide access for motorized and non-motorized boats by maintaining a ramp and providing parking.	✓	✓	✓
B. Maintain refuge portion of Willapa Bay and channel portion of Bear River open for fishing.	✓	✓	✓
C. Maintain public clam beds on Long Island.	✓	✓	✓
D. Allow bank fishing from the Wheaton Unit on the Willapa River.	✓		
E. Fishing will be prohibited in all non-tidal refuge streams and wetlands not mentioned above.	✓	✓	✓

Rationale:

Fishing is identified as a priority public use by the Improvement Act, as long as it is found compatible with National Wildlife Refuge purposes (Appendix C). Fishing is a popular visitor activity that occurs on the Refuge. Currently fishing is allowed on Willapa Bay within the Presidential Proclamation Boundary, accessible by boat. A boat launch facility is provided along Highway 101 across from the current refuge headquarters.

Clamming is allowed on public tidelands found on the west side Long Island within the Presidential Proclamation Boundary. Areas identified in the “Recreational Shellfish Harvesting in Pacific County” booklet are Diamond Point and Pinnacle Rock.

All fishing and clamming activities occurring within the refuge boundary are in accordance with Washington State fishing/shellfish regulations.

Fishing will continue to be prohibited in all non-tidal refuge streams and wetlands not mentioned above.

Objective 2.4.8.6 Environmental Education

Provide environmental education opportunities that initiate a sense of wonder and foster a connection with nature and the Refuge for students both on and off the Refuge annually. A high-quality program would:

1) Fully support national and state academic learning standards.

2) Provide interdisciplinary opportunities that link natural resources through all subject areas.
3) Involve local communities, Friends, volunteers, and other partners.
4) Incorporate the importance of the NWRS and the purpose, goals, and objectives of the Willapa Complex Refuges.
5) Incorporates current conservation issues and concerns.
6) Provide experiences that are hands-on and integrate the habitats and associated plants, fish, and wildlife species found on the Refuge.
7) Use various types of facilities including wildlife observation structures, interpretive exhibits, trails, outdoor classroom shelters, etc.
8) Take place both on and off the Refuge.
9) Involve all three of the Willapa Complex Refuges at varying levels.
10) Be directly linked to wildlife observation and interpretation programs and balanced within the overall public use program.

Alternatives	**Alt. 1**	**Alt. 2**	**Alt. 3**
Estimated No. of Students/yr	**2,500**	**3,000**	**3,000**
Strategies for Achieving the Objective			
A. Encourage the Friends of the Willapa Refuge and volunteers to assist with the Refuge's environmental education program.	✓	✓	✓
B. Increase environmental education emphasis within the Youth Conservation Corps programs.	✓	✓	✓
C. Work with other Federal, state and county natural resource agencies, Tribes, nonprofit conservation organizations, and selected school districts within the local area to help define the specific roles and responsibilities for providing environmental education opportunities on the Refuge.	✓	✓	✓
D. Construct a visitor center and office facility that would include indoor/outdoor environmental education facilities.		✓	✓
E. Establish an environmental education specialist position that would focus specifically on improving the Refuge environmental education program.		✓	✓
F. Develop and provide site-specific materials and tools for educators' use both on- and off-site. These materials should include information about the NWRS and the unique habitats and associated fish and wildlife species and management programs on the Refuge.		✓	

Rationale:
Environmental education activities can foster an understanding and appreciation for our natural resources. As such, environmental education is identified as one of the priority public uses of the NWRS. The Willapa Refuge has an opportunity to provide expanded environmental education programs for local schools. Students participate primarily from southwest Washington and northwest Oregon schools. The environmental education program will focus on integrating environmental concepts and concerns into structured activities on the Refuge, involving educators, students, and others in first-hand activities that promote discovery and fact-finding, developing problem-solving skills, and helping students develop their own ways of personal involvement and action.

Objective 2.4.8.7 Camping			
To facilitate archery hunting, photography, and wildlife-dependent experiences, camping is available in five designated campgrounds on Long Island. These primitive conditions provide isolated vistas and an intimacy with nature.			
Alternatives	**Alt. 1**	**Alt. 2**	**Alt. 3**
Strategies for Achieving the Objective			
A. Maintain five campgrounds with 21 campsites on Long Island.	✓	✓	✓
B. Update and provide brochures, website, and tear sheets with camping info.	✓	✓	✓
C. Provide trail network from several of the campgrounds to the Cedar Grove trail.	✓	✓	✓
D. Work with various partner groups, e.g., Friends and Audubon Society, and use the Youth Conservation Corps and volunteers to improve/maintain existing trails and campsites.	✓	✓	✓

Rationale:
Public scoping indicated continued demand for camping opportunities on Long Island Unit.

While camping is not a priority public use of the NWRS, on Long Island it does support wildlife-dependent public uses such as hunting, wildlife observation, photography, environmental education, and interpretation. Maintaining a camping program is important for public safety reasons due to the tides and accessibility limits to and from the island.

An appropriate use and compatibility determination have been applied to camping (see Appendices B and C).

Access to Long Island's trails and campsites requires some form of watercraft. Motorized and non-motorized boating (e.g., canoeing, kayaking) is currently constrained due to the tides (shallowness of the bay at low tides) as well as distance between the boat launch and camping access points. A main trail down the center of the island provides access to several of the campsites. Occasionally the refuge staff and volunteers need to maintain and rehabilitate some of the 21 campsites.

Objective 2.4.8.8 Develop an Administrative/Maintenance and Visitor Facility			
Design and build a refuge administrative/maintenance and visitor facility to be constructed within the life of the CCP.			
Alternatives	**Alt. 1**	**Alt. 2**	**Alt. 3**
Strategies for Achieving the Objective			
A. Partner with Friends of the Willapa Refuge, TNC, local community and the State.	✓	✓	✓
B. Locate the new facility on Tarlatt Unit.		✓	✓
C. Create a facility recognized as the latest symbol of energy efficient design in southwest Washington using many partners. Design a facility using effective "green" energy efficient resources.		✓	✓
D. Construct office space for a projected 21 staff.		✓	✓
E. Develop approximately 12 acres of refuge lands for administrative, visitor, and maintenance facilities.		✓	✓

F. Remove proposed headquarters development area from the wetlands reserve program according to Natural Resources Conservation Science (NRCS) regulations.		✓	✓
G. Move refuge maintenance operations and equipment shop and storage from three existing sites to consolidate operations at proposed Tarlatt Slough headquarters HQ site.		✓	✓
H. Develop HQ building and site to provide visitor parking for 55 cars and 3 buses, 1 mile of trails; construct an 11,000 sf. office and visitor building, and construct site amenities to serve up to 150,000 visitors per year.		✓	✓
I. Restore current HQ site and dispersed maintenance facilities to protect, maintain and restore habitats characteristic of the Willapa Bay region for the benefit of migratory birds, salmonids, amphibians, mussels, lamprey, and a diverse assemblage of other native species.		✓	✓
J. Maintain public access to the Willapa Interpretive Art Trail, parking lot, and public boat ramp on Highway 101		✓	✓
K. Maintain current HQ and Maintenance facilities	✓		

Rationale:

The Refuge has been identified in the Service's maintenance and management system (MMS) to receive a new visitor contact station and administrative/maintenance facility. Funding is expected within the life of the CCP (15 years). This CCP identifies partners, location, and design elements for the Service's standardized facility. The current office/maintenance and visitor contact facility is located along Highway 101. This office building was formerly a home and was built in late 1930s. A change in location is preferable due to the lack of potable water, no sanitation service, electrical wiring issues (safety concerns), inadequate fire escape routes, and visitor access from the highway. Various potential locations were identified for the facility on the Refuge, yet due to constraints regarding accessibility of utilities and limited public access, the preferred location was identified on the Tarlatt Unit.

The location of the proposed facilities would have city water and sewage. It is closer to the population center on the Long Beach Peninsula which would allow greater public access to Refuge visitor services. The facilities would meet Leadership in Energy and Environmental Design (LEED) energy conservation and sustainability standards. A site plan combines creatively-designed visitor facilities with habitat restoration efforts in an attempt to provide the visitor with a natural and educational experience. Other features of the project include an outdoor classroom shelter and a new interpretive trail. The interpretive trail would be along an existing dike road from the new visitor information center to a new observation deck on the south bay, which would offer unparalleled views of the bay and migratory birds. Overall, the new facilities location would better serve the community, improve staff productivity, conserve crucial wildlife habitat, reduce annual operations and maintenance costs, and serve as an interpretive area for approximately 150,000 annual visitors.

2.4.9 Goal 9. Protect and preserve the cultural resources of the Refuge for the benefit of present and future generations.

Objective 2.4.9.1 Cultural Resources			
Implement cultural resource education and management programs that meet the requirements of the NHPA, state education/curriculum needs, consultation, identification, inventory, evaluation, and protection of all cultural resources.			
Alternatives	**Alt. 1**	**Alt. 2**	**Alt. 3**
Strategies for Achieving the Objective			
A. Identify archaeological sites that coincide with existing and planned roads, facilities, public use areas, and habitat projects. Evaluate threatened and impacted sites for eligibility to the National Register of Historic Places. Prepare and implement activities to mitigate impacts to sites as necessary.	✓	✓	✓
B. Evaluate the National Register of Historic Places eligibility of those archaeological sites that may be impacted by refuge management activities or erosion.	✓	✓	✓
C. Prepare environmental/cultural education materials for interpretation displays/exhibits/brochures regarding cultural resources of the Refuge.		✓	✓
D. Protect cultural resource sites through law enforcement patrols.	✓	✓	✓
Rationale: Interpretation of cultural resources can instill a sense of stewardship among the public and others who encounter these resources. The goals of the cultural resource education and interpretive program are: to inspire an appreciation for the Native American culture and perspective of the cultural resources on the Refuge, relate the connection between cultural resources and natural resources, and the role of humans in the environment (which is one of the goals of the NWRS), and inspire an understanding and the conservation of our cultural heritage, including archaeological sites.			

2.4.10 Goal 10. Contribute to the protection of the long-term environmental health of the Willapa Bay ecosystem.

Objective 2.4.10.1 Refuge Boundary Expansion			
Within five years, begin implementing the new Land Protection Plan, recognizing the prioritized lands which provide habitat for endangered and threatened wildlife and the overall protection of the Willapa Bay ecosystem.			
Alternatives	**Alt. 1**	**Alt. 2**	**Alt. 3**
Acres to Achieve the Objectives	**761**	**4,895**	**6,804**
Strategies for Achieving the Objective			
A. As funding becomes available, continue to acquire the identified priority lands from willing sellers through fee, easement, or agreement.	✓	✓	✓
B. Work with willing sellers within current acquisition boundary.	✓	✓	✓

C. Work with partners and neighbors to identify, protect, and restore wildlife resources within the Willapa Bay ecosystem.	✓	✓	✓
D. Provide technical assistance and encourage best management practices for private land owners on conservation matters, using the Refuge's private lands biologist.	✓	✓	✓
E. Work with the county, state, nongovernmental organizations, and other interested parties to address land protection needs.	✓	✓	✓
F. Divest Shoalwater and Wheaton units of the Refuge.		✓	✓

Rationale:
Land use activities have impacted fish and wildlife habitat values in the Willapa Bay area. Increased pressure from development for residential use as well as timber harvest make additional protection critical. There is a need to restore and increase the amount of late-successional forest, freshwater stream habitat, salt marsh, and other habitats currently at risk to further impacts.

The Refuge contains portions of the typical habitats found in and around Willapa Bay. However, some of the refuge units are small in size and the ability of the Refuge to provide landscape-level benefits such as watershed protection and buffers to sensitive habitats are somewhat compromised.

Acquisition efforts would increase land protection and allow habitat restoration efforts to take place for federally threatened species, anadromous fish, migratory birds, and other native wildlife. Efforts to protect and improve forests in the Willapa Bay area would provide habitat for the marbled murrelet and spotted owl, which are both federally listed as threatened (However, the spotted owl is currently extirpated from the Refuge.) Long-term protection of the watershed and water quality would also be provided through these efforts.

Willapa Bay is often described as one of the most pristine water bodies along the western coast of the United States. Mariculture is a large fishing industry that relies completely on the good water quality of the bay. In addition to commercial shellfish operations and commercial fishing, recreational clamming, crabbing, and fishing are also supported by the excellent water quality and healthy tidelands of Willapa Bay. All are important industries and activities in Pacific County.

Nonpoint source pollution in the bay may increase and degrade the water quality within the watershed as lands are cleared and developed with roads and homes constructed. Potential nutrient loads, sedimentation, concentrations of pollutants, with runoff in the future, may all contribute and degrade this important ecosystem and its fishery resources.

Recovery efforts regarding the marbled murrelet and spotted owl would best be accomplished by large contiguous areas of late-successional forest in the Willapa Bay area. (Late-successional forests are forests in the mature and old-growth age classes). Currently, suitable late-successional forest habitat in the Willapa Bay area is isolated and highly fragmented. Less than 1% of the original old-growth forests remain in the 700,000-acre Willapa Bay watershed (Davis et al. 2009).

Currently, second- and third-growth forests dominate the watershed. According to recommendations in the Recovery Plan for the Threatened Marbled Murrelet, in order to maintain a well-distributed marbled murrelet population, recovery efforts should be directed toward increasing the size and distribution of marbled murrelet populations between the southern Olympic Peninsula and the small populations in southwestern Washington. Non-Federal lands in this area currently provide a limited amount of marbled murrelet nesting habitat and have the potential to be managed to increase the amount of suitable nesting habitat in the future (USFWS 1997).

Since 2003, the Willapa Refuge and TNC have been collaborating to restore forests on their respective properties at a landscape scale, with a focus on marbled murrelet recovery as well as restoring ecological function to these former commercial forests.

Efforts toward additional protection of the Willapa Bay watershed have been initiated between a number of entities including the Refuge and TNC, as well as State and County agencies and private landowners.

2.4.11 Goal 11. Provide support for off-refuge conservation efforts in southwest Washington in partnership with private landowners, agencies, and nongovernmental organizations.

Objective 4.11.1 Private Lands Program

Work in partnership with private landowners, nongovernmental organizations, Tribes and other agencies for voluntary protection, enhancement, and restoration of native habitats and the associated fish, wildlife, and plants.

Attributes of habitat and wildlife project assistance:

- Occur on lands near or adjacent to the Refuge.
- Provide a connection to active refuge projects.
- Benefit and support the Service's trust species and programs (i.e., Birds of Conservation Significance, Birds of Management Concern).
- Benefit threatened and endangered species.
- Support state wildlife action plans.

Alternatives	Alt. 1	Alt. 2	Alt. 3
Strategies for Achieving the Objective			
A. Provide technical assistance and implementation for restoration projects.		✓	✓
B. Provide financial assistance to landowners and organizations.		✓	✓
C. Develop and maintain memorandums of understanding (and/or cooperative agreements) and other agreements with Federal agencies, Tribes, state, local governments, and private stakeholders to share equipment, staff, funds, and services.	✓	✓	✓
D. Implement the Partners for Fish and Wildlife Program Strategic Plan within the Willapa Bay and lower Columbia River estuary.		✓	

Rationale:
The decline of the quantity and quality of wildlife habitat around Willapa Bay has necessitated looking beyond the refuge boundaries to identify areas for protection and restoration. The private lands program provides the means to initiate partnerships with diverse groups and

individuals to complete projects that protect and restore coastal habitats outside of refuge boundaries. These projects help to restore habitat connectivity and offset increased pressures from development for residential use as well as timber harvest that have impacted fish and wildlife habitat values around the Willapa Bay area.

The private lands program provides opportunity to work with willing private landowners, nongovernmental organizations, and other government agency partners to protect and restore important wildlife habitat areas on a landscape level. This level of protection and restoration provides benefits such as watershed protection and buffers to sensitive habitats. Working with partners in the private lands program enables conservation to be delivered more effectively and leverage financial and technical resources from other conservation entities including other governmental agencies, nongovernmental organizations, and private landowners. These projects would help to enhance the wildlife habitats currently exiting within the boundary of the Willapa Refuge Complex.

Developing working relationships with landowners in the Willapa Bay area and outside refuge boundaries provides opportunity to restore and increase the amount of late-successional forest, freshwater stream habitat, salt marsh, and other habitats currently at risk and at a landscape level. Focusing on a landscape-scale approach to the protection and restoration of these unique habitats helps to offset the loss of and reduces the impacts to native habitats that would negatively affect federally threatened species, anadromous fish, migratory birds, and other native wildlife. Efforts to protect and improve forests in the Willapa Bay area will provide habitat for the marbled murrelet and spotted owl which are both listed as threatened under the Endangered Species Act. (However, the spotted owl is currently extirpated from the area surrounding Willapa Bay.) Long-term protection of the watersheds and water quality would also be provided through these partnership efforts.

The Willapa National Wildlife Refuge contains portions of the typical habitats found in and around Willapa Bay. However, some of the refuge units are small, and the ability of the Refuge to provide landscape-level benefits such as watershed protection and buffers to sensitive habitats are somewhat compromised.

Working with private landowners to restore and protect these unique coastal habitats ensures that protection and restoration is targeted at accomplishing these activities on watershed/landscape levels. To ensure the success of the private lands program and ultimately protect and restore habitat essential to the recovery of threatened and endangered wildlife species partnerships will be developed, projects identified that will enrich existing Refuge habitat and obtain funding for these projects to be planned, implemented and completed. The Partners and Coastal Programs enable conservation to be delivered more effectively by leveraging financial and technical resources from other conservation entities (other governmental organizations, nongovernmental organizations, and private landowners).

Willapa Bay is often described as one of the most pristine water bodies along the western coast of the U.S. Mariculture is a large fishing industry which relies completely on good water quality in the bay. In addition to commercial shellfish operations and commercial fishing, recreational clamming, crabbing and fishing are also supported by the water quality and healthy tidelands of Willapa Bay. All are important industries and activities in Pacific County.

Nonpoint source pollution in the bay may increase and degrade the water quality within the watershed as lands are cleared and developed with roads and homes constructed. Potential nutrient loads, sedimentation, concentrations of pollutants, with runoff in the future, may all contribute and degrade this important ecosystem and its fishery resources.

Recovery efforts regarding the marbled murrelet and spotted owl would best be accomplished by large contiguous areas of late-successional forest in the Willapa Bay area. (Late-successional forests are forests in the mature and old-growth age classes). Currently, suitable late-successional forest habitat in the Willapa Bay area is isolated and highly fragmented. Less than 1% of the original old-growth forests remain in the 700,000-acre Willapa Bay watershed (Davis et al. 2009). Currently, second- and third-growth forests dominate the watershed. According to recommendations in the Recovery Plan for the Threatened Marbled Murrelet, in order to maintain a well-distributed marbled murrelet population, recovery efforts should be directed toward increasing the size and distribution of marbled murrelet populations between the southern Olympic Peninsula and the small populations in southwestern Washington. Non-Federal lands in this area currently provide a limited amount of marbled murrelet nesting habitat and have the potential to be managed to increase the amount of suitable nesting habitat in the future (USFWS 1997).

Since 2003, the Willapa National Wildlife Refuge and TNC have been collaborating to restore forests on their respective properties at a landscape scale, with a focus on marbled murrelet recovery as well as restoring ecological function to these former commercial forests.

Efforts toward additional protection of the Willapa Bay watershed have been initiated between a number of entities including the Refuge and TNC, as well as State and County agencies as well as private landowners.

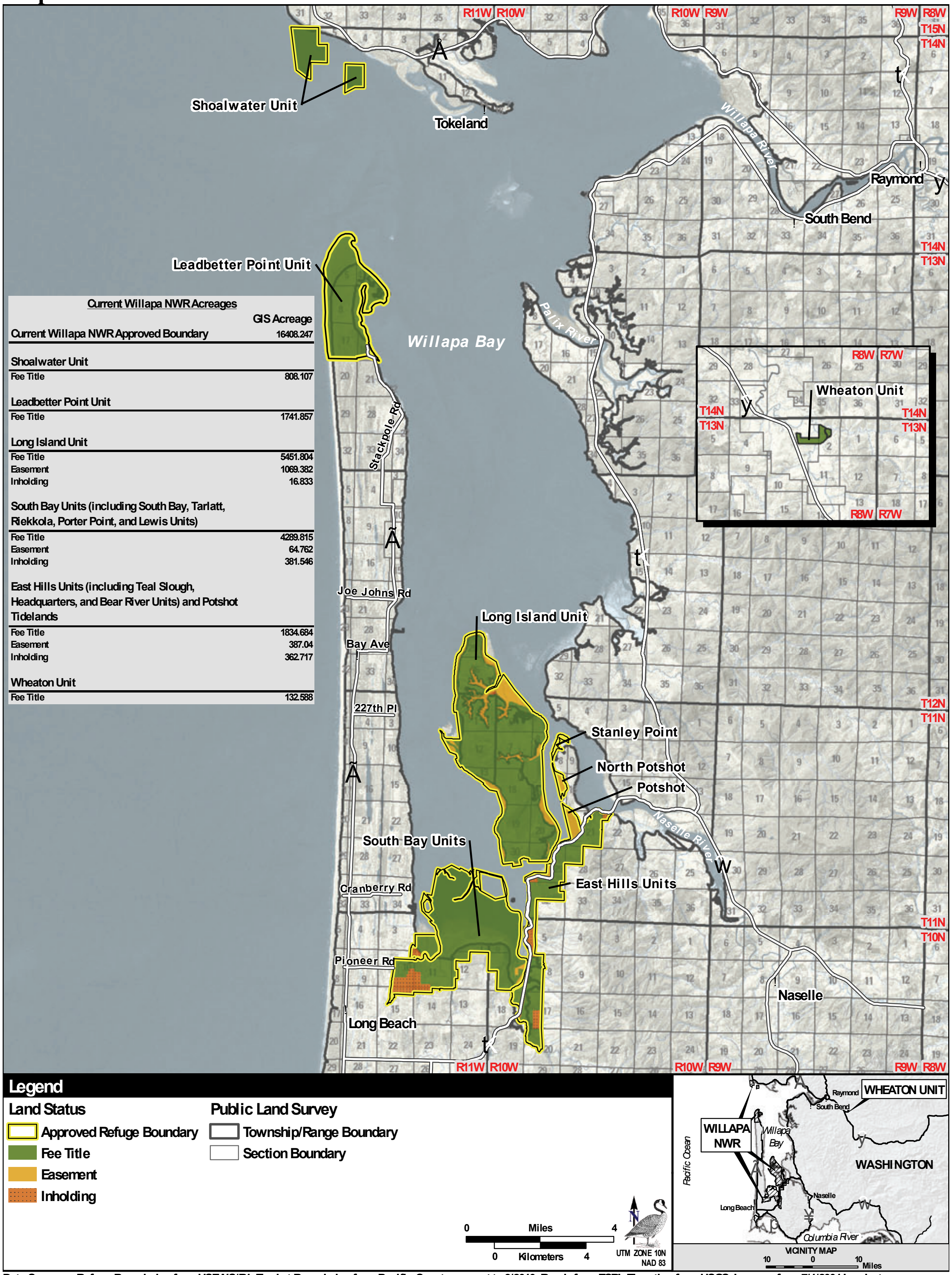
Table 2-1. Alternatives Summary Table for the Willapa CCP/EIS

Theme/Issue	Alternative 1 Continue Current Management	Alternative 2 Healthy Wildlife Habitats, Endangered Species and Biodiversity Gains, Focused Refuge Expansion, Expanded Public Use	Alternative 3 Partial Restoration of Habitats, Endangered Species Gains, Limited Refuge Expansion, Moderate Public Use
Forest Habitat			
Late-successional Sitka spruce zone forest	Protect and maintain 557 acres of existing late-successional Sitka spruce forest, while implementing forest management techniques where necessary to accelerate development of late-successional conditions in 6,178 acres of second-growth Sitka spruce forest	Same as Alternative 1	Same as Alternative 1
Estuarine Habitats			
Open water	Annually protect and maintain 878 acres of open water and channel habitat	Same as Alternative 1 and increase open water on Lewis, Porter Point, and Riekkola units to County Road (0.2 acre)	Same as Alternative 1
Intertidal flats	Annually protect and maintain 4,178 acres of intertidal flats	Same as Alternative 1 and increase intertidal flats (11 acres)	Same as Alternative 1 and increase intertidal flats (2 acres)

Theme/Issue	Alternative 1 Continue Current Management	Alternative 2 Healthy Wildlife Habitats, Endangered Species and Biodiversity Gains, Focused Refuge Expansion, Expanded Public Use	Alternative 3 Partial Restoration of Habitats, Endangered Species Gains, Limited Refuge Expansion, Moderate Public Use
Salt marsh	Annually protect and maintain 1,636 acres of salt marsh	Same as Alternative 1 and increase salt marsh (749 acres)	Same as Alternative 1 and increase salt marsh (429 acres)
Freshwater Aquatic Habitats			
Riverine	Protect, maintain and conduct restoration activities within the 27 miles of riverine habitats	Same as Alternative 1	Same as Alternative 1
Wetlands, seasonally managed	Annually protect and maintain 317 acres of seasonal, managed freshwater wetland habitats on Tarlatt, Riekkola, Porter Point, and Lewis units	Annually protect and maintain 17 acres of seasonal, managed freshwater wetland on the Tarlatt Unit	Annually protect and maintain 25 acres of seasonal, managed freshwater wetland on Riekkola and Tarlatt units
Wetlands, naturally occurring	Annually protect and maintain 610 acres of permanent and semi-permanent, naturally occurring freshwater wetlands	Same as Alternative 1	Same as Alternative 1
Coastal Habitat			
Coastal dune	Maintain and protect 1,581 acres at Leadbetter Point Unit (not including wetlands)	Same as Alternative 1 and restore 229 acres	Same as Alternative 2
Upland Field Habitats			
Short-grass fields	Maintain 250 acres of short-grass fields on Riekkola/Tarlatt units	Restore pasture on the Riekkola Unit to salt marsh habitat	Same as Alternative 1
Grassland	Maintain 33 acres of grassland habitat through IPM control at the Tarlatt Unit	Establish 33 acres of habitat for Oregon silverspot butterfly at Tarlatt/Leadbetter Point units	Same as Alternative 2
Federal and State Listed Species			
Western snowy plover	Protect western snowy plover and their habitat from nest predation, human disturbance, and invasive species	Same as Alternative 1 and avian and mammalian predator management as necessary	Same as Alternative 1 and avian predator management as necessary
Oregon silverspot butterfly	Current management has limited management focus for this species	Reintroduce Oregon silverspot butterfly to successful host plant habitat (33acres)	Same as Alternative 2
Recreation			
Wildlife observation and photography	Maintain opportunities for self-guided wildlife observation and photography on theLeadbetter Point, Long Island, and Mainland units	Same as Alternative 1 plus expanded opportunities at Tarlatt Unit, new trail and South Bay observation deck, concurrent with tidal restoration	Same as Alternative 1
Interpretive trails	Maintain 3 miles of existing interpretive trail	Add 1 mile interpretive trail and South Bay observation deck, concurrent with tidal restoration	Same as Alternative 1

Theme/Issue	Alternative 1 Continue Current Management	Alternative 2 Healthy Wildlife Habitats, Endangered Species and Biodiversity Gains, Focused Refuge Expansion, Expanded Public Use	Alternative 3 Partial Restoration of Habitats, Endangered Species Gains, Limited Refuge Expansion, Moderate Public Use
Waterfowl hunting	Regulated goose hunting on Riekkola Unit (currently 2 days per week), Leadbetter Point/ Stanley Point (currently 7 days per week), Porter Point (currently 3 days per/week), 2,894 acres available	All areas of the Refuge (excluding the Presidential Proclamation Boundary and Tarlatt Slough) open in accordance with state season, 6058 acres available	Limited expansion of hunting on South Bay and regulated goose hunting on Riekkola Unit, 5450 acres available
Big game hunting (archery only on long island)	Long Island and mainland portion of the Refuge (excluding Headquarters) open	Same as Alternative 1 plus expand elk and deer hunting in South Bay and permit-only elk hunt on Leadbetter Point Unit	Same as Alternative 1 plus limited elk and deer hunting in South Bay and regulated elk hunt on Leadbetter Point.
Fishing	Maintain refuge portion of Willapa Bay and channel portion of Bear River open for fishing	Same as Alternative 1	Same as Alternative 1
Environmental education and Interpretation	Maintain current program providing on- and off-site environmental education and interpretation programs	Same as Alternative 1 with increased on-site environmental education program with addition of new visitor facility	Same as Alternative 1
Camping	Maintain five campgrounds with 21 campsites on Long Island	Same as Alternative 1	Same as Alternative 1
Visitor/admin-istrative and maintenance facility	Maintain current site and existing facilities	Construct new office/maintenance and visitor facility at Tarlatt Unit	Same as Alternative 2
Cultural Resources			
Cultural resource protection	Protect cultural resource sites through best management practices	Same as Alternative 1	Same as Alternative 1
Refuge Boundary Expansion			
North Bay	Maintain ownership of Cape Shoalwater and Wheaton units	Divest property Cape Shoalwater and Wheaton units	Same as Alternative 2
Nemah-Naselle	No expansion of refuge acquisition boundary	Proposed expansion 1,909 acres	Same as Alternative 2
East Hills	No expansion of refuge acquisition boundary	Proposed expansion 4,334 acres	Same as Alternative 2
South Bay	No expansion of refuge acquisition boundary	Proposed expansion 561 acres	Same as Alternative 2

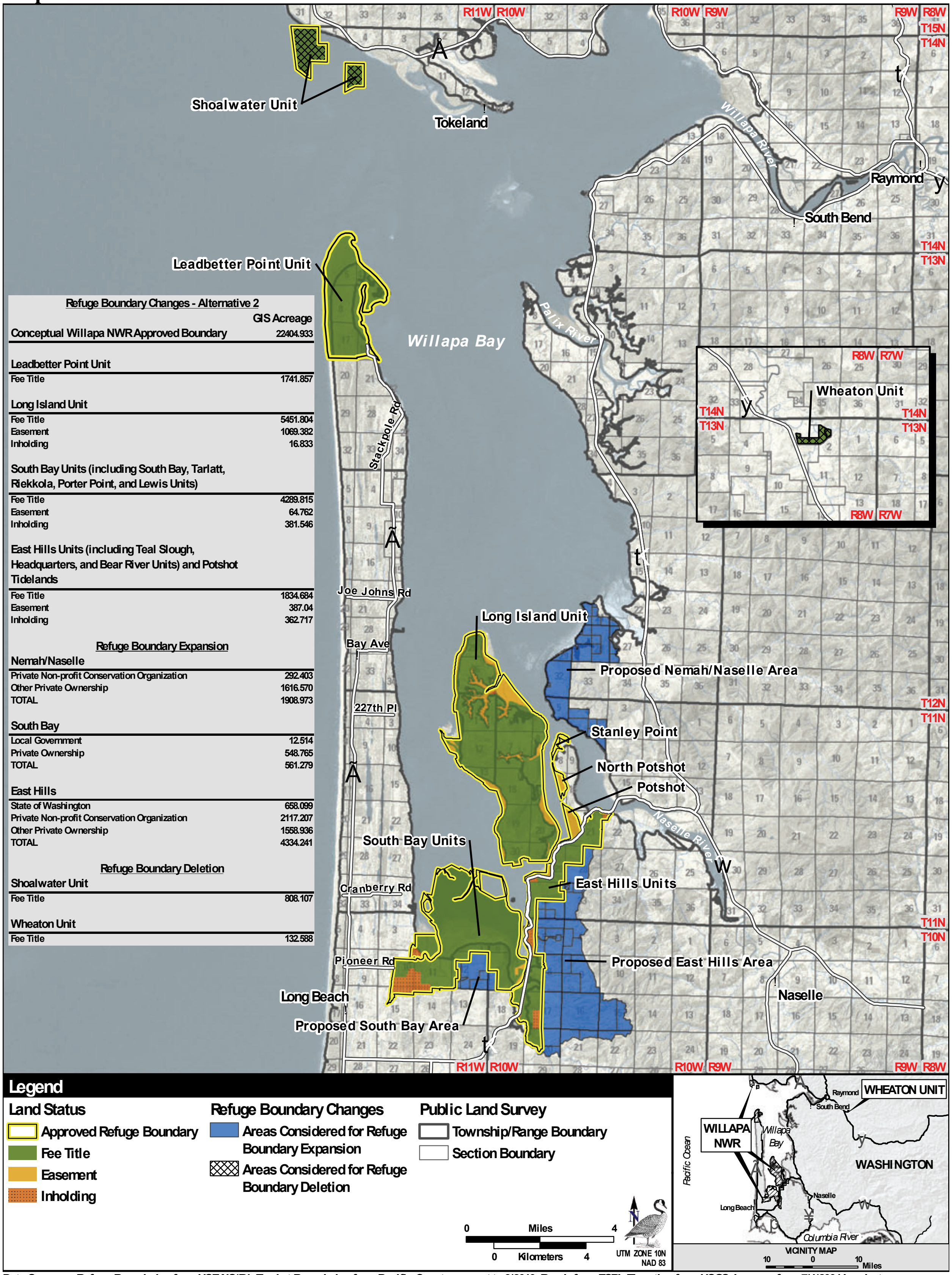
Map 2. Land Status—Alternative 1



Current Willapa NWR Acreages	GIS Acreage
Current Willapa NWR Approved Boundary	16408.247
Shoalwater Unit	
Fee Title	808.107
Leadbetter Point Unit	
Fee Title	1741.857
Long Island Unit	
Fee Title	5451.804
Easement	1069.382
Inholding	16.833
South Bay Units (including South Bay, Tarlatt, Riekkola, Porter Point, and Lewis Units)	
Fee Title	4289.815
Easement	64.762
Inholding	381.546
East Hills Units (including Teal Slough, Headquarters, and Bear River Units) and Potshot Tidelands	
Fee Title	1834.684
Easement	387.04
Inholding	362.717
Wheaton Unit	
Fee Title	132.588

Data Sources: Refuge Boundaries from USFWS/R1; Tax Lot Boundaries from Pacific County, current to 3/2010; Roads from ESRI; Elevation from USGS; Imagery from 7/1/2001 Landsat

Map 3. Land Status—Alternative 2



Data Sources: Refuge Boundaries from USFWS/R1; Tax Lot Boundaries from Pacific County, current to 3/2010; Roads from ESRI; Elevation from USGS; Imagery from 7/1/2001 Landsat

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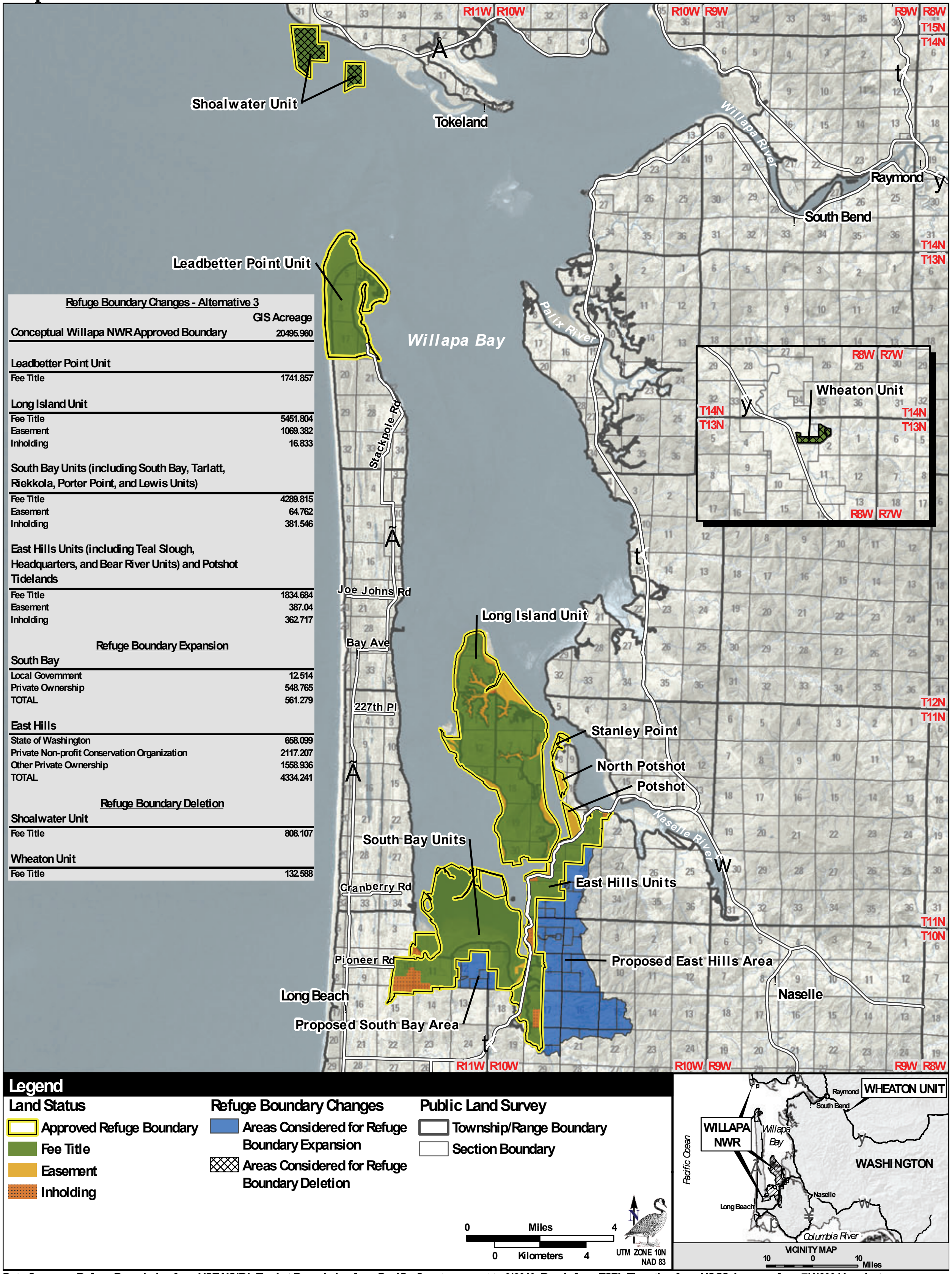
Map 4. Land Status—Alternative 3



Refuge Boundary Changes - Alternative 3	GIS Acreage
Conceptual Willapa NWR Approved Boundary	20495.960
Leadbetter Point Unit	
Fee Title	1741.857
Long Island Unit	
Fee Title	5451.804
Easement	1069.382
Inholding	16.833
South Bay Units (including South Bay, Tarlatt, Riekkola, Porter Point, and Lewis Units)	
Fee Title	4289.815
Easement	64.762
Inholding	381.546
East Hills Units (including Teal Slough, Headquarters, and Bear River Units) and Potshot Tidelands	
Fee Title	1834.684
Easement	387.04
Inholding	362.717
Refuge Boundary Expansion	
South Bay	
Local Government	12.514
Private Ownership	548.765
TOTAL	561.279
East Hills	
State of Washington	658.099
Private Non-profit Conservation Organization	2117.207
Other Private Ownership	1558.936
TOTAL	4334.241
Refuge Boundary Deletion	
Shoalwater Unit	
Fee Title	808.107
Wheaton Unit	
Fee Title	132.588

Data Sources: Refuge Boundaries from USFWS/R1; Tax Lot Boundaries from Pacific County, current to 3/2010; Roads from ESRI; Elevation from USGS; Imagery from 7/1/2001 Landsat

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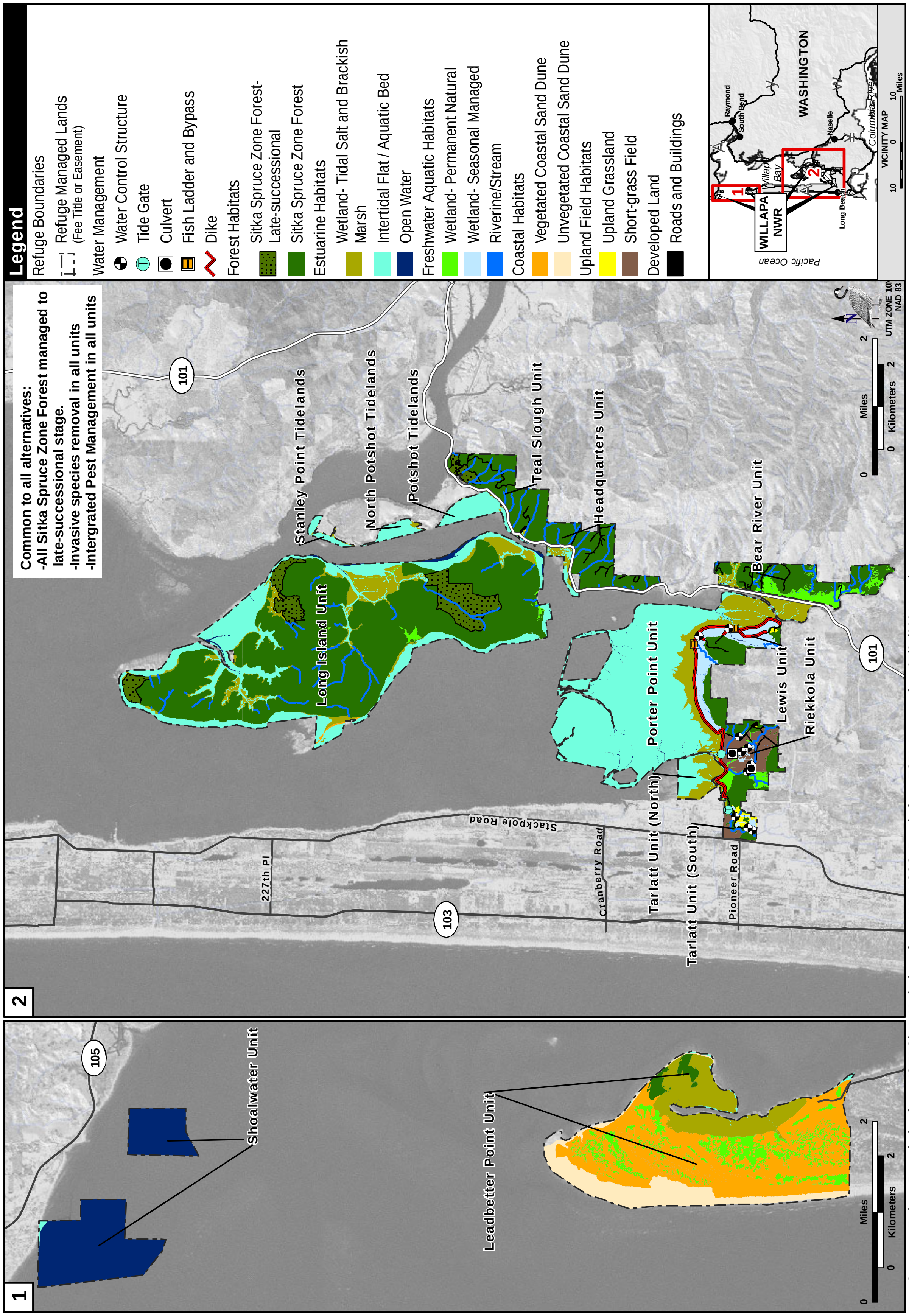
Map 5. Willapa National Wildlife Refuge Habitats - Alternative 1



Data Sources: Refuge Boundaries from USFWS/R1; Hydrology from NHD USGS; Roads from ESRI; Imagery fom 07/01/2001 Landsat

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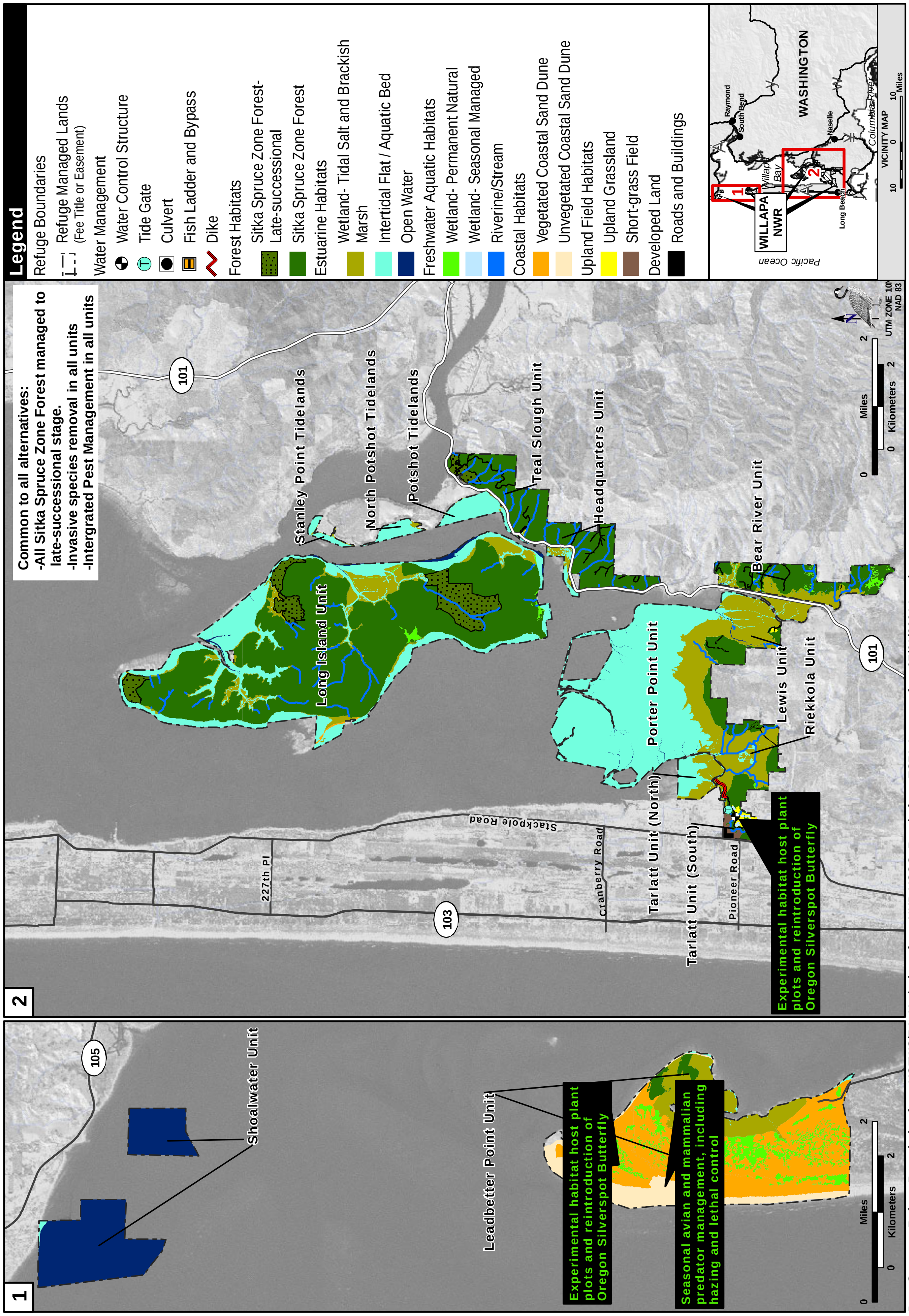
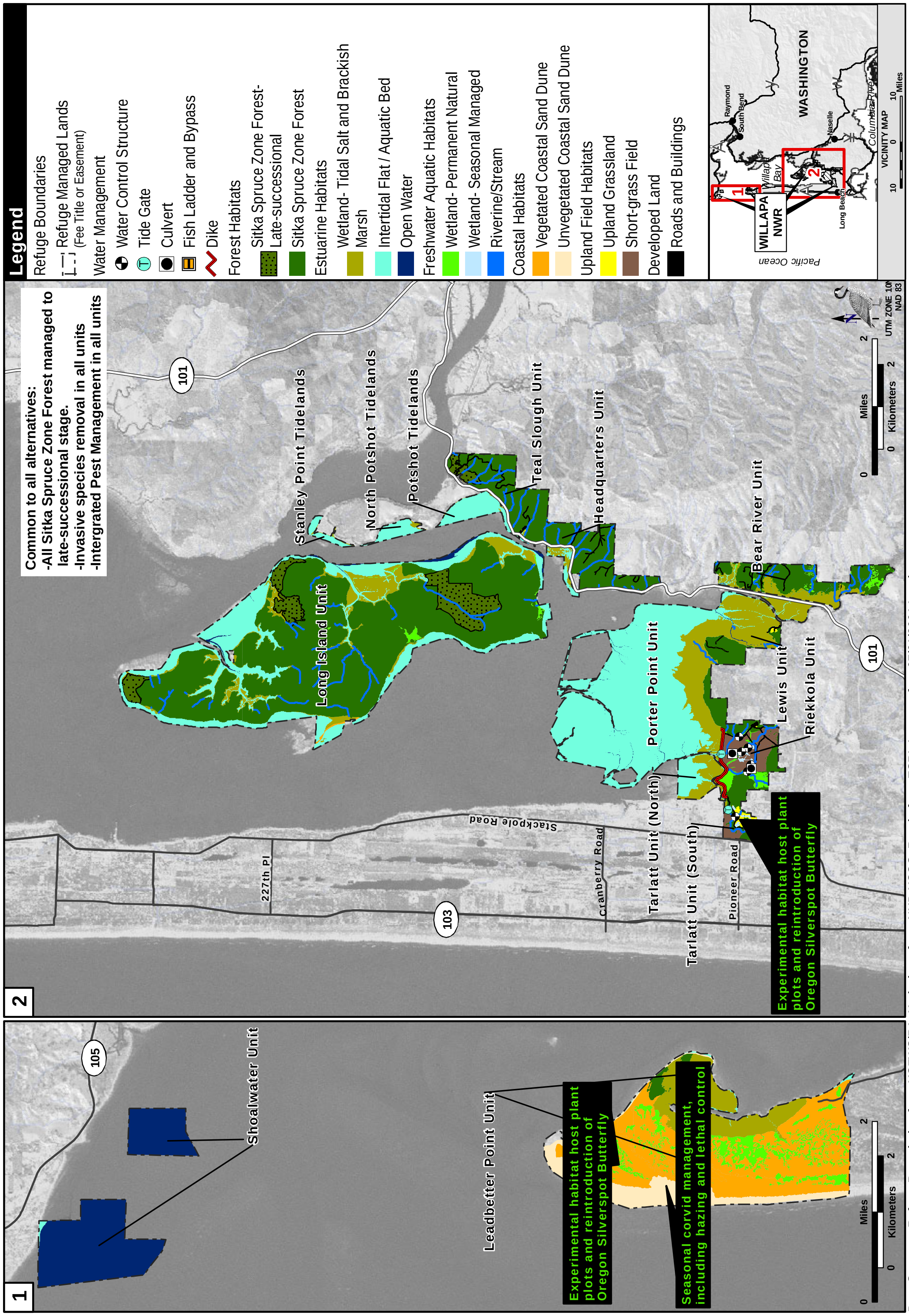
Map 6. Willapa National Wildlife Refuge Habitats - Alternative 2



Data Sources: Refuge Boundaries from USFWS/R1; Hydrology from NHD USGS; Roads from ESRI; Imagery fom 07/01/2001 Landsat

The back sides of map pages are blank to facilitate map readability.

Map 7. Willapa National Wildlife Refuge Habitats - Alternative 3



Data Sources: Refuge Boundaries from USFWS/R1; Hydrology from NHD USGS; Roads from ESRI; Imagery fom 07/01/2001 Landsat

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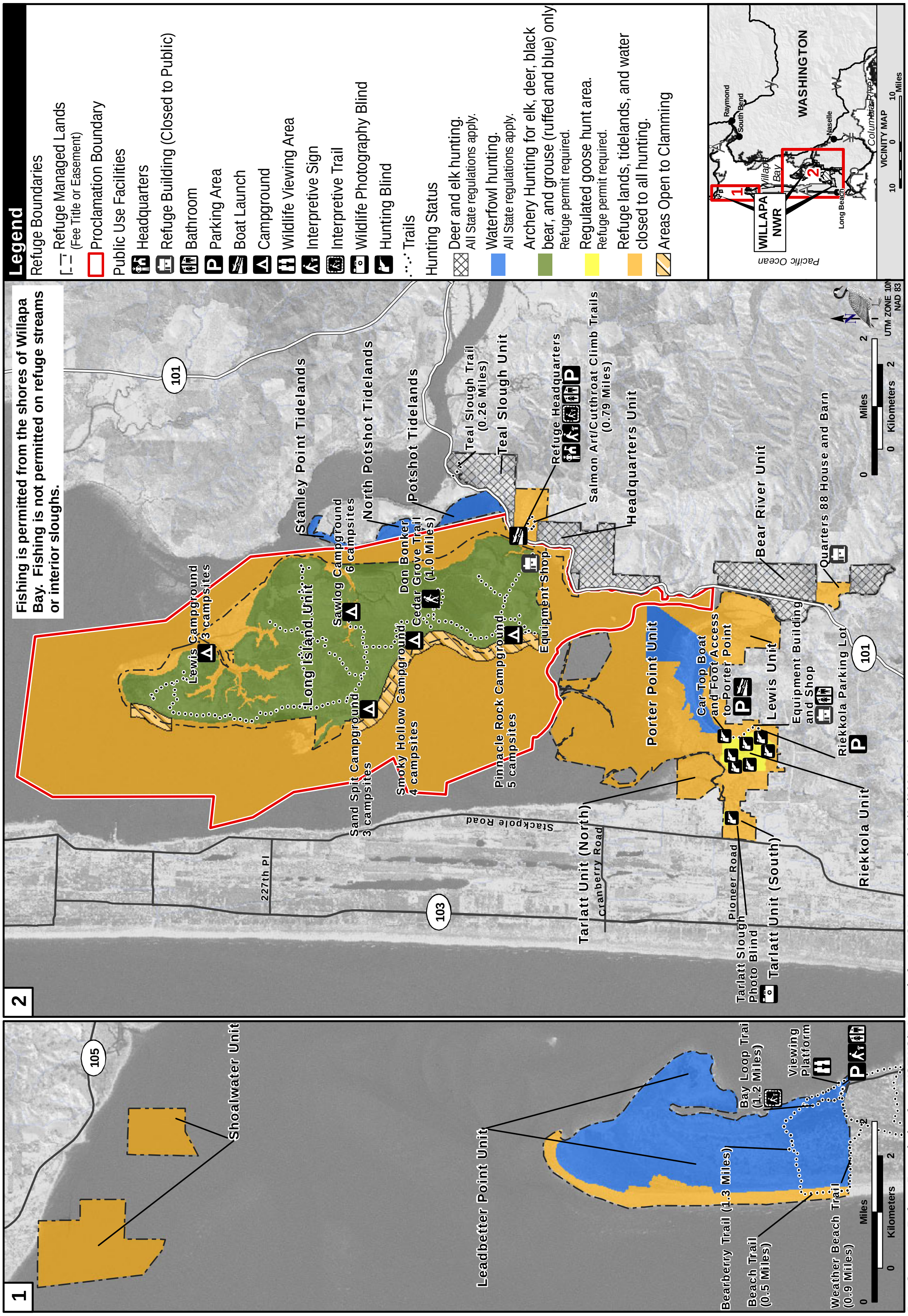
Map 8. Public Use Facilities and Hunting Status - Alternative 1



Data Sources: Refuge Boundaries from USFWS/R1; Roads from ESRI; Imagery from 07/01/2001 Landsat

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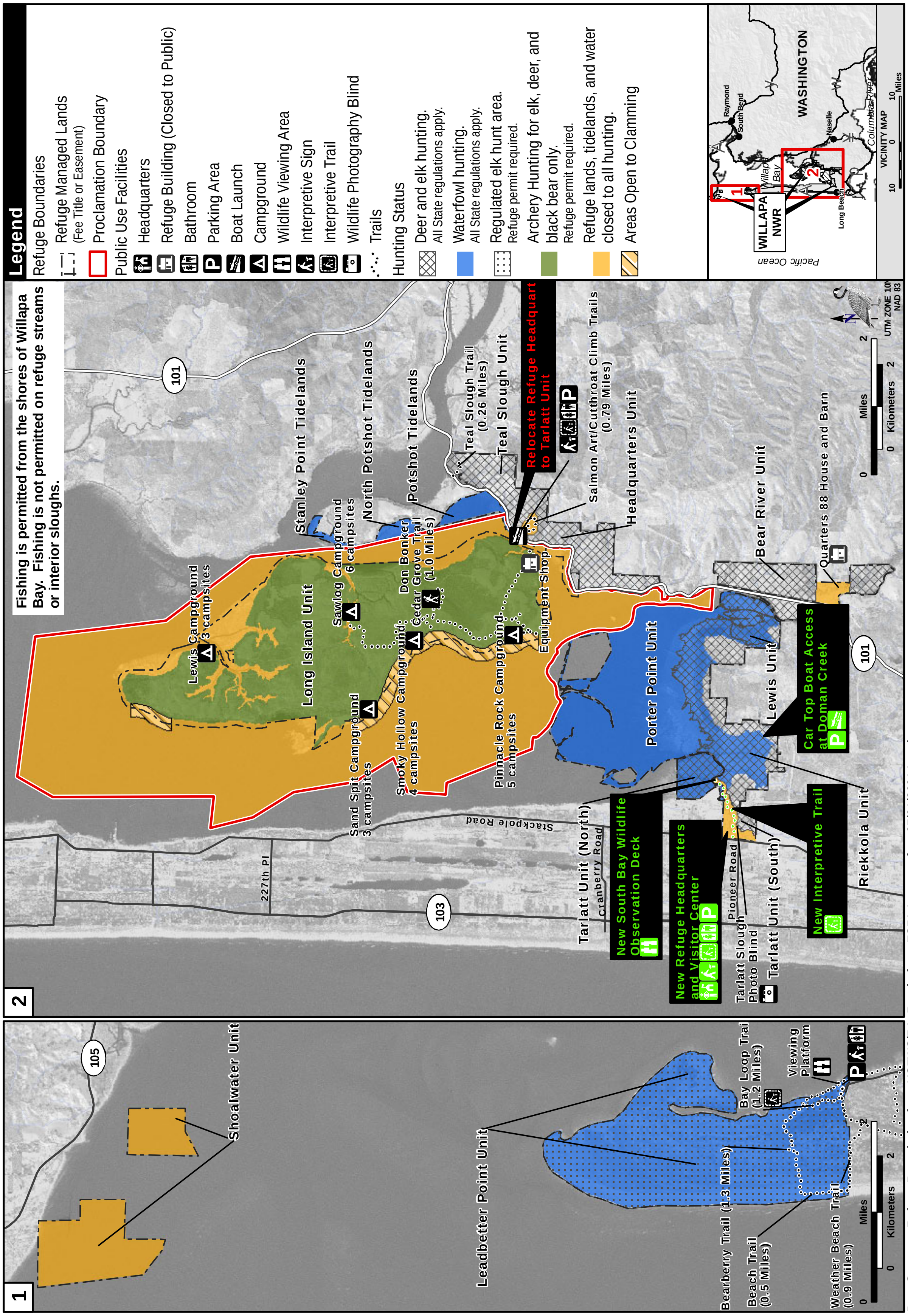
Map 9. Public Use Facilities and Hunting Status - Alternative 2



Data Sources: Refuge Boundaries from USFWS/R1; Roads from ESRI; Imagery fom 07/01/2001 Landsat

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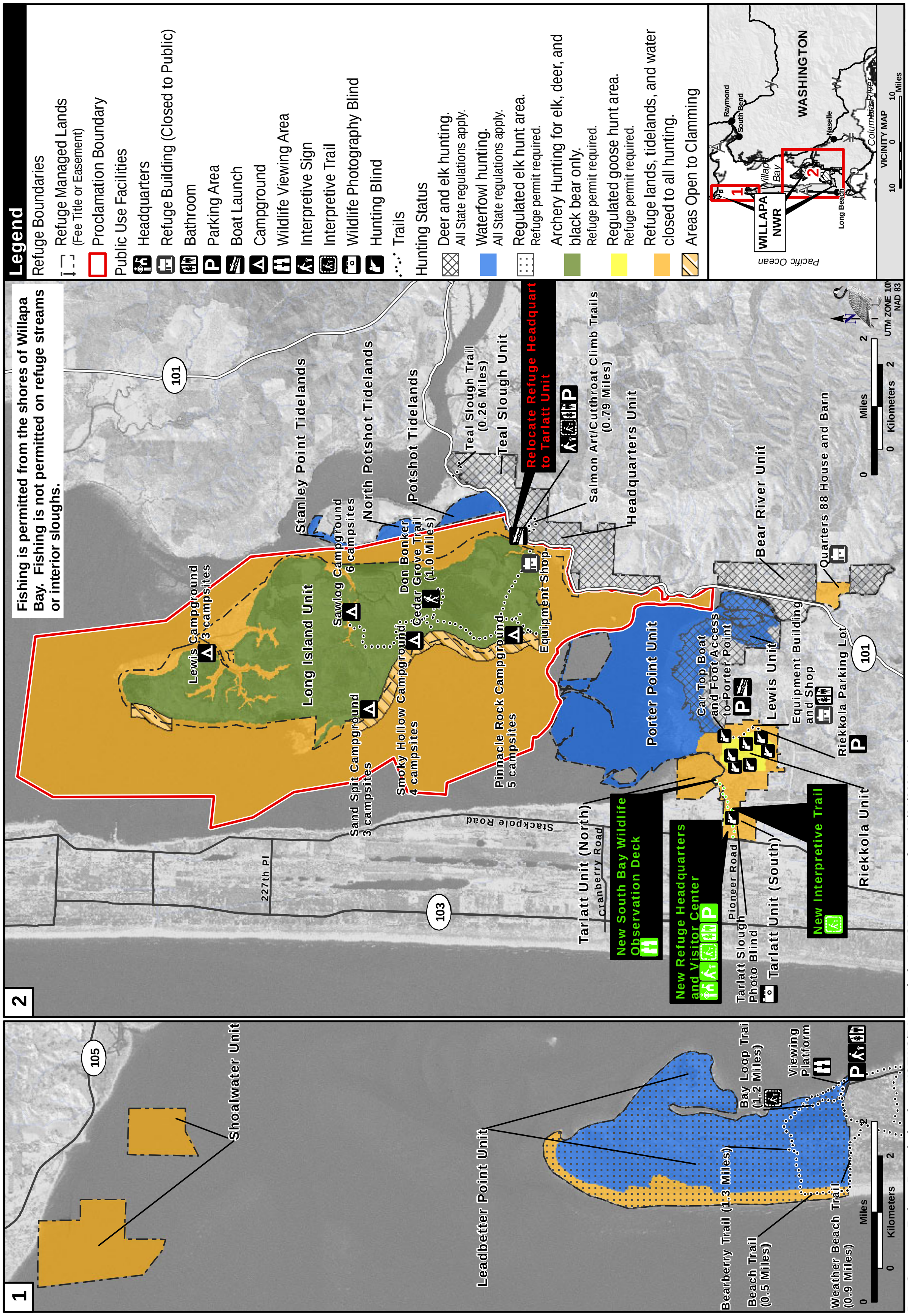
Map 10. Public Use Facilities and Hunting Status - Alternative 3



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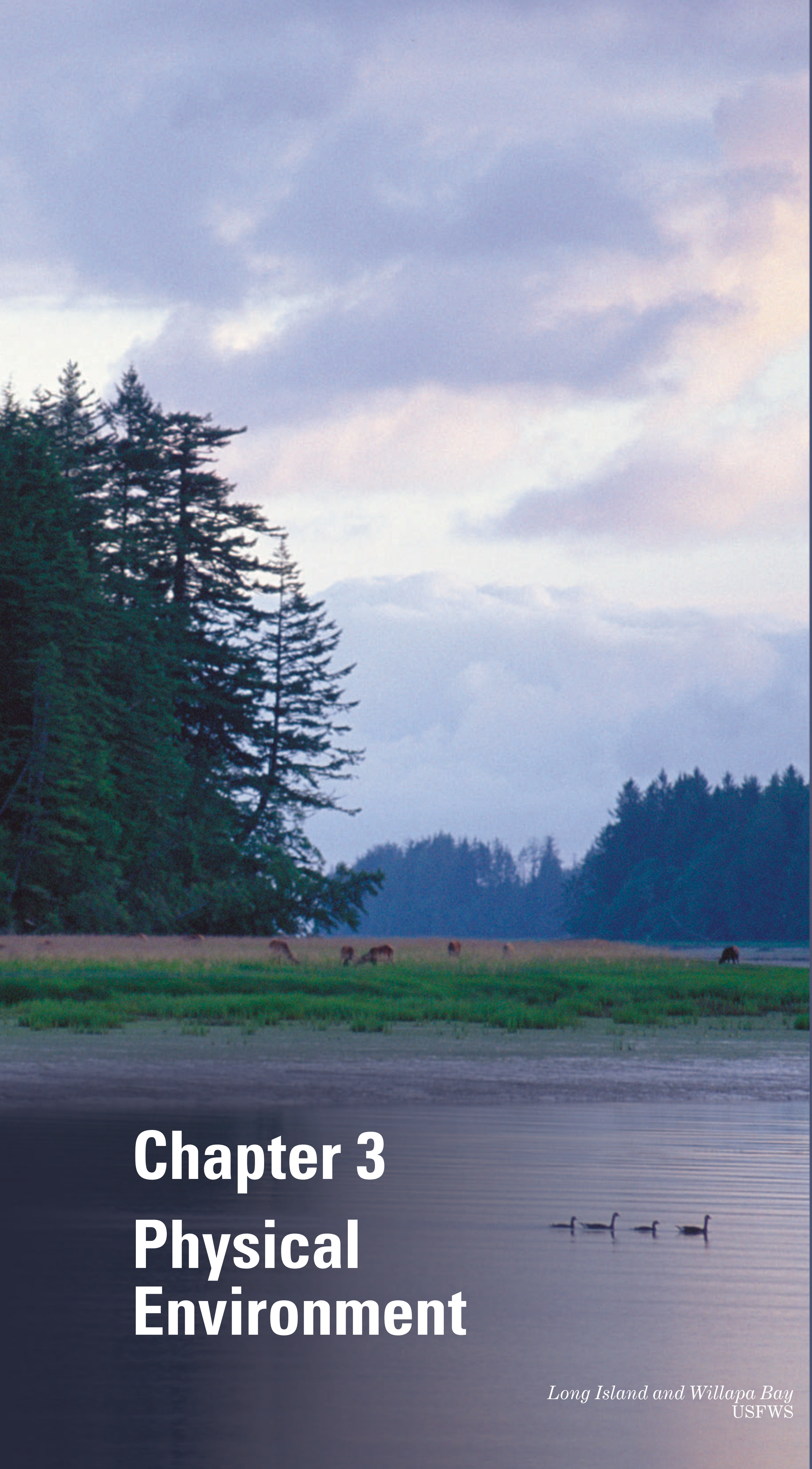

Chapter 3
Physical Environment

Long Island and Willapa Bay
USFWS

Chapter 3. Physical Environment

3.1 Introduction

The Willapa National Wildlife Refuge is located along U.S. Highway 101 extending from the Naselle River to Bear River and westward to Tarlatt Slough and areas north to Leadbetter Point and the Shoalwater Bay units. The Refuge encompasses approximately 16,000 acres in the approved refuge boundary, which includes the Presidential Proclamation Boundary waters in the south Willapa Bay area.

3.2 Climate

The Refuge has a mild marine climate characterized by moderate temperatures, high humidity, copious rainfall, and breezy winds. Temperature, wind, and snow fall representative of most of the Refuge have been historically measured at the U.S. Weather Station at North Head, Washington, about 14 miles southeast of the Refuge. Other historical climatic parameters, such as humidity and hourly wind, are measured at the Astoria Airport in Oregon.

Area temperatures are mild. The average annual temperature in areas surrounding Willapa Bay is 51 degrees Fahrenheit (°F). The annual average maximum and minimum temperatures for the Long Beach area from 1967 to 2000 were 57.8°F and 47.8°F respectively. Annual precipitation on the Refuge ranges from 80 to 115 inches and occurs mostly as rain in the winter. Thunderstorms over the area's lower elevations occur on four to eight days each year and over the mountains on seven to 15 days. Damaging hailstorms rarely occur.

Precipitation can be extreme at Willapa Bay. During the driest months of July and August, it is not unusual for two to four weeks to pass with only a few showers. In the wettest months of December and January, precipitation is frequently recorded on 20 to 25 days or more each month. The average annual total precipitation for the Long Beach area from 1967 to 2000 was 82.18 inches. June, July, and August were the driest months in the period 1967 to 2000. The monthly average precipitation for the Long Beach area from 1967 to 2000 was 3.01 inches in June, 1.61 inches in July, and 1.78 inches in August. Periodic dry weather conditions in the fall typically prompt a temporary fire ban to be issued by Pacific County each fall that lasts about four to eight weeks. During the winter, rainfall is usually of light to moderate intensity and continuous over a period of time rather than heavy downpours for brief periods. Thunderstorms are unusual but occur periodically each year in summer. Fog and drizzle occur year round and often from October through June, particularly on the Long Beach Peninsula. Snowfall occurs almost yearly with an average of 1.6 inches annually.

Onshore westerly winds from the Pacific Ocean are predominant year round at Willapa Bay. The average annual wind speed at the airport in Astoria, Oregon is 7.9 miles per hour (mph). Average monthly wind speeds in Astoria range from 6.8 mph in October to 9.1 mph in December. The prevailing wind direction in summer is northwest and in winter southwest and west. Drier east and southeasterly winds are uncommon but occur periodically each year and are often strong. Strong winds usually accompany annual winter storms, which can result in winds of 40 to 90 mph, with gusts from 65 to over 100 mph. Winter storms often have sustained winds of 40 to 65 mph and gusts that exceed 65 mph. Hurricane force winds (>74 mph) are experienced almost annually and occasionally produce a recognized hurricane. A hurricane with 120 mph winds occurred on October 12, 1962 and a 100 mph wind storm on November 25 of the same year, resulted in approximately 1 million board feet of timber downed on Long Island (USFWS 2003b).

3.3 Climate Change

A growing body of scientific evidence has emerged demonstrating that the world climate is changing and that changes in atmospheric composition due to human activity are the drivers for global warming (Bierbaum et al. 2007; IPCC 2007). Average annual air temperatures on the earth's surface have increased by 1.3°F since the mid-nineteenth century. Furthermore, the increasing trend in global temperatures over the last 50 years is approximately twice the trend of the previous 50 years. Globally, 11 of 12 years from 1995 to 2006 surface temperatures are the warmest on record since 1850 (IPCC 2007).

The global climate system, in turn, controls regional and local-scale climate conditions within the Pacific Northwest (Washington and Oregon). Projected impacts to the region encompassing the Refuge include changes in seasonal temperatures, precipitation, extreme weather events, oceanic conditions, and sea level rise.

3.3.1 Projected Temperature Changes

Since 1920, the annual average temperature in the Pacific Northwest has risen 1.5°F (UWCIG 2009). Further, all of the climate change models used in the Intergovernmental Panel on Climate Change (IPCC) Fourth Assessment Report (AR4) indicates that the future climate would be warmer than in the past and that the warming rates in the twenty-first century would be greater than those observed in the twentieth century. Averaged across 20 different climate models, the annual average temperature within the Pacific Northwest is projected to increase 2.0°F (range of projections from all models: +1.1°F to +3.3°F) by the 2020s, 3.2°F (range: +1.5°F to +5.2°F) by the 2040s, and 5.3°F (range: +2.8°F to +9.7°F) by the 2080s, compared with the average from 1970 to 1999. The rates of warming range from 0.2° F to 1.0°F per decade. Warming is expected to occur during all seasons with most models projecting the largest temperature increases in summer (Mote and Salanthe 2009).

3.3.2 Projected Precipitation Changes

Projected changes in annual precipitation vary considerably between climate change models and therefore are less certain than projected temperature changes (Salanthe et al. 2009). The range of models analyzed by University of Washington Climate Impacts Group (2009) project average annual precipitation increases within the Pacific Northwest of 1.3% (range of projections from all models: -9% to 12%) by the 2020s, 2.3% (range: -11% to 12%) by the 2040s, and 3.8% (range: -10% to 20%) by the 2080s, compared with the average from 1970 to 1999. Studies of twentieth-century climate variability suggest, however, that the relatively small trends in precipitation projected with climate change may be less than the range of precipitation associated with natural decadal-scale variability (Hamlet et al. 2005; Mote 2003).

Some climate change models show large seasonal changes, especially toward wetter autumns and winters and drier summers. Both global and regional climate change models project increases in extreme high precipitation in western Washington (Salanthe et al. 2009). Additionally, projected temperature increases for the coming century are expected to increase the proportion of winter precipitation falling as rain, increase the frequency of winter flooding, reduce snowpack, increase winter stream flow, result in earlier peak stream flow, and decrease late spring and summer stream flows (Hamlet and Lettenmaier 1999; Hamlet et al. 2007; Mote et al. 2003; Mote et al. 2005; Payne et al. 2004; Tague et al. 2008 cited in Lawler et al. 2008).

3.3.3 Projected Change in El Niño/La Niña Events

A seasonal change in the Pacific Ocean circulation brings the effects of the phenomenon known as El Niño to a wide region including the Pacific Northwest. A periodic weakening of the trade winds in the central and western Pacific, often occurring in December, allows warm water to invade the eastern Pacific. This seasonal change in the wind and ocean circulation can have global impacts to weather events. During an El Niño event, the winters of the Pacific Northwest tend to be warmer than usual. An El Niño cycle may be followed by a La Niña event, characterized by a cooler than normal ocean temperature. Likewise, La Niña also can have significant impacts on global weather. Within the Pacific Northwest, a La Niña brings cooler than normal winters. Collectively, this cycle is known as the El Niño–Southern Oscillation (ENSO) (Conlan and Service 2000; Newton et al. 2003; Pidwirny 2006). The shift between the two conditions of the ENSO cycle takes about four years (Conlan and Service 2000).

El Niño events are not caused by global climate change; however, global warming trends may exacerbate the impacts of these events. To address the relationship between El Niño and global warming, the National Oceanic and Atmospheric Administration (NOAA 2007) summarizes data from the IPCC’s 2001 climate change report, a 2001 report from the National Research Council, and the NOAA National Climatic Data Center’s own data as follows:

> Clear evidence exists from a variety of sources (including archaeological studies) that El Niños have been present for hundreds, and some indicators suggest maybe millions, of years. However, it has been hypothesized that warmer global sea surface temperatures can enhance the El Niño phenomenon, and it is also true that El Niños have been more frequent and intense in recent decades. Recent climate model results that simulate the twenty-first century with increased greenhouse gases suggest that El Niño-like sea surface temperature patterns in the tropical Pacific are likely to be more persistent.

3.3.4 Projected Change in Coastal Water Properties

Coastal sea surface temperature helps determine the biological and physical conditions of the marine environment and estuaries of the Pacific Northwest. Climate models project warming in summer sea surface temperatures for the 2040s on the order of 2.2°F. This change is somewhat less than the warming projected in the 2040s for land areas (3.5°F) but is significant relative to the small inter-annual variability of the ocean (Mote and Salanthe 2009).

How global climate change would influence the ocean currents and coastal upwelling (affecting the nearshore and offshore environments adjacent to Willapa Bay) is unknown. However, current climate model simulations indicate little change in coastal upwelling in any of the major regions of upwelling (Mote and Mantua 2002; Mote and Salanthe 2009).

3.3.5 Sea Level Rise

Sea level rise on the Washington coast and inland marine waters of the state is the result of four major forces: global mean sea level rise driven by the thermal expansion of the ocean, global mean sea level rise driven by the melting of land-based ice, local dynamical sea level rise driven by changes in wind which pushes coastal waters toward or away from shore, and localized vertical land movements driven primarily by tectonic forces (Mote et al. 2008). Mean sea level is defined as the average sea level over a 19-year period, about which other fluctuations (e.g., tides, storm surges, etc.) occur (Smerling et al. 2005). Global mean sea level rise has been in the range of 1.3 to 2.3 millimeters per year (mm/yr) between 1961 and 2003 (IPCC 2007). This global impact is primarily the result of general thermal expansion of the oceans (as warming occurs, the water volume expands) and ice field and glacier melt-off (Warrick and Oerlemans 1990 as cited in Canning 2001). In addition, vertical land movements are occurring as the North American plate and the off-shore Juan de Fuca plate collide. Uplift occurs along the Washington coast while subsidence occurs off-shore.

Based on monthly mean sea level data from 1973 to 2000, the linear mean sea level trend at Toke Point (North Willapa Bay) is +2.82 ±1.05 mm/yr (Mote et al. 2008). Estimates for sea level rise for central and southern Washington coast by 2050 range from 1 inch under the “very low” scenario to 5 inches under the “medium” scenario to 18 inches under the “very high” scenario. By 2100, estimates for sea level rise range from 2 inches under the “very low” scenario to 11 inches under the “medium” scenario to 43 inches under the “very high” scenario. Both the “very low” and “very high” scenarios are considered low probability (Mote et al. 2008).

3.3.6 Potential Changes to the Refuge Due to Climate Change

The climate-induced changes to physical systems are anticipated to have cascading effects on the ecological systems and habitats of Willapa Bay. For example, wetland habitats within the Refuge would be threatened by altered spatial and temporal patterns of temperature and precipitation, increased tidal inundation, and salt water intrusion. The Sea Level Affecting Marshes Model, Version 5.0 (SLAMM 5.0) was run along the Pacific Coast from Willapa Bay through the Columbia River delta to just south of Tillamook Bay in northwest Oregon in order to simulate the dominant processes involved in wetland conversion and shoreline modification under long-term sea-level rise.

The model assumes that global average sea level increases could increase by an average of 0.28 meters (11.2 inches) by 2050 and by 0.69 meters (27.3 inches) by 2100. Some of the potential habitat losses that could occur by 2100 within this region under a conservative estimate of sea level rise follow (Glick et al. 2007).

This region is predicted to lose at least 5,000 hectares (12,355 acres) of dry land.

- There is likely to be extensive loss of tidal flat and area beaches, especially at higher rates of sea level rise.
- Inland and tidal fresh marsh would be fairly vulnerable at this site to saltwater inundation. By 2100, the site could lose 32% of brackish marsh, 31% of tidal swamp, 47% of estuarine beach, and 63% of tidal flats.

Since a significant proportion of the Refuge consists of wetlands, a rise in water levels could impact the management of the Refuge and the type of species and numbers of wildlife that inhabit the area. Additionally, refuge shorelines and spits are anticipated to be adversely affected by climate change. Likely effects due to sea level rise and other factors include increased inundation, erosion, and overwash during storm events, leading to losses of shoreline habitats (Huppert et al. 2009; Mote et al. 2008). Additionally, climate-driven changes in ocean currents, sea temperatures, salinity, and the timing of resource availability have the potential to affect intertidal communities (Menge et al. 2008) and eelgrass beds (Snover et al. 2005).

For the forests occurring on Long Island and the East Hills, the responses to climate change would vary according to local topography, forest type, soil moisture, productivity rates, species distribution and competition, and disturbance regimes. However, based on the projected changes in the spatial and temporal patterns of temperature and precipitation associated with climate change, some general patterns affecting large-scale processes can be described (adapted from Aldous et al. 2007):

- Species distributions are likely to change. Cool coniferous forests in the western part of the Pacific Northwest would contract and be replaced by mixed temperate forests over substantial areas (Mote et al. 2003). Douglas fir appears relatively sensitive to low soil moisture, especially on drier sites (Case 2004; Hessl and Peterson 2004; Holman 2004 citations in UWCIG 2004).
- Increasing temperature would generally increase forest fire frequency and extent.
- Higher temperatures would increase rates of evapotranspiration, leading to greater water losses from forests.
- The change in seasonality of precipitation could lead to a drier growing season, increasing water stress.
- Warmer temperatures could lead to a change in the timing of reproduction, which may lead to asynchronies between flowering and pollinator activity, fruit ripening, and foraging by fruit-consumers or predator behavior by pest-eating species.
- An increase in extreme weather events (e.g., wind storms) could change the frequency of disturbance, leading to a shift to forests that are younger and species that are more fast-growing, short-lived, and disturbance-tolerant.
- Warmer temperatures could increase development of insect and other pathogen outbreaks, as well as extend their growing season, potentially leading to an increase in the frequency and extent of outbreaks.
- Some tree species may experience an increase in productivity if carbon dioxide acts as a fertilizer and allows trees to increase their water use efficiency. However, this increased productivity, coupled with warmer temperatures, longer growing seasons, and prolonged drought, may also increase fire frequency and severity.

Numerous other changes to the Refuge's habitat and wildlife would likely result from increases in ambient temperature and precipitation over the next 50 to 100 years. However, until a more detailed analysis of the effects of global climate change can be completed on specific refuge units, more generalized modeling would continue to be used to assess how and what the Refuge should do to prepare for upcoming changes to the natural environment. While this CCP covers a 15-year time span, it is clear that for the Refuge to adequately plan for climate change, staff would have to look further into the future. During the 15-year time span of this CCP, the Refuge would begin a focused effort to plan on how best to address climate change effects in the Willapa Bay estuary.

3.4 Geology and Topography

The areas covered by this plan each have distinct geological, topographic, and soil characteristics. Elevations on the Refuge range from sea level on Willapa Bay up to 1,715 feet at the highest point along the Bear River Ridge within the coastal hills area.

3.4.1 Willapa Hills

The Willapa hills have a rounded topography and the landscape is dissected with deep drainage ravines. The Refuge portion of the coastal hills includes the Bear River, Headquarters, and Teal Slough units. Approximately 1,700 acres of the current refuge boundary are included in the Willapa hills.

This area of Pacific County and the Refuge is made up of marine sedimentary rock from the late Eocene through early Miocene (60 to 20 million year old), which underlies most of this zone and consists of thin-bedded, laminated tuffaceous siltstones and lesser amounts of sandstone (Wells 1989). Middle Miocene intrusions of basalt also exist and are much more resistant to the forces of weathering than the surrounding sedimentary rocks. This contrast in rock hardness has resulted in the development of locally steeper slopes and higher relief and can be found on the Bear River Ridge (Wells 1989).

Due to the lack of glaciation over the last two million years, soils and exposed bedrock are highly weathered. Thick soils have developed on the stable upland surfaces and the slopes range from a very gentle grade to very steep rocky cliffs.

Three major geologic formations exist in this area: Lincoln Creek, Grand Ronde, and Shoalwater Bay. Each formation has corresponding observable geomorphic features.

The Lincoln Creek formation consists of steep, dissected hill slopes west of the Bear River Ridge divide and west of Ellsworth Creek (Wegmann 2004) where the soils are primarily from the Palix and Narel Series. These deep, well-drained soils were generally formed in mixed slope deposits, which are derived from sandstone and siltstone consisting of silt loams and silty clay loams with 10-30% pebble-sized rock fragments. Partly consolidated sandstone ranges in depth from 40 to 60 inches and water moves readily through these soils.

The Grand Ronde Basalt formation contains steep ridges and cliffs, which are found on the Bear River Ridge and are associated with the Columbia River basalt flows. The soils in this area are highly weathered basalts from the Vesta series on ridge tops and the Knappton series on side slopes. These deep, well-drained soils consist of silt loams and are gravelly with silt clay loams with 0-30% pebble sized rock fragments. Weathered fractured basalt ranges in depth from 40 to 60 inches, and water moves readily through these soils.

The Shoalwater Bay formation consists of moderately to low dissected hill slopes and bluffs west and north of Bear River Ridge that slope gently toward Willapa Bay. Soils are weathered sandstones and siltstones from the Palix, Illwaco, Leban, and Treham series, with some intrusions of Knappton soils. The Illwaco and Leban series are similar to the Palix series, while the Treham series is similar to Knappton. Intrusions of basalt, with more recent estuarine deposits mixed in, make for a very complex geology.

All of the soils in the Willapa hills of the SWBCA are fine-textured soils, which, in combination with the abundant rainfall, give the area excellent soil productivity.

The combination of steep slopes, bedrock types, and significant precipitation makes this area of the coastal hills very susceptible to landslides. While most landslides have been shallow rapid slides or debris flows, there have been some deep seated landslides that affect much larger areas and consist of poorly sorted colluvium and bedrock slump blocks. In general, Wegmann's (2004) analysis found that forestry activities have greatly hastened landslide activity and roughly 85% of the 319 landslides since 1958 were related to forestry activities within this region of Willapa Bay.

3.4.2 Long Island Unit

Long Island is considered its own watershed unit; the island is approximately 6,000 acres in size and is located in the southern portion of Willapa Bay.

Long Island and other areas (Leadbetter Point) bordering Willapa Bay are composed of estuarine terraces and alluvial deposits that are generally flat to gently sloped (Wells 1989). They consist of unconsolidated to semi-consolidated mud and silt, layered with sand lenses. Terrace surfaces occur up to 260 feet above sea level on the approximately 6,000-acre island.

The marine terraces consist of uplifted and wave cut terraces of highly stratified Willapa Bay estuarine sediments that were laid down over the last two million years, as sea levels fluctuated. These terraces occur on Long Island and parts of the mainland shoreline areas and often overlay older, consolidated sandstone that can be seen on Long Island cliffs. Basalt intrusions are also present. Due to rapid weathering, the geological history here is not well known.

In estuaries, floodplains, and the low terraces of the major streams entering Willapa Bay, soils are derived from recent alluvial sediments. Soils from the Ocosta series are the most prevalent (Pringle 1986). These very deep, poorly drained soils occur in floodplains and the deltas of coastal bays and consist of silty clay loam and silty clay. The Aabab series occurs in terraces along streams and is a silt loam. The small area of the Refuge on Leadbetter Point consists of former sand dunes where soils are from the Netarts and Yaquina series (Pringle 1986).

Soil productivity of marine terrace areas tends to be a little lower than in the coastal hills, but is still quite high as compared to most soil types. Risk of landslides is generally low, except on steep slopes along the edge of the Willapa Bay estuary, which have a history of land sliding in response to forest management activities. Both shallow-rapid and small deep-seated failures have occurred here on the slopes averaging 34%, indicating a lower slope threshold for landslide risk than in the coastal hills (Wegmann 2004).

3.5 Hydrology and Bathymetry

Estuaries are most commonly defined as semi-enclosed coastal bodies of water having a free connection with the open sea and within which seawater is diluted measurably by freshwater from land drainage (Litle and Parish 2003).

As a transition zone between fresh water and marine ecosystems, estuaries are highly productive areas that offer habitat of special importance to the early life stages of the many marine animals. Estuaries are categorized according to their physical shape and the forces that created them. Oceanographers describe Willapa Bay as a coastal plain or a "drowned river" estuary, the type most common along the west coast of North America. Drowned river estuaries are remnant river mouths submerged by sea level rise within the past 10,000 years (Little and Parish 2003). Bordered by the Long Beach Peninsula, a large bar formed from the Columbia River sediments, Willapa Bay's estuary also has some of the features of a bar built estuary.

The Willapa Bay and its surrounding basin lie in a region of cool, dry summers. The moderate winters are often accompanied by heavy rainfall with occasional snowfall in the lowlands. Annual precipitation on the beach ranges from 165 to 216 cm (65-85 inches), while areas in the Willapa Hills receive 254 cm or 100 inches per year. Mean annual runoff ranges from 127 cm (50 inches) in the west and north to about 305cm (120 inches) in the upper Naselle River Basin. Mean annual runoff for the entire basin is estimated to be 173 cm (68 inches) or 3,400,000 acre-feet per year. There are often winter floods of short duration and the mean maximum discharge at the mouth of the Willapa Bay is 1,600,000 cubic feet per second. Mean daily runoff, however, is estimated to be about 0.004% of the total volume of the bay.

The tidal range in Willapa Bay is 4 to 5 m (14 to 16 feet). In some parts of the bay, there are strong rip tides and the incoming tide rises over the extensive tidal flats at an extremely fast speed. The volume of the Bay at mean higher high water is 56,585,900 cubic feet; the volume at mean lower low is 31,169,000 cubic feet. The difference, 25,416,900 cubic feet, is considered to be the tidal prism, which, according to the U.S. Army Corps of Engineers, Seattle District (1975:20), "means that approximately 45 percent of the water in the Bay is emptied into the Pacific Ocean on a tidal cycle from M.H.H.W. to M.L.L.W." This seems to suggest that there is only one tide per day, which is not the case; the mixed semi-diurnal tides of the Pacific coast waters result in a discrepancy in the tidal prism volume (i.e., successive tidal prisms are consistently unequal in volume).

There are other factors that inhibit or change the tidal exchange in an estuary of the size of Willapa Bay, and the flushing rate (or residence time) remains to be determined, as indicated in the following:

> While it might appear that the large prism would bring about a fast turnover of the Bay water, this is not always the case. Conditions on the ocean determine how much of the water exiting the Bay will return on the next incoming tide. In the summer, strong northwesterly winds bring upwelled water from the ocean to the Bay, promoting a rapid turnover. Storms and high wave action will also promote mixing. At other times, the Columbia River plume, acting as a discrete water mass, prevents much mixing from occurring and the water from the Bay moves back and forth for days. U.S. Army Corps of Engineers, Seattle District 1975:20

Willapa Bay is fringed by extensive wetlands, including mud flats and salt marshes. The tidal action, which enables regular exposure to air and light, has stimulated the growth of many shore plants, including buttercups, velvet-grass, monkey flower, bulrush, sedges, and tussocks. With the tidal action, these plants are eventually broken up and transported into the bay. This plant detritus is a significant contribution to the various filter feeders in the bay, especially clams and oyster (Hedgpeth and Obrebski 1981).

3.5.1 Riekkola Unit

Historically this refuge unit was tidally influenced and later was protected from tidal influence by a dike built in the 1940s, which was constructed for freshwater wetlands and the management of waterfowl purposes. Active management through haying, grazing, mowing, and weed control provides habitat for geese. The four freshwater wetlands are actively managed by refuge staff. These activities include moist soil management and water control, timed annually to maximize the period for wildlife use; native amphibian development, plant development, shorebirds, and invasive plant control.

Doman Creek crosses through the pastures and exits into South Bay via a double tide gate located along the dike. This tide gate creates a barrier to saltwater influence within this creek, maintaining the freshwater influence to the surrounding plants.

3.5.2 Lewis 1, Lewis 2, and Porters Point Wetland Units

The wetlands are recharged by the watershed immediately located to the south and are fed by Lewis and Porter Point streams. These streams are fed by seeps and rainfall.

These three units are extensively managed by refuge staff and require annual flooding and draw-downs of the wetlands to accomplish moist soil management practices for wildlife purposes.

Lewis 1 and Porter Point wetlands are on a two-year draw-down schedule opposite of each other for control of reed canarygrass, nonnative control and to offer wildlife an opportunity to find available habitat. The Lewis 2 wetland is drawn down annually in concert with the Lewis 1 or Porter Point draw-down.

Draw-downs are timed to maximize the period for native amphibian development before the impoundment is completely dried out. The exposed mudflats during the draw-down also provide foraging areas for shorebirds.

3.5.3 Leadbetter Point Unit

Leadbetter is located on the far north end of the Long Beach Peninsula, north of Leadbetter State Park. This unit is approximately 1,700 acres in size and is affected by the tidal exchange in the estuary on the bay side. The west side of the unit is affected by the open ocean tides. Located throughout this unit are several ephemeral wetlands.

3.5.4 Tarlett Unit

Willapa Bay is the local collection basin for eastern Long Beach Peninsula storm drainage of the surrounding land and coastal hillsides. The proposed new headquarters site for the Willapa National Wildlife Refuge is located along Sandridge Road south of the intersection with 95th Street in Pacific County. From this intersection, the USFWS has a larger land holding that extends south to 85th Street, and eastward, to land directly abutting other refuge property and Willapa Bay. Approximately 29 acres of the northeastern corner of the site is available for the new headquarters facility development. All of this land drains into Tarlett Slough, which winds through the property, generally flowing in a northerly direction before making a bend to the east within the property.

Tarlett Slough is a major stormwater drainage channel for Pacific County, draining the southeastern portions of the Long Beach Peninsula into Willapa Bay. Historically, Tarlett Slough was tidally influenced but may not be now due to the downstream dike where it outlets into Willapa Bay. According to a recent wetland delineation performed on the new headquarters site, the vegetated edge along Tarlett Slough would also be considered a Category I estuarine wetland.

The source of hydrology for the large Category I wetland is Tarlett Slough (Key Environmental Solutions 2010).

Several Category IV freshwater depressional wetlands are also found on the site. One hydrology source for the Category IV wetlands appears to be culverts draining from 95th Street onto the site. There is also drainage coming off of Sandridge Road down a slope and a high groundwater table found in the depressional areas (Key Environmental Solutions 2010).

According to the Flood Insurance Rate Map for Pacific County (FEMA 1985), much of the easterly portion of the property is considered to be within the 100-year floodplain. For planning purposes, the elevation of the 100-year flood occurrence on the property is estimated to be 13.2 feet (North American Vertical Datum of 1988) (Parametrix 2009). However, flooding of the site during a significant event is unlikely due to a county owned dike and tidegate system that is currently in place. It is unlikely that the portions of the dike system that prevent flooding on this and adjacent properties will be removed in the future.

3.5.5 Wheaton Unit

The Willapa River and Mill Creek run through the Wheaton Unit, which is located east of Raymond, Washington. Both the river and creek are tidally influenced and are prone to floods during times of high rain/snow runoff.

3.6 Soils

Soils are the natural bodies of loose material on the earth's surface. They are formed by the dynamics between climate and living matter acting on parent material. Five factors determine the properties of soil: the physical and mineral composition of the parent material; the climate under which the soil material has accumulated and existed since accumulating; the relief, or position of the land; living organisms; and the length of time the soil forming forces have acted on the parent material.

The following soil information was taken from a soil survey of Grays Harbor, Pacific, and Wahkiakum counties, published by the Soil Conservation Service (Pringle 1986).

3.6.1 Headquarters Unit (Current)

The Headquarters unit is made up of Palix silt loam soils on slopes ranging from 8% to 90%. The Palix silt loam soils are deep, well-drained soils. These soils support productive western hemlock and Douglas fir forest, as well as red alder, Sitka spruce and western red cedar. Without vegetation the Palix silt loam soils are unstable, hard to pack, and subject to erosion when wet.

The Omeara's Point area, within the Headquarters Unit, is made up of several soil types: Palix, Ilwaco, Vesta, Knappton, and Montesa silt loams. Palix silt loam occurs on 30% to 90% slopes. Ilwaco silt loam is a very deep, well-drained soil occurring on broad ridge tops, small plateaus, shoulders, and the back slopes of uplands. The principal tree species found on Ilwaco silt loams is western hemlock where it grows well.

Vesta silt loam occurs on 1% to 8% slopes over much of the Omeara's Point area. Vesta silt loam is a very deep, well-drained soil formed from basalt parent material on ridge tops. Vesta silt loams are slightly more productive for growing western hemlock than Palix and Ilwaco silt loams.

Knappton silt loams generally support the growth of western hemlock and Douglas fir forest. Knappton silt loam is moderately permeable with a rapid runoff rate; therefore, the hazard of water erosion on this soil is severe.

The Montesa silt loam occurs on alluvial fans, the broad fan-like deposits of soil at the mouth of small streams. These very deep, somewhat poorly drained deposits were formed from sedimentary and igneous sediments at low elevations (25 to 300 feet elevation). The seasonal water table occurs at 18 to 30 inches from fall to spring. Montesa silt loam typically produces red alder.

3.6.2 Bear River Unit

The Bear River area of the Refuge contains a diverse group of soils; including Knappton, Palix, Lebam and Nuby silt loams, and Ocosta silty clay loam, as well as smaller areas of Traham very gravelly loam and Orcas peat. Lebam silt loam is very deep, well-drained soil occurring on 1% to 30% slopes. It has slow runoff and does not easily erode from water, but does get muddy when wet. Nuby silt loam is a very deep, poorly drained soil occurring on floodplains, where it was deposited by the Bear River. The seasonal water table in this soil is at a depth of 24 to 36 inches. Nuby soil is moderately permeable and occurs on flat (0% to 3% slope) areas that are subject to brief periods of winter flooding. Red alder is the principal forest species on Nuby soils. Traham loam soils are very rocky and this type occurs on a narrow ridge top. Traham soil occurs on 5% to 30% slopes and is a moderately deep, well-drained soil. Traham soil is generally used for forest production. Western hemlock is the principal tree species found on Traham soil. Tree root depth is limited to 24 to 36 inches, the depth at which fractured basalt is found.

Two small areas of Orcas peat soil are present in the lower portion of the Bear River Area. Orcas peat is very deep, very poorly drained soil occurring in depressions. The native vegetation of Orcas peat is living sphagnum, bog Labrador tea, rushes and sedges.

3.6.3 Long Island Unit

Long Island is made up primarily of Willapa silt loam and Ilwaco silt loam, with lesser amounts of Newskah loam, Palix silt loam, and Ocosta silty clay loam. Willapa silt loam is very deep, moderately well-drained soil that supports the growth of western hemlock, Sitka spruce, western red cedar, and red alder in a major part of the island's northern interior, north of Sawlog Slough. The soil surface is typically covered with about 1 inch of duff. Willapa silt loam has a seasonally high water table that is at a depth of 30 to 42 inches in winter. Runoff is slow and water erosion hazard is slight for this soil, although it is muddy when wet and can be damaged without its protective duff layer.

Ilwaco silt loam is a very deep, well-drained soil on broad ridge tops, small plateaus, and shoulders. It has a 2-inch layer of duff on the surface, slow runoff, and slight hazard for erosion, except when steeply cut. Ilwaco silt loam primarily supports western hemlock and Sitka spruce and is the soil type in the old-growth cedar grove and other parts of the island south of Sawlog Slough. Newskah loam is a very deep, well-drained soil on terraces and back slopes of terraces, occurring south of Sawlog Slough. It supports primarily western hemlock and has a protective surface covering of 3-inch-thick moss, needles, and twigs. Newskah loam erodes readily if steeply cut, wet or devoid of vegetation or its duff layer. Palix silt loam is a deep, well-drained soil that occurs along the island's steep shorelines. Ocosta silty clay loam occurs near sloughs and marshes.

3.6.4 Tarlatt Unit

According to the Soil Survey for Grays Harbor County Area, Pacific County and Wahkiakum County, Washington (NRCS 2009), three soil types are found on the new headquarters property: Yaquina loamy fine sand (162), Netarts fine sand, 3% to 12% slopes (92), and Ocosta silty clay loam (104), with the Netarts find sand unit apparently occurring on slightly higher elevations.

Yaquina loamy fine sand is typically found in depressional landforms and is considered somewhat poorly drained with a frequent occurrence of ponding. The Yaquina loamy find sand unit has a water table that is near the ground surface. Netarts fine sand is a deep, well-drained soil type found on dune formations with little to no occurrence of ponding. The Netarts fine sand unit has a depth to water table that is listed as more than 80 inches and no frequency of flooding. Ocosta silty clay loam is a very deep, poorly drained soil found on floodplains and deltas protected from tidal overflow. On the new headquarters site, the Ocosta silty clay loam unit is primarily associated with Tarlett Slough.

All three soil types found on the site are listed on the hydric soils list for Washington (NRCS 1995). However, the presence of mapped hydric soils does not necessarily correlate directly with the presence of mapped wetlands on this site. In order to classify an area as wetland, hydrology and hydrophytic vegetation must be present (Key Environmental Solutions 2010).

Netarts fine sand and Yaquina loamy fine sand are also considered very limited for septic drain field construction: Netarts fine sand because of slope and Yaquina loamy find sand due to the depth to water table. Both soil types are also considered very limited for building site development.

The proposed new headquarters site topography is relatively flat, and elevations are within 10 to 20 feet above sea level. Slopes on the site are generally quite flat within the Yaquina loamy fine sand soil mapping unit, and a little steeper and higher in elevation within the Netarts fine sand unit. Actual elevations and grades have been surveyed for only part of the site: the area studied internally by the USFWS, which measures approximately 1,250 by 400 feet. There is a slight ridge running generally north and south through the surveyed portion of the site, apparently where the transition from dune landform to the depressional landform occurs on the site (also likely the transition between the two soil mapping units). Slopes on this ridge range from 2% to 14%. Elsewhere on the site, slopes are generally flatter, in the 0% to 5% range.

According to the soil survey for the site (NRCS 2009), a Netarts fine sand soil mapping unit can be found along 95th Street and east of the USFWS study area portion of the site. There is also an area of Netarts fine sand identified just south and east of the surveyed zone. It is possible that these land areas are slightly higher, with a greater depth to water table than the adjacent depressional areas within the Yaquina loamy fine sand unit.

3.6.5 Riekkola, Lewis, and Porter Point Units

Riekkola, Lewis, and Porter Point Units consist primarily of Ocosta silty clay loam in the diked pastures and marsh areas. Forested areas in the higher elevations surrounding the units, including Lewis Hill, consist of Palix silt loam and some Ilwaco silt loam.

3.6.6 Leadbetter Point Unit

Leadbetter Unit has five soil types. The outer beach above mean high tide is classified as beach, this area has no vegetation and is subject to continual wave action during high tide. Dune land makes up the majority of outer peninsula westward and north. The dune land is very deep fine sand, drains excessively, and is constantly shifted by strong coastal winds. The dune land topography consists of a primary foredune, an interdune area of dunes and hollows and foredune ridges that run parallel with prevailing winds from the shoreline (also called the foredune complex), and a relatively flat deflation plain still further inland. The water table is at the surface of the interdune area during the winter months. The beachgrass and lodgepole pine areas of the peninsula tip and interior of Grassy Island is Westport fine sand, which forms on slightly weathered stabilized sand dunes. Westport fine sand is covered in a thin mat of organic material and is also very deep and excessively drained. The protective organic layer of Westport fine sand is extremely fragile. The dune land and Westport fine sand are highly susceptible to wind erosion when exposed.

The salt marsh and most of the southern portion of Grassy Island are Ocosta silty clay loam. The forested area near the Leadbetter parking area is Yaquina loamy fine sand, a very deep, somewhat poorly drained soil. The water table in winter is from 24 inches deep to the surface of this soil. The duff layer is half an inch thick (USFWS 2003b).

3.6.7 Wheaton Unit

Wheaton Unit has three soil types: Arta silt loam, Grehelam silt loam, and Rennie silty clay loam. Arta silt loam is a very deep, moderately well-drained soil present in the eastern hay field and higher areas of the homestead site and field. Runoff is slow and the hazard of water erosion is slight in Arta soil. Arta soil supports hemlock and red alder forest but is presently maintained as pasture. Grehelam silt loam is also a very deep, well-drained soil found on the natural dikes of the floodplain, which makes up the majority of the unit and includes the west field that is across the Willapa River and the field that is between Mill Creek and the Willapa River. Grehelam soil is subject to brief periods of flooding in winter. Grehelam soil typically supports Douglas fir and red alder forest but is maintained as pasture. A small area of Rennie silty clay loam exists in the oxbow wetland on the north side of the Willapa River, near the bend in the boundary fence. Rennie soil is very deep, poorly drained soil occurring on the floodplain. Permeability is slow, the water table is high seasonally and runoff is very slow in this soil, resulting in the formation of small seasonal wetlands.

3.7 Environmental Contaminants

3.7.1 Air Quality

The air quality may be affected by various activities on and adjacent to the Refuge including: marine vessels, industrial facilities, automobiles, and other human caused activities such as outdoor burning, wood stoves, and operation of various vehicles and machines (e.g., gasoline powered equipment, motorboats). The refuge staff uses various types of equipment and transportation methods to achieve the refuge habitat conservation projects and research. Habitat improvement projects and daily monitoring activities may include the use of tractors, heavy equipment (bulldozer, backhoe, and excavator) and/or the operation of trucks, boats, or other vessels to access Long Island or other portions of the Refuge found in Willapa Bay. Refuge visitors generally drive their automobiles to visit the various units of the Refuge and others operate motor boats to visit Long Island or participate in wildlife-dependent recreation opportunities on the bay (hunting, fishing, wildlife observation).

3.7.2 Water Quality

The Washington Department of Ecology (WDOE) is responsible for water quality defined under Chapter 173-201A WAC, "Water Quality Standards for Surface Waters of the State of Washington." Willapa Bay and its tributaries are classified as Class A excellent waters which shall meet or exceed the requirement for all or substantially all beneficial water uses (Seyferlich and Joy 1993).

These water uses include:

- Domestic consumption;
- Primary and secondary contact recreation;
- Fish and shellfish spawning, rearing, and harvesting;
- Wildlife habitat;
- Stock watering;
- Commerce and navigation; and
- Aesthetic enjoyment.

Measuring bacteria is one of the common measures used to identify the waters ability to provide beneficial uses. In Class A freshwater (rivers, streams), fecal coliform organisms shall not exceeded a geometric mean value of 100 organisms per100mL, with no more than 10% of samples exceeding 200 organisms per 100mL. Class A marine waters shall not exceed a geometric mean value of 14 organisms per 100mL, with not more that 10% samples exceeding 43 organisms per 100mL. In estuarine conditions (Willapa Bay) the marine criteria are applicable when ambient water salinity is equal or greater than 10 parts per thousand (WAC 173-201A-060(2)).

The overall water quality conditions in the bay are influenced by the tidal flushing characteristics. In Willapa Bay, tidal volumes are five to 10 times the watershed's freshwater input, even during periods of high river discharge. Diurnal tidal ranges (mean higher high water [MHHW] to mean lower low water [MLLW]) are 8.1 to 10.2 feet (2.5 to 3.1 m) at locations within Willapa Bay. The volume of the bay at MHHW is 56,585,900 cubic feet (1,602,513 m^3);

the volume at MLLW is 31,169,000 cubic feet (88,271 m^3). The difference, 25,416,900 cubic feet (719,807 m^3), is the tidal prism (Hedgpeth and Obreski 1981).

The flushing rate of the bay is also influenced by coastal and oceanic processes. A low salinity plume (area where fresh water and salt water mix) from the mouth of the Columbia River is evident year-round and is carried north into Willapa Bay during the cooler and wetter months of October through April (Hedgepeth and Obreski 1981). The salinity and temperature data collected in Willapa Bay show that the Columbia River plume influence lowers salinity and increases water temperatures within the bay in the winter months relative to ocean conditions. The intrusion of colder, more saline oceanic waters may occur in the summer months when the increased plume influences are absent due to lower freshwater input/volume during drier summer months (unpublished Washington State Department of Fisheries data). The plume influence increases oceanic vertical stability, decreases vertical mixing, reduces upwelling, and diverts ocean currents. In this way the plume acts as a discrete water mass to limit oceanic mixing with Willapa Bay and may reduce the flushing rate of the bay (Strickland and Chasan 1989).

The overall Willapa Bay estuary is 92 square miles (238 km^3) at mean higher high water and the watershed is 1,100 square miles (2,850 km^3). The watershed's influence on the bay's water quality is evident by the rural nature of the surrounding land uses, which are primarily intensively managed forests for timber production. Over 20 tributaries are found within the watershed and water runoff drains the managed forest uplands, agricultural holdings, and urban areas located here, along the shoreline of the bay. Pacific County has a resources-based economy with no large industries and supports approximately 19,400 permanent residents. Tourism annually accounts for approximately 450,000-500,000 visitors to the Long Beach Peninsula alone (Long Beach Peninsula Visitors Bureau 2010).

The Refuge's Presidential Proclamation Boundary (approximately 11,000 acres) is located in the southern portion of the bay surrounding the Long Island Unit. The Class A water quality of the bay is of importance because it supports a strong mariculture industry as well as the privately owned oyster beds within the Refuge's Proclamation Boundary. The Refuge has approximately 25 miles of shoreline along the bay. A continued goal for the Refuge is maintaining the high water quality for wildlife.

3.7.2.1 Proposed Visitor/Administrative and Maintenance Site Potable Water

There is no public water distribution system serving the proposed project site. Neighboring and surrounding properties throughout the region use wells to meet domestic water demands. Well log data for the PUD substation facility adjacent to the site, just north of 95th Street, suggests that domestic water is supplied from a 20-foot-deep well on the PUD property and supplies approximately 20 gallons per minute. This would suggest that a well is viable for providing water to the new headquarters site (KPFF Consulting Engineers 2009).

The closest public water distribution system is from the City of Long Beach. Conversations with the water district suggest that the pipe network ends approximately ½-mile south of the project site along Sandridge at 79th Street. The water system has sufficient capacity to serve the site and the long-range plan for the district is to extend the main along Sandridge Road and loop it back to the city system at Cranberry Road. This 12-inch water main at 79th Street can be extended north to serve the site but would require coordination with Pacific County for construction of the water main in the right-of-way. There may be an opportunity to approach adjacent property owners for potential service connections under a Late-Comers Agreement process to offset the cost for construction (KPFF Consulting Engineers 2009).

Since this region gets 120 inches of rain per year, a portion of the water demands, such as bathroom toilets, can be met by installing a rainwater harvesting system (KPFF Consulting Engineers 2009).

Fire protection is currently provided by Pacific County Fire District 1. Without a public water distribution system, fire suppression is accomplished by transporting water to the site with tender trucks and pressurizing the hoses with pumper trucks. According to conversations with the District 1 fire chief, the tender trucks would be filled with water at the closest hydrant, which in this case is supplied by the City of Long Beach Water District. If the building size warrants a sprinkler system per code, then an appropriately sized water reservoir and fire pump would be required as part of the project improvements (KPFF Consulting Engineers 2009).

3.7.2.2 Potential Threats to Water Quality

As stated earlier the water quality of Willapa Bay and its tributaries is currently classified by the State of Washington as Class A, excellent quality. Identifying potential threats is an opportunity to correct whenever possible the potential future negative impacts to water quality.

Potential nonpoint bacterial sources identified in various locations in the watershed include malfunctioning or inadequate on-site septic systems, urban storm-water, livestock, boats, and wildlife. Only on-site systems, urban storm-water, and livestock have been identified as serious threats to water quality. Boats and wildlife have been considered highly localized sources with unquantified contamination potential (Seyferlich and Joy 1993).

Historical surveys and monitoring data have documented various nonpoint sources of bacteria in the Willapa Bay watershed. By far, fecal coliform has been the most common data collected for evaluation of bacterial contamination. Most of the bacterial sources are located in and around towns/cities and agricultural areas along the bay shoreline and in the river valleys. Although the interior hills make up most of the watershed area, only the wildlife and recreational land uses would be the likely candidates for generating additional bacterial loads on these lands. The areas that may contribute to the bacterial contamination around the bay include malfunctioning or inadequate on-site septic systems, urban/community stormwater runoff, livestock, and wildlife. The current refuge office site uses a septic system for office staff.

Stormwater from developed communities and urban areas tend to increase the velocity and amount of water runoff, increasing peak flows in the constructed and localized natural drainage systems. Stormwater runoff from towns and cities can potentially carry a substantial load of various point and nonpoint source pollutants including toxic chemicals, bacteria, and pathogens. In older sewage collection systems stormwater can get mixed with sanitary wastewater. Some of the most serious threats to the water quality of the area may initiate from the communities located near or on the Willapa Bay and its tributaries.

Livestock manure can be a major source of bacterial contamination and is considered a serious threat to the water quality of the bay. Implementing BMPs for pasturing and manure management may prevent waste and wastewater from reaching water courses (drainages, streams, rivers, and estuary). Agricultural areas with livestock and farming practices within the Willapa Bay watershed are primarily located along the river valleys and the bay. The Refuge integrates best management practices (i.e., grazing rotation, erosion control) within the

Cooperative Land Management Agreements for all grazing activities on the refuge lands (currently on the Riekkola, Tarlatt and Wheaton units).

Boats and wildlife have been considered highly localized sources with unquantified contamination potential (Seyferlich and Joy 1993). There are a total of six boating facilities with 249 wet moorage slips available in Willapa Bay. Four major moorage areas are Bay Center, the Port of Nachotta, the Port of Willapa, and the Tokeland Marina. All of these moorage slips are occupied during the summer months.

The refuge staff's use of boats occurs for implementing specific projects and law enforcement patrols, all of which may require use of motorized boats on Willapa Bay and Bear River. Operations include the use of air boats, 12- to 18-foot skiffs, inboard and outboard motors, and motorized and non-motorized boats. Peak boat use occurs in the spring and summer for refuge conservation purposes.

In addition to potential threats from humans to the water quality of the bay there are also naturally occurring impacts from wildlife. In Willapa bay there are 32 observed and documented seal haul-out sites on intertidal sand bars and mud flats (Beach et al. 1985). The estimated population of harbor seals in Willapa Bay is 4,000 to 6,000 (Jeffries 1992). The breeding season from May to August presents the largest gatherings, when over 2,000 seals congregate at the most popular sites. In August, after the end of the pupping season, the seals congregate in large haul-out groups on the entrance shoals along Pine Island Channel. Winter populations may be as high as a 1,000 or more at these sites (Beach et al. 1985). The harbor seal population in Willapa Bay had been increasing between 1976 and 1982 at approximately 10% annually. The high range estimates for fecal coliform production per adult per seal per day is 55×10^{9} bacteria (Caalambokidis et al. 1989). This implies a potential fecal coliform load from 6,000 seals could be as high as 33×10^{13} colony forming units per day. Seals use haul-outs on the South Bay and along the shores of Leadbetter Point.

The list of year-round waterfowl in Willapa Bay includes mergansers, teal, wood duck, mallard, bald eagle, great blue heron, gulls, grebes, and more. These species do not occur in large populations. The dominant migratory species is the American wigeon. The highest quarterly loadings of fecal coliform from birds occur in April through June. The October through December period has the second highest quarterly loading (Seyferlich and Joy 1993).

3.8 Surrounding Land Uses and Roads

Directly adjacent to the Willapa NWR Headquarters Unit is TNC Ellsworth Creek Preserve. TNC is an international nonprofit conservation organization whose mission is to preserve plants, animals, and natural communities that represent the diversity of life on earth by protecting the lands and waters they need to survive. TNC of Washington began acquiring properties as part of the Ellsworth Creek Preserve in 1998. Currently, the Ellsworth Creek Preserve is approximately 7,436 acres in size, encompassing almost the entire Ellsworth Creek watershed, and includes upland forest and estuarine habitats, and freshwater stream systems.

Primary goals for the Ellsworth Creek Preserve include:

1) Restoring ecologically functional estuarine, freshwater, and upland forest habitats that support species and ecological processes representative of those found within unmanaged late-successional forest landscapes of the Pacific Northwest coast.

2) Developing and implementing restoration strategies that accomplish ecological goals in a cost effective and financially replicable manner.
3) Maximizing opportunities for learning how coastal forest landscapes respond to restoration treatments and exporting those lessons to other forest resource managers.
4) Managing the preserve with exemplary stewardship that earns respect and builds productive relationships within the local community and amongst resource management partners.
5) Attaining and maintaining Forest Stewardship Council certification.
6) Serving as a contributor to positive carbon sequestration.

The Refuge and TNC have formed a forest landscape restoration partnership and work closely together protecting, managing, and restoring the forest landscapes within the watershed.

One of the larger tributaries that drains into Willapa Bay is the Naselle River. Along the banks of this river is the small community of Naselle, which is currently an unincorporated town of approximately 400 residents with approximately 1,400 people living within the school district. Primary economic activity centers on timber production and commercial fishing and decreasingly on farming (The Nature Conservancy and USFWS 2007 South Willapa Bay Conservation Area, Forest Landscape Restoration Plan. Final Draft).

Land use patterns in largely rural Pacific County are dominated by private forestland dedicated to commercial timber production. Private homes are generally located on large lots and are scattered along major highways and secondary county roads. This pattern is consistent within the immediate vicinity of the Refuge. That is, neighboring lands are, by in large, commercial timber holdings with limited numbers of home sites adjacent to county roads. The commercial timberlands directly adjacent to the Refuge are largely owned by investment groups and managed by timber investment management organizations. The Campbell Group and Hancock Investments manage adjacent forestland for investment return purposes.

The city of Long Beach is located in Pacific County, south of the Leadbetter Point unit and west of Tarlatt Slough unit. According to the U.S. Census Bureau (2000), the community encompasses a total area of 1.26 square miles of land on the Long Beach Peninsula. The main industry to this area is tourism. The Long Beach Peninsula includes the communities of Long Beach, Ilwaco, Seaview, Nahcotta, Ocean Park, and Oysterville. There are approximately 450,000 to 500,000 visitors to the peninsula on an annual basis (Long Beach Peninsula Visitors Bureau 2010). The local communities offer many tourist attractions.

Cape Disappointment State Park is located in the area of the historical military Fort Canby, with two lighthouses and several opportunities for hiking, biking, kayaking, fishing, beach coming, bird watching, horseback riding, and clam digging. Local museums include the Cranberry Museum and the World Kite Museum. The Washington State International Kite Festival, held in the late summer every year, draws kite flyers from all over the world. In late April or early May, the Blessing of the Fleet is held in Ilwaco in conjunction with Loyalty Day Celebrations. The annual Northwest Garlic Festival takes place in June, and the Annual Sand Stations sand Sculpture Contest is held in July. Salmon derbies also take place throughout the year (Long Beach Peninsula Visitors Bureau 2010).

A small unincorporated town, Oysterville is located on Willapa Bay side of the Long Beach Peninsula. This town was placed on the Register of National Historic Districts in 1976 and encompasses about 80 acres. The historic and current mariculture industry (production and harvest of oysters and clams and crabs) has sustained the economy of this community for over a century. The high quality of the annual harvest is due to the overall water quality of Willapa Bay. Willapa Bay oysters are shipped to restaurants and enjoyed all over the world.

3.8.1 Proposed Visitor/Administrative and Maintenance Facility Site Context and Surrounding Land Use

The proposed new headquarters site is generally north and east of the municipality of Long Beach, Washington, in unincorporated Pacific County, and is considered to be outside of the urban growth boundary of this community. Approaching the site from the south along Sandridge Road, the project vicinity has a rural-residential quality. Agricultural land uses are readily visible in the locale, such as cranberry farming, cattle grazing, and a horse arena. Large-lot single-family residences dot the landscape directly across the street from the site along Sandridge Road. The land surrounding the site is predominantly zoned agricultural. The site itself is zoned conservation district. As such, all U.S. government facilities are permitted outright within the conservation district. Pacific County code also allows nature parks and interpretive centers including buildings, trails, parking areas, interpretive areas, and signs describing natural history, cultural history, and/or natural habitat.

The property is abutted on the north by a Pacific County PUD substation. A series of 115 kV transmission lines enter and leave the substation along both sides of 95th Street, and along the east side of Sandridge Road. The 115 kV is owned and maintained by Bonneville Power Administration (BPA) along 95th Street, and according to BPA personnel, the 115 kV line along Sandridge Road is PUD owned. Distribution voltage (15 kV) circuits exit the substation underground and daylight at PUD utility poles along Sandridge Road. There is additional under-build along the common transmission/distribution pole line on the east side of Sandridge Road that fronts the west edge of the site (PAE Consulting Engineers 2010).

With the multi-service pole line along the east edge of Sandridge Road, electrical and telecommunications services to the new headquarters development will be readily available. The transmission lines will have the largest easements associated the overhead systems, and while a 100-foot easement is common for this voltage, actual size and location are unknown at this time. According to the PUD, new building structures should be no closer than 25 feet to the pole line, and trees should be no closer than 40 feet to their pole line along Sandridge Road (PAE Consulting Engineers 2010).

Pacific County governs the roadways in the direct vicinity and would be expected to be the lead review agency from a transportation perspective. Pacific County has the discretionary authority to require a traffic study in conjunction with future development activities. Based upon preliminary conversations with county staff, a few traffic studies have been completed in the area in the past few years. The initial inclination of county staff is that a full traffic study would not likely be required but the county will not make a determination until a conceptual site plan can be reviewed. The county also governs the location of any driveway(s) that will serve the new headquarters site. The county will require that an access permit be obtained for any driveway (Kittelson & Associates 2009).

Pacific County classifies Sandridge Road as a major collector, the highest level facility designation the county employs. Pioneer Road is located south of the site and connects

Sandridge Road with Highway 103 and downtown Long Beach. Pioneer Road is also classified as an east-west major collector on the peninsula. Within the vicinity of the new headquarters site, both roadways have a two-lane cross section (one travel lane in each direction) with gravel shoulders. No sidewalks or bicycle lanes are currently provided. County staff have indicated that the county is planning to provide a sidewalk and bicycle lanes on Pioneer Road in the future (Kittelson & Associates 2009).

Preliminary review of Pacific County Road Standards indicates that some off-site roadway improvements may be required to improve safety in the vicinity of the proposed site when developed. A 100-foot-long northbound right-turn deceleration taper on Sandridge Road at 95th Street as well as a 55-foot radius may be required based upon the county's standard intersection design of the road standards. This widening would help facilitate large equipment maneuvers accessing the site but the area required could interfere with a large power pole located on the southeast corner of the intersection (Kittelson & Associates 2009).

Based upon the review of other intersections and driveways in the site vicinity along Sandridge Road, a southbound left-turn lane may also be warranted at the site access point. The need for a separate southbound left-turn lane on Sandridge Road at the site driveway (or at 95th Street) could be evaluated in conjunction with a transportation impact analysis for the project (Kittelson & Associates 2009).

Right-of-way improvements, such as sidewalks and landscape strips with street tree plantings, are likely not required for this project, since this site is within a rural district and there are no frontage improvements along adjacent properties. Pacific County does not have any specific requirements set up for implementing frontage improvements at this site (KPFF Consulting Engineers 2009).

Long Beach Peninsula and Pacific County are Pacific Ocean coastal communities and, as such, have been engaged in tsunami evacuation planning. On Pacific County Emergency Management maps, the project site is shown to be within the greatest risk tsunami hazard zone, although a boundary of this zone is just south of the site, near the intersection of Sandridge Road and Pioneer Street. The evacuation route for the site is well established to be southbound on Sandridge Road. The nearest designated assembly area is located south and east of the new headquarters site at 67th Place, east of Sandridge Road (Kittelson & Associates 2009).

3.9 Effects to Physical Environment

This section provides an analysis of the environmental consequences of implementing the alternatives as described in Chapter 2, specifically as they relate to the physical environment. Topics not covered consist of climate, climate change, and geology, because these areas would not be affected by management activities proposed in the alternatives. A summary of the cumulative effects is presented in Chapter 6.

3.9.1 Habitat Management

3.9.1.1 Effects to Hydrology

Alternative 1: Under this alternative, current maintenance and management actions would continue as defined by the refuge purposes, and no significant changes to the hydrology are anticipated. Actively managed freshwater wetlands would be maintained for use by waterfowl, shorebirds, amphibians, and associated wildlife. If predicted trends and models on climate change continue, with sea level rise in time, dike maintenance would prove much more difficult, and extensive repairs may be required. Some limited improvements in water management may occur in time as a result of water structure replacement or installation activities.

Alternative 2: Under this alternative, the Lewis, Porter Point, and Riekkola dike would be removed, historical tidal flow regimes would be re-established, and previously disconnected sloughs would be reconnected. Alternative 2 would maximize the restoration processes specifically increasing 0.2 acre of open water, 11 acres of intertidal flats, and 749 acres of salt marsh. The dike would be restored to grade, borrow ditches would be filled, and deeper connector channels created in the restored areas. The seasonally flooded and highly managed freshwater wetlands and pastures would transition to tidal influences and the historic estuarine habitat conditions of the South Bay would return.

The proposed action under alternatives 2 and 3 for the proposed new headquarters facility at the Sandridge Road/ 95th Street may impact site wetland resources. Careful facility planning and site design will minimize wetland impacts. Where wetland impacts are unavoidable in order to accommodate the area required for new facilities, these will be mitigated on site with the in kind construction of replacement wetlands. As previously mentioned, dike removal within the refuge would not likely affect flood levels on the new headquarters site. Pacific County Flood Damage Prevention Ordinance No. 116B will require that the lowest floors, including the basement, be elevated one foot or more above the elevation of the base flood. Where elevating a structure is considered impractical due to site constraints, three other criteria must be met, as follows: flood-proofing, structurally designing facilities to resist flood pressures, and certification by a registered professional engineer. However, it may be possible to make the case that the remaining dike system left in place will prevent a flood of 100-year magnitude from ever reaching the developable portions of the new headquarters site.

Alternative 3: Under this alternative, the Lewis and Porter Point dike would be removed, historical tidal flow regimes would be re-established, and previously disconnected sloughs would be reconnected. Alternative 3 is a more limited scope of restoration which includes 0.2 acres of open water, less than 11 acres intertidal flats, and 430 acres of salt marsh. The Riekkola and Tarlatt units would remain managed pastures.

3.9.1.2 Effects to Soil

Alternative 1: Under this alternative, current maintenance and management actions would continue as defined by the refuge purposes, with no significant changes to the soils or sediments on the Refuge. Extensive dike repairs would be required in time, to prevent dike failure and retain the freshwater impoundments. Repairs to the dike may require topping and stripping materials, installing erosion control fabric, filling areas with gravel, filling seeps, among other measures. Some disturbance to existing soils or sedimentation due to maintenance or construction of added fill would occur during repairs of dike.

Alternative 2 and 3: The effects to soils would largely be due to the activities and the changes from seasonally flooded and highly managed freshwater wetlands and pastures as they would transition to the tidal influences and the historic estuarine conditions of the South Bay. Saltwater influences would dramatically change the soil salinity and the sedimentation in the areas impacted by the dike removal and restoration proposed. The project timing, extent, and contouring would be designed to minimize the erosion and sediments in water runoff. Fewer impacts to soils would occur in Alternative 3 due to the limited scope of the restoration project.

During construction of the proposed new headquarters facility, soils would be disturbed to form graded surfaces and adequate foundations for proposed buildings and paved areas. Equipment and material staging areas would be identified to minimize soil disturbance and compaction on the site. The collective footprint of the facility—buildings, parking lots, vehicle access routes and maintenance yard facilities—would occupy approximately 10 acres.

On-site soils would be used to the extent possible. Required fills would be balanced with required excavations. Given that much of the site is currently considered to be below the 100-year flood elevation, it is possible that site grading would be required to result in no net change in storage volume on the site.

Topography can also affect buildable area facility development and septic suitability. From a constructability perspective, slopes of less than 5% are the easiest to build on and can readily accommodate ADA access. Slopes of 5% to 10% are still workable for road or path construction but would involve some grading to create functional solutions and building pads. The facility would be designed to minimize extensive grading. Erosion control measures would be incorporated into site development plans to reduce or eliminate loss of site soils during construction.

The effects to soils due to the implementation of the forest restoration activities (Appendix K) on current refuge lands and proposed lands (Appendix A) would most likely eliminate soil erosion caused by direct forest management practices and road decommissioning. Best management practices are utilized to minimize soil erosion from occurring. Future land acquisitions would in the long-term eliminate soil erosion caused by road building and maintenance, and commercial logging activities on these proposed lands.

3.9.1.3 Effects to Air Quality

Alternative 1: No significant effects in air quality are anticipated with Alternative 1. Some factors that could affect air quality in habitat management may include the use of mechanized equipment (including mowing, disking, and heavy equipment). These activities can cause periodic increases in dust and vehicular emissions during field operations but would not change from current conditions.

Alternative 2 and 3: The restoration activities may result in a slight temporary increase in emissions due to the proposed estuarine restoration identified under these alternatives. During the restoration and construction projects, a temporary increase in emissions would occur; however, once the projects are completed and natural processes are restored there would be no need for further active management or to access these areas with equipment or vehicles. A modest increase in vehicular emissions could be expected due to an increase in visitation with the proposed construction of a visitor/administrative facility.

3.9.1.4 Effects to Water Quality and Salinity

Alternative 1: There would not be any direct change to the water quality or salinity parameters of the bay or freshwater wetlands. Water chemistry, temperature, and risk of contaminant release would remain unchanged. Some localized, short-term effects might occur associated with dike repairs. Management within the diked areas would continue. Indirect benefits would occur with efforts to strengthen the watershed protection through partnerships and education programs outside the refuge boundary. There will be continued water quality and septic sewer contamination issues at the existing refuge headquarters site.

Alternatives 2 and 3: With the implementation and removal of the dike, the tidal inundation would change the fresh water to salt water and change soil characteristics and the associated flora. Short-term effects to water quality are expected in terms of the biological oxygen demand and would likely increase locally as die back of decaying plant matter would result from the tidal restoration. There are no anticipated long-term effects to water quality.

The proposed action of extending the 12-inch water main along Sandridge Road would supply the proposed new headquarters site with adequate potable water supplies and benefit the local community by providing a high-quality water supply to adjacent land owners. The potential installation of a rainwater harvesting system would supplement a portion of water demands with a sustainable water source. The stored water could be used to flush toilets, thereby reducing domestic water usage. Extension of the public water main as discussed above would provide water to the site and also negate the need for the reservoir and fire pump. There are no anticipated long-term effects to water quality.

Implementation and completion of the proposed forest restoration activities on current refuge lands and proposed lands (Appendix A), downstream water quality is likely to improve by eliminating the need for road building and maintenance, and commercial logging activities.

3.9.1.5 Effects to Surrounding Land Uses

Alternative 1: There is no effect to the surrounding land uses as the Refuge would not seek expansion beyond the current acquisition boundary. The refuge boundary would remain, and current maintenance and management actions would continue as defined by the refuge purposes.

Alternative 2: Under this alternative, land uses would change (upon acquisition from willing sellers) on 6,804 acres, resulting in a change away from commercial timber production to managed forest harvest activities needed for long-term ecological restoration.

Land uses in Pacific County would not change by implementing the proposed Visitor/Administrative and Maintenance Facility proposed as part of Alternatives 2 and 3. All U.S. government facilities are permitted outright at the Sandridge Road site, and Pacific County code allows for interpretive centers and natural areas, with related amenities such as buildings, parking, trails, and signage.

A new headquarters located along Sandridge Road would provide a more central location for Willapa Refuge management activities. Willapa Refuge management would benefit by consolidating the multiple maintenance facilities (shops, storage, warehouses) located in three separate areas of the Refuge. Having the equipment and staff centrally located would cut down on extensive building maintenance and utility expenses, and on travel within Pacific County between the various facilities. The Sandridge Road site would provide safer highway access for large refuge vehicles, compared to the current headquarters site along U.S Highway 101.

It is anticipated that off-site roadway improvements to Pacific County roads would be necessary to accommodate refuge vehicles and provide safe ingress/egress to the new headquarters site.

The intersection of Sandridge Road and 95th Street would be improved to provide sufficient turning radii for large vehicles. Other potential roadway improvements would include a southbound left-turn land and a northbound right-turn lane at required driveway access points onto Sandridge Road. A northbound right-turn taper on Sandridge Road at 95th Street may also be required. These types of roadway improvements were recently implemented on Sandridge Road for another site development north of the project site and would be considered typical for site development in this area. When developed, site design should address potential impacts to local residents along the west side of Sandridge Road. Care should be taken to locate any site driveway in a manner that avoids headlight glare into residential homes. If the primary access point is the intersection of Sandridge Road and 95th Street, these impacts would be minimal.

Sandridge Road is currently used by refuge visitors to reach the Leadbetter Point Unit. Relocating the refuge headquarters to the Sandridge Road site may result in increased visitation to the facility, which may increase local traffic on the county roadway. However, traffic impacts have not been studied.

Pioneer Road can potentially serve as a primary route from the refuge headquarters to the city of Long Beach. The future provision of sidewalk and bicycle facilities by Pacific County along Pioneer Road would create an opportunity to better link downtown Long Beach with the existing Cranberry Museum (on Pioneer Road, west of the site), and the new refuge headquarters site.

Relocating the refuge headquarters to the Sandridge Road site also offers future opportunities for local residents and environmental education groups to access Willapa Bay via the system of dike trails, which wind around the eastern portions of the site. When developed, the overlook feature will offer spectacular views of Willapa Bay, as well as wildlife observation, environmental education, and interpretive opportunities. A trail system will be provided through the Sandridge Road site that links the local community to this invaluable natural resource. Site planning and design will need to consider the possible need for evacuation in the future event of a tsunami.

Alternative 3: Under this alternative, land uses would change (upon acquisition from willing sellers) on 4,895 acres, resulting in a shift away from commercial timber production to managed forest harvest activities needed for long-term ecological restoration. The visitor/administrative office facility proposal would remain the same as decribed in Alternative 2.

3.9.2 Public Use

3.9.2.1 Effects to Geology and Hydrology and Soils, Air and Water Quality, Environmental Contaminants

Alternative 1: Changes in the public use program are not expected to cause changes in geology, hydrology, soils, air quality, water quality, or environmental contaminants. Minor changes and maintenance in the trail system would still require repairs and soil disturbance along with possible water diversion devices.

Alternative 2 and 3: The new trail site established for the new Visitor/Administrative and Maintenance Facility and enlarged environmental education program would produce localized areas of soil compaction from foot traffic. BMPs regarding site locations and design would be considered to minimize all effects to soils, water, etc. Some minor effects on soils would occur from new construction and vehicle parking areas and foot traffic, but these would be expected to be less than current conditions because of planned improvements in access and facilities consolidation.

The proposed action of developing a new headquarters facility at Sandridge Road and 95th Street may impact site wetland resources. Careful facility planning and site design will minimize wetland impacts. Where wetland impacts are unavoidable in order to accommodate the area required for new facilities, these will be mitigated on site with the in-kind construction of replacement wetlands. As previously mentioned, dike removal within the Refuge would not likely affect flood levels on the new headquarters site.

Pacific County Flood Damage Prevention Ordinance No. 116B will require that the lowest floors, including the basement, be elevated one foot or more above the elevation of the base flood. Where elevating a structure is considered impractical due to site constraints, three other criteria must be met: flood-proofing, structurally designing facilities to resist flood pressures, and certification by a registered professional engineer. However, it may be possible to make the case that the remaining dike system left in place will prevent a flood of 100-year magnitude from ever reaching the developable portions of the new headquarters site.

Reduction of human activities at the old headquarters site and other scattered maintenance facilities would help to restore more natural process to those sites, while combining all activities at one location. Effects from an expanded elk hunting program on refuge soils would be negligible, but with a successful hunt program, the associated benefits may reduce impacts to soils from the expanding elk population.

3.9.3 Refuge Boundary Expansion

3.9.3.1 Effects to Hydrology, Soils and Sediments, Geology, Environmental Contaminants, Water Quality, and Air Quality

Alternative 1: Other than the completion of the existing approved refuge boundary, there is no refuge expansion proposed in this alternative. There are no effects anticipated to hydrology, soils and sediments, geology, water quality, salinity, or air quality that are different than that described above in the habitat restoration section. In-holdings (760 acres) within the current boundary include forested uplands and riparian habitat. Refuge acquisition and management of these parcels would be beneficial to their long-term conservation.

Alternative 2: Refuge boundary expansion (6,804 acres) would benefit some of these physical factors. Refuge expansion would protect and restore lands that would continue to be managed as commecircal forest land or otherwise be developed for residential or commercial development or that would not be restored.

Additional protection of areas would prevent accelerated erosion caused by development or continued commercial logging. Retaining more habitats in a natural, vegetated condition would improve water quality in wetlands and waterways by reducing erosion and sedimentation and nonpoint source contamination from stormwater and runoff from adjacent commercially logged lands or developments and roadways build on those lands. Areas that have been logged and many areas which were used as a road system would be reforested, improving watershed protection.

Wetland areas store flood waters and help maintain water quality by trapping sediments and removing excess nutrients. Air quality may decline if residential and commercial development increase in the area, as effects associated with increased traffic, industrial development, and other pollutant sources such as wood stoves increase. Refuge expansion would reduce this possibility.

Improved protection of this portion of the lower Willapa Bay watershed would maintain or improve the natural tributary processes that protect water quality, reduce flooding effects to human infrastructure, and distribute river and stream sediments naturally.

Alternative 3: Effects to these physical environment factors under this 4,895-acre expansion of the refuge boundary would be similar to those described for Alternatives 1 and 2.

Chapter 4 Biological Environment

Western snowy plover
© Rudy Schuver

Chapter 4. Biological Environment

4.1 Biological Integrity Analysis

The National Wildlife Refuge System Improvement Act of 1997 directs the USFWS to ensure that the biological integrity, diversity, and environmental health (BIDEH) of the System are maintained for the benefit of present and future generations of Americans. In simplistic terms, elements of BIDEH are represented by native fish, wildlife, plants, and their habitats as well as those ecological processes that support them. National Wildlife Refuge System policy on BIDEH (601 FW 3) also provides guidance on consideration and protection of the broad spectrum of fish, wildlife, and habitat resources found on refuges and associated ecosystems that represents BIDEH on each refuge. The BIDEH of the Willapa Bay watershed and estuary have been negatively affected by human activities. Land use activities in particular have had an impact on fish and wildlife habitat values.

In the Pacific Northwest, a large portion of historical estuarine habitat has been lost to diking, channelization, dredging, and filling. Washington is estimated to have lost between 45% and 62% of its pre-settlement estuarine habitat (Aitkin 1998). About 30% of the original wetlands of Willapa Bay have been reclaimed by diking and filling (Hedgpeth and Obrebski 1981).

According to ONRC calculations, Willapa Bay originally contained approximately 14,620 acres of saltwater wetlands. Now there are 5,277 acres. This represents a 64% loss of estuarine wetlands (Coastal Resources Alliance 2007). Loss of saltwater wetland habitat is considered one of the most common limiting factors related to the decline of nearshore or estuarine salmon habitat.

An estimated 50%-90% of streams in the state of Washington are in a degraded state (Knutson and Naef 1997). Rivers and streams in the Willapa NWR support runs of anadromous fish such as chum, coho, and Chinook salmon, and cutthroat trout. River and stream channels provide migration pathways for adult anadromous fish traveling to spawning grounds and juveniles traveling to the estuary and/or Pacific Ocean.

Land use activities have impacted wildlife habitat values in and along rivers and streams in the Willapa Bay watershed. Stream processes in many areas have been altered. Degradation of streams, including those on the Refuge, has occurred historically. Problems include loss of connectivity to the estuary due to highway and dike construction, hydrologic regime alteration, presence of fish passage barriers, water quality issues (i.e., temperature and sedimentation), and presence of exotic species.

There is a need to protect and maintain ecological processes and functions in streams and associated habitat. Positive effects of healthy streams include enhanced nutrient production and cycling, improved water quality, and support of a diverse riparian and estuarine plant and wildlife community.

Late-successional forest habitat in the Willapa Bay area is isolated and highly fragmented. Less than 1% of the original old-growth forests remain in the 700,000-acre Willapa Bay watershed (Davis et al. 2009). Currently, second- and third-growth forests dominate the watershed.

Native grassland habitat has been affected by invasion by exotic species, natural succession, fire suppression, conversion to pasture, and land development. The loss of native grasslands has resulted in loss of a federally threatened species, the Oregon silverspot butterfly, which has been extirpated from the state of Washington.

Extensive areas of formerly open or sparsely vegetated coastal dune habitat have been invaded by exotic beach grasses, including introduced American beach grass (*Ammophila breviligulata*) and European beach grass (*A. arenaria*). These grasses out-compete native vegetation, alter the dune ecosystem and form dense stands that reduce the amount and quality of nesting habitat for native wildlife, including the federally threatened western snowy plover and a Federal candidate species, the streaked horned lark. The invasion of *Ammophila* has caused a dramatic reduction of coastal native plants and is a primary threat to a Federal species of concern, the pink sandverbena. In addition, substantial loss of coastal dune habitat has occurred due to industrial, urban, and recreational development.

As a consequence of habitat loss, anadromous fish, migratory birds, and many other native wildlife species of the watershed and estuary have declined. Other factors such as pollution and overuse by humans have played a role in wildlife losses, but it is certain that wildlife cannot persist without suitable habitat. At least 34 wildlife and plant species of the Willapa Bay watershed and estuary area are now federally or state listed as endangered or threatened (The Willapa Alliance 1993).

Habitat and wildlife losses have magnified the importance of conservation and management activities on the Refuge. Willapa NWR currently contains about 16,000 acres of wildlife habitat. Habitats include Sitka spruce zone forest (including late-successional forest), estuarine open water, intertidal flats, salt marsh, rivers and streams, freshwater wetlands, coastal dunes, and grasslands. These habitats represent vegetative communities important for the maintenance of BIDEH in the Willapa Bay estuary and watershed. The Refuge is vital to preserving the natural environment as well as native species of fish, wildlife, and plants of the entire estuary and watershed.

Although protected from development, refuge habitats and wildlife still face threats. Invasive plants and pest animals can displace and compete for resources with native species. Reed canarygrass is especially pervasive and monopolizes much of the aquatic habitat, especially in managed wetlands. It has little value to wildlife compared to the native diversity of wetland plants it displaces. Bog loosestrife has invaded ditches and managed wetlands. Formerly, *Spartina*, a non-native cordgrass that was accidently introduced to the Willapa Bay ecosystem, covered a large portion of Willapa Bay. However, due to eradication efforts by Federal, state, and county agencies as well as the efforts of the oyster industry and private landowners, *Spartina* is now virtually absent from the bay. Non-native nutria and bullfrogs frequent refuge wetlands. Non-native invasive species found in refuge forests include English ivy (*Hedera helix*) and English holly (*Ilex aquifolium*). Several exotic invertebrate species are also found within the waters of Willapa Bay. New invasive species may appear in the future. Nonpoint source pollution in the Bay may increase and degrade the water quality within the watershed as lands are cleared and developed for roads and home sites. Potential nutrient loads, sedimentation, concentrations of pollutants, and associated runoff, may all contribute to degradation of this important ecosystem and its fishery resources.

These problems, while serious, are surmountable. Pollutant sources are being addressed. New methods of slowing or stopping the spread of invasive plants are being adopted. Efforts toward additional protection of the Willapa Bay watershed have been initiated between a number of entities including the Refuge, TNC, state and county agencies, and private landowners. Overall, the refuge environment is relatively healthy and the varied habitats support an abundance and diversity of wildlife.

4.2 Identification of Refuge Resources of Concern and Analysis

In preparing this plan, the Service reviewed other local, regional, and national plans that pertain to the wildlife and habitats of the Willapa Bay watershed and estuary. The Service also sought input from Washington State conservation agencies, nongovernmental organizations, and the general public. The refuge purposes, as stated in the enabling legislation for the Refuge (see Chapter 1), were carefully reviewed as was the Refuge's contribution to maintenance of BIDEH in the Willapa Bay watershed and estuary. As a result of this information gathering and review process, certain species and habitats were identified as resources of concern (Table 4-1). From this list of resources of concern, those species and habitats that are most representative of refuge purposes, BIDEH (Table 4-2), and other USFWS and ecosystem priorities, were chosen as priority resources of concern. Examples include the western snowy plover, marbled murrelet, and brant. The complete list of priority resources of concern (i.e., focal species and habitat types) for the Refuge is contained in Table 4-3. These priority resources of concern are the species and habitats whose conservation and enhancement will guide refuge management now and in the future. Potential management actions will be evaluated on their effectiveness in achieving refuge goals and objectives for the priority resources of concern.

Management of refuge focal species and the habitats that support them will benefit many other native species that are present on the Refuge. Many of the species that will benefit from management of the refuge focal species are identified in the "Other Benefiting Species" column in Table 4-3. Through the consideration of BIDEH, the Refuge will maintain all appropriate native habitats and species. Refuge management priorities may change over time and because the CCP is designed to be a living, flexible document changes will be made at appropriate times.

Table 4-1. NWRS Resources of Concern for Willapa National Wildlife Refuge

SPECIES	Refuge Purpose	Biological Integrity, Diversity Health [a]	Federally Listed	Washington Listed	Partners in Flight [b]	Birds of Conservation Concern [c]	Bird Focal Species [d]	State Wildlife Plan [e]	Shorebird Plan [f] (score 1-5)[2]	N.A.Waterbird Conservation Plan [g]	Pacific Flyway Management Plans [h]	WDFW 2006 [i]	NAWMP [j]	WA NHP [k]	Seabird Cons. Plan [l]	HABITAT TYPE
Mammals																
Yuma myotis bat			SoC[1]					✓						S5[3]		Forests, forest openings, riparian areas, wetlands
Long-eared myotis bat			SoC[1]	SM[1]				✓						S4[3]		Forests, forest openings, riparian areas, wetlands
Fringed myotis*			SoC[1]	SM[1]				✓						S3[3]		Forests, forest openings, riparian areas, wetlands
Long-legged myotis bat			SoC[1]	SM[1]				✓						S3/S4[3]		Forests, forest openings, riparian areas, wetlands
Keen's myotis*				SC[1]				✓						S1[3]		Forests, forest openings, riparian areas, wetlands
Pacific Townsend's big-eared bat*			SoC[1]	SC[1]				✓						S3[3]		Forests, forest openings, riparian areas, wetlands
Mazama pocket gopher*			FC[1]	T[1]				✓						S1[3]		Meadows, grasslands
Pine marten								✓						S4[3]		Dense coniferous forests
Fisher*			FC[1]	E[1]				✓						SH		Coniferous forests
Gray whale*				SS[1]				✓								Open ocean and bay
Pacific harbor porpoise				SC[1]				✓								Open ocean and bay
Stellar sea-lion (eastern DPS)			T[1]	T[1]				✓						S2[3]		Open water, sandbars for resting
Harbor seal				SM[1]				✓						S4[3]		Open water, sandbars for resting
Northern sea otter*			SoC[1]	E[1]				✓						S2[3]		Outer coast
Roosevelt elk								✓				✓		S5		Grassland, riparian forest and shrub, tidal and non-tidal marsh

SPECIES	Refuge Purpose	Biological Integrity, Diversity Health [a]	Federally Listed	Washington Listed	Partners in Flight [b]	Birds of Conservation Concern [c]	Bird Focal Species [d]	State Wildlife Plan [e]	Shorebird Plan [f] (score 1-5)[2]	N.A.Waterbird Conservation Plan [g]	Pacific Flyway Management Plans [h]	WDFW 2006 [i]	NAWMP [j]	WA NHP [k]	Seabird Cons. Plan [l]	HABITAT TYPE
Birds																
Common loon				SS[1]				✓		✓				S3[3]		Ocean and bay
Red-throated loon							✓			✓				S3/S4[3]		Ocean and bay
Pacific loon										✓				S4/S5[3]		Ocean and bay
Western grebe				SC[1]				✓		MC[4]				S3[3]		Ocean and bay
Short-tailed albatross*			E[1]	SC[1]			✓	✓		HC[4]					✓	Open ocean
Black-footed albatross*						✓	✓			HI[4]				S3[3]	✓	Open ocean
Brown pelican			E[1]	E[1]			✓	✓		✓				S3[3]	✓	Ocean, bay, sandbars and islands, shore edge
Brandt's cormorant*				SC[1]				✓		HC[4]				S3/S4[3]	✓	Ocean, bay, grassy slopes, cliff tops
Double-crested cormorant							✓	✓		NAR[4]				S4/S5[3]	✓	Open water
Great blue heron				SM[1]				✓		NAR[4]				S4/S5[3]		Tidal and non-tidal marsh, shallow open water, forested wetland, coastal forest
Tundra swan	✓							✓			✓		NT[5]	S4[3]		Tidal and non-tidal marsh
Trumpeter swan (Pacific pop.)	✓	✓						✓			✓		I[5]	S3[3]		Tidal and non-tidal marsh, bay
Tule greater white-fronted goose	✓						✓	✓			✓		NT[5]	S3/S4[3]		Grassland, open water (roosting), tidal and non-tidal marsh
Snow goose (lesser)	✓						✓	✓			✓		I[5]	S3[3]		Grassland, open water (roosting), tidal and non-tidal marsh
Emperor goose	✓						✓				✓		NT[5]			Grassland, open water (roosting), tidal and non-tidal marsh

SPECIES	Refuge Purpose	Biological Integrity, Diversity Health [a]	Federally Listed	Washington Listed	Partners in Flight [b]	Birds of Conservation Concern [c]	Bird Focal Species [d]	State Wildlife Plan [e]	Shorebird Plan [f] (score 1-5)[2]	N.A.Waterbird Conservation Plan [g]	Pacific Flyway Management Plans [h]	WDFW 2006 [i]	NAWMP [j]	WA NHP [k]	Seabird Cons. Plan [l]	HABITAT TYPE
Cackling Canada goose	✓						✓	✓			✓		NT[5]			Grassland, open water (roosting), tidal and non-tidal marsh
Aleutian cackling goose	✓		SoC[1]	SM[1]				✓			✓		I[5]			Grassland, open water (roosting), tidal and non-tidal marsh
Dusky Canada goose	✓						✓	✓			✓		U[5]			Grassland, open water (roosting), tidal and non-tidal marsh
Western Canada goose	✓						✓	✓			✓		U[5]	S5[3]		Grassland, open water (roosting), tidal and non-tidal marsh
Brant	✓	✓					✓	✓			✓		NT[5]	S3[3]		Estuary
Wood duck							✓	✓					I[5]	S4[3]		Forested wetland, riparian forest, tidal and non-tidal marsh
Mallard	✓						✓	✓					NT[5]	S5[3]		Tidal and non-tidal marsh, bay
American wigeon	✓						✓	✓					NT[5]	S4/S5[3]		Grassland, tidal and non-tidal marsh
Northern pintail	✓						✓	✓					D[5]	S3/S4[3]		Tidal and non-tidal marsh, bay
Greater scaup	✓						✓	✓					D[5]	S3[3]		Open water
Lesser scaup	✓						✓	✓					D[5]	S3[3]		Open water
White-winged scoter	✓						✓	✓					D[5]	S3[3]		Open water
Surf scoter	✓						✓	✓					D[5]	S3[3]		Open water
Long-tailed duck	✓						✓	✓					D[5]	S3/S4[3]		Open water
Northern harrier					✓	✓								S4[3]		Grassland, tidal and non-tidal marsh
Golden eagle				SC[1]				✓						S3[3]		Open areas

SPECIES	Refuge Purpose	Biological Integrity, Diversity Health [a]	Federally Listed	Washington Listed	Partners in Flight [b]	Birds of Conservation Concern [c]	Bird Focal Species [d]	State Wildlife Plan [e]	Shorebird Plan [f] (score 1-5)[2]	N.A.Waterbird Conservation Plan [g]	Pacific Flyway Management Plans [h]	WDFW 2006 [i]	NAWMP [j]	WA NHP [k]	Seabird Cons. Plan [l]	HABITAT TYPE
Bald eagle		✓	SoC[1]	ST[1]				✓						S4[3]		Forested wetland, riparian forest, open water, tidal and non-tidal marsh
Cooper's hawk					✓									S4[3]		Riparian forest; large structurally diverse patches
Northern goshawk			SoC[1]	SC[1]		✓		✓						S3[3]		Forests
American kestrel					✓			✓						S4/S5[3]		Grassland, riparian forest
Merlin				SC[1]				✓						S3[3]		Grassland, forested wetland, riparian forest, tidal and non-tidal marsh
Peregrine falcon (American) *anatum*			SoC[1]	SS[1]		✓	✓	✓						S2[3]		Forested wetland, riparian forest, tidal and non-tidal marsh, ocean beach, cliffs/human-made structures for nesting
Peregrine falcon (Arctic) *tundrius*			SoC[1]	SS[1]		✓	✓	✓						S2[3]		Open areas, especially ocean beach
Peregrine falcon (Peale's) *pealei*			SoC[1]	SS[1]		✓	✓	✓						S2[3]		Open areas, especially ocean beach
Sandhill crane				E[1]			✓	✓		✓	✓			S2[3]		Shallow wetlands, freshwater marshes
Willet								✓	2					S3[3]		Coastal beaches and bay edges
Black-bellied plover								✓	4					S4[3]		Coastal beaches and bay edges
Western snowy plover		✓	T[1]	E[1]			✓	✓	5					S1[3]		Coastal beaches and dunes
Semipalmated plover									3					S4[3]		Coastal beaches and bay edges

SPECIES	Refuge Purpose	Biological Integrity, Diversity Health [a]	Federally Listed	Washington Listed	Partners in Flight [b]	Birds of Conservation Concern [c]	Bird Focal Species [d]	State Wildlife Plan [e]	Shorebird Plan [f] (score 1-5)[2]	N.A.Waterbird Conservation Plan [g]	Pacific Flyway Management Plans [h]	WDFW 2006 [i]	NAWMP [j]	WA NHP [k]	Seabird Cons. Plan [l]	HABITAT TYPE
Killdeer					✓			✓	4					S4[3]		Grassland, tidal and non-tidal marsh
Greater yellowlegs								✓	4					S4/S5[3]		Tidal and non-tidal marsh, freshwater wetlands
Whimbrel						✓		✓	4					S3[3]		Coastal beaches and bay edges
Marbled godwit						✓	✓	✓	4					S3[3]		Coastal beaches and bay edges
Ruddy turnstone								✓	4					S4[3]		Coastal beaches and bay edges
Black turnstone						✓		✓	4					S4/S5[3]		Coastal beaches and bay edges
Red knot						✓		✓	4					S3[3]		Coastal beaches and bay edges
Sanderling								✓	4					S4[3]		Coastal beaches and bay edges
Dunlin						✓		✓	4					S4/S5[3]		Coastal beaches and bay edges
Western sandpiper								✓	4					S4/S5[3]		Coastal beaches and bay edges
Least sandpiper									3					S4[3]		Coastal beaches and bay edges
Short-billed dowitcher						✓		✓	4					S4[3]		Coastal beaches and bay edges
Long-billed dowitcher									3					S4/S5[3]		Freshwater wetlands, bay edges
Wilson's snipe								✓	4					S4/S5[3]		Grassland, tidal and non-tidal marsh
Red phalarope								✓	4					S4[3]		Open ocean, ponds

SPECIES	Refuge Purpose	Biological Integrity, Diversity Health [a]	Federally Listed	Washington Listed	Partners in Flight [b]	Birds of Conservation Concern [c]	Bird Focal Species [d]	State Wildlife Plan [e]	Shorebird Plan [f] (score 1-5)[2]	N.A.Waterbird Conservation Plan [g]	Pacific Flyway Management Plans [h]	WDFW 2006 [i]	NAWMP [j]	WA NHP [k]	Seabird Cons. Plan [l]	HABITAT TYPE
Red-necked phalarope								✓	4					S4[3]		Open ocean, ponds
Western gull										LC[4]				S4[3]		Coastal beaches, open ocean and bay
Glaucous-winged gull										LC[4]				S5[3]		Coastal beaches, open ocean and bay
California gull										MC[4]				S4/S5[3]		Coastal beaches, open ocean and bay
Heermann's gull										MC[4]				S5[3]		Coastal beaches, open ocean and bay
Caspian tern				SM[1]		✓	✓	✓		LC[4]				S3[3]	✓	Coastal beaches, open ocean and bay
Common tern							✓			LC[4]				S4[3]		Coastal beaches, open ocean and bay
Common murre				SC[1]				✓		MC[4]				S4/S5[3]	✓	Open ocean and bay
Marbled murrelet		✓	T[1]	T[1]		✓	✓	✓		HC[4]				S3[3]	✓	Open ocean and bay; old-growth forest for nesting
Ancient murrelet*								✓		HC[4]				S3/S4[3]	✓	Open ocean and bay
Cassin's auklet*			SoC[1]	SC[1]			✓	✓		MC[4]				S3[3]	✓	Open ocean and bay
Tufted puffin*			SoC[1]	SC[1]				✓		✓				S3/S4[3]	✓	Open ocean
Band-tailed pigeon					✓		✓	✓			✓			S4[3]		Coniferous forest, riparian forest and shrub, mineral springs
Short-eared owl					✓		✓	✓						S4[3]		Grassland, tidal and non-tidal marsh
Northern spotted owl **			T[1]	E[1]				✓						S2[3]		Late-successional forest
Western screech owl					✓			✓						S4[3]		Coniferous forest, riparian forest, grassland

SPECIES	Refuge Purpose	Biological Integrity, Diversity Health [a]	Federally Listed	Washington Listed	Partners in Flight [b]	Birds of Conservation Concern [c]	Bird Focal Species [d]	State Wildlife Plan [e]	Shorebird Plan [f] (score 1-5)[2]	N.A.Waterbird Conservation Plan [g]	Pacific Flyway Management Plans [h]	WDFW 2006 [i]	NAWMP [j]	WA NHP [k]	Seabird Cons. Plan [l]	HABITAT TYPE
Northern saw-whet owl							✓							S4[3]		Coniferous and riparian forest
Burrowing owl			SoC[1]	SC[1]	✓	✓	✓	✓						S3[3]		Grassland
Common nighthawk					✓			✓						S4[3]		Grassland, bare ground
Vaux's swift		✓		SC[1]	✓			✓						S3[3]		Old-growth forest, large snags
Rufous hummingbird					✓	✓		✓						S4/S5[3]		Early seral forest, nectar producing plants
Downy woodpecker					✓			✓						S4/S5[3]		Coniferous forest, riparian forest, snags
Pileated woodpecker		✓		SC[1]	✓			✓						S4[3]		Mature multi-layered forest, large snags
Olive-sided flycatcher			SoC[1]		✓	✓	✓	✓						S4[3]		Forested wetland, riparian forest, tidal and non-tidal marsh
Willow flycatcher			SoC[1]		✓			✓						S4/S5[3]		Riparian shrub, dense shrub layer
Hammond's flycatcher					✓			✓						S5[3]		Forested wetland, riparian forest; mature/young forest, open mid-story
Pacific-slope flycatcher					✓			✓						S4/S5[3]		Forested wetland, riparian forest; mature/young forest, deciduous canopy
Streaked horned lark (*strigata*)		✓	FC[1]	E[1]	✓	✓		✓						S1[3]		Grassland (sparse), sparsely vegetated coastal dunes
Tree swallow					✓									S5[3]		Forested wetlands, riparian forest, open water, snags
Purple martin				SC[1]	✓			✓						S3[3]		Riparian forest, snags, open water

SPECIES	Refuge Purpose	Biological Integrity, Diversity Health [a]	Federally Listed	Washington Listed	Partners in Flight [b]	Birds of Conservation Concern [c]	Bird Focal Species [d]	State Wildlife Plan [e]	Shorebird Plan [f] (score 1-5)[2]	N.A.Waterbird Conservation Plan [g]	Pacific Flyway Management Plans [h]	WDFW 2006 [i]	NAWMP [j]	WA NHP [k]	Seabird Cons. Plan [l]	HABITAT TYPE
Brown creeper					✓			✓						S4/S5[3]		Old-growth/mature forest, multi-layered
Winter wren					✓			✓						S5[3]		Mature/young forest, forest floor complexity
Western bluebird				SM[1]	✓			✓						S3[3]		Riparian forest/grassland mosaic, snags
Swainson's thrush					✓			✓						S5[3]		Riparian forest, dense shrub understory
Varied thrush					✓									S5[3]		Mature forest, mid-story tree layer
Hermit warbler					✓			✓						S4[3]		Mature/young forest, closed canopy
Yellow warbler					✓			✓						S4/S5[3]		Riparian forest, scrub-shrub
Wilson's warbler					✓			✓						S5[3]		Mature/young forested, deciduous understory
Western meadowlark					✓									S4[3]		Grassland with perch sites, large patches
Red crossbill					✓									S4[3]		Old-growth/mature forest, conifer cones
Fish																
Chinook salmon		✓		SC[1]				✓				✓		S3/S4[3]		Riverine, estuary, marsh, open water
Chum salmon		✓		SC[1]				✓				✓		S3[3]		Riverine, estuary, marsh, open water
Coho salmon		✓						✓				✓		S3[3]		Riverine, estuary, marsh, open water
Steelhead		✓		SC[1]				✓				✓		S5[3]		Riverine, estuary, marsh, open water

SPECIES	Refuge Purpose	Biological Integrity, Diversity Health [a]	Federally Listed	Washington Listed	Partners in Flight [b]	Birds of Conservation Concern [c]	Bird Focal Species [d]	State Wildlife Plan [e]	Shorebird Plan [f] (score 1-5)[2]	N.A.Waterbird Conservation Plan [g]	Pacific Flyway Management Plans [h]	WDFW 2006 [i]	NAWMP [j]	WA NHP [k]	Seabird Cons. Plan [l]	HABITAT TYPE
Coastal cutthroat trout		✓	SoC[1]					✓				✓		S4[3]		Riverine, estuary, marsh, open water
Bull trout*			T[1]	SC[1]				✓						S3[3]		Riverine, estuary, marsh, open water
Green sturgeon*				SM[1]				✓						S2[3]		Open ocean, bay, river
Pacific lamprey*			SoC[1]	SM[1]				✓						S3/S4[3]		Open ocean, bay, river
River lamprey*			SoC[1]	SC[1]				✓						S2[3]		Open ocean, bay, river
Western brook lamprey		✓		SM[1]										S3/S4[3]		Freshwater streams and rivers
Eulachon*				SC[1]				✓						S4[3]		Open ocean, bay, river
Amphibians and Reptiles																
Tailed frog		✓	SoC[1]	SM[1]										S4[3]		Riverine, riparian
Columbia torrent salamander		✓	SoC[1]	SC[1]				✓						S3[3]		Riverine, riparian
Cope's giant salamander		✓		SM[1]				✓						S3/S4[3]		Freshwater streams
Dunn's salamander		✓		SC[1]				✓						S3[3]		Freshwater streams, riparian areas
Van Dyke's salamander		✓	SoC[1]	SC[1]				✓						S3[3]		Freshwater streams, riparian areas, moist forests
Red-legged frog		✓	SoC[1]											S4[3]		Forested wetland, riparian forest
Western toad		✓	SoC[1]	SC[1]				✓						S3[3]		Riparian forest, grassland, marsh
Green sea turtle			T[1]	T[1]												Open ocean and bay
Leatherback sea turtle*			E[1]	E[1]												Open ocean and bay
Loggerhead sea turtle*			T[1]	T[1]												Open ocean and bay

SPECIES	Refuge Purpose	Biological Integrity, Diversity Health [a]	Federally Listed	Washington Listed	Partners in Flight [b]	Birds of Conservation Concern [c]	Bird Focal Species [d]	State Wildlife Plan [e]	Shorebird Plan [f] (score 1-5)[2]	N.A.Waterbird Conservation Plan [g]	Pacific Flyway Management Plans [h]	WDFW 2006 [i]	NAWMP [j]	WA NHP [k]	Seabird Cons. Plan [l]	HABITAT TYPE
Olive ridley sea turtle*			T[1]													Open ocean and bay
Invertebrates																
Makah's copper butterfly*			SoC[1]	SC[1]				✓						S2[3]		Coastal bogs and meadows
Oregon silverspot butterfly		✓	T[1]	E[1]				✓				✓		SX[3]		Coastal salt-spray meadows, back-dune troughs, forest glades
Newcomb's littorine snail*			SoC[1]	SC[1]										S1[3]		Mudflats and Salicornia salt marsh
Olympia oyster				SC[1]												Bay
Western pearlshell mussel		✓		SM[1]				✓						S3[3]		Freshwater streams
Plants																
Pink sandverbena		✓	SoC[1]	E[1]										S1[3]		Sparsely vegetated coastal dunes and beaches
Footsteps of spring			SoC[1]	E[1]										S1[3]		Coastal dunes and meadows
Frigid shooting star*			SC[1]	E[1]										S1[3]		Riparian areas
Henderson's checkermallow		✓	SoC[1]											watch		Salt marsh
Queen of the forest*			SoC[1]	T[1]										S2/S3[3]		Forest and river
Water howellia*			T[1]	T[1]										S2/S3[3]		Wetland
Water pennywort		✓		SS[1]												Wetland
Habitats																
Upland forest		✓			✓			✓		✓		✓				
Short-grass field					✓				✓		✓					
Riparian		✓			✓			✓	✓			✓				
Riverine		✓						✓	✓	✓						
Palustrine–wetland		✓						✓	✓	✓	✓	✓				

SPECIES	Refuge Purpose	Biological Integrity, Diversity Health [a]	Federally Listed	Washington Listed	Partners in Flight [b]	Birds of Conservation Concern [c]	Bird Focal Species [d]	State Wildlife Plan [e]	Shorebird Plan [f] (score 1-5)[2]	N.A.Waterbird Conservation Plan [g]	Pacific Flyway Management Plans [h]	WDFW 2006 [i]	NAWMP [j]	WA NHP [k]	Seabird Cons. Plan [l]	HABITAT TYPE
Palustrine—freshwater marsh		✓						✓	✓	✓	✓					
Estuarine		✓						✓	✓	✓	✓	✓			✓	
Salt marsh		✓						✓	✓	✓					✓	
Coastal dunes and beaches		✓						✓	✓	✓					✓	
Grassland—OSB habitat		✓						✓				✓				

* = Not documented on refuge. Species occupies habitat adjacent to refuge or potential suitable habitat exists on refuge.
** = Historically nested on refuge; not documented since 1986.
[1] T = threatened; E = endangered; FC = Federal candidate; SoC = species of concern; SC = state candidate; SS = state sensitive; SM = state monitor
[2] Regional score. Category codes: 5 = highly imperiled; 4 = high concern; 3 = moderate concern; 2 = low concern; 1 = no risk
[3] S1 = critically imperiled; S2 = imperiled; S3 = rare, uncommon; S4 = apparently secure; S5 = demonstrably secure; SX = apparently extirpated; SH = historical occurrences, but still expected to occur
[4] HI = highly imperiled, HC = high concern, MC = moderate concern, LC = low concern, NAR = not currently at risk, ✓ = included in plan
[5] Long-term trend code: D = decreasing; I = increasing; NT = no trend; U = undetermined
[a] USFWS 2001b
[b] Altman 1999, 2000
[c] USFWS 2002a
[d] USFWS 2005b
[e] WDFW 2005
[f] Drut and Buchanan 2000
[g] Kushlan et al. 2002
[h] Pacific Flyway Council 1983, 1991, 1998, 1999a, 199b, 2001, 2002, 2003, 2005, 2006a, 2006b, 2006c, 2007
[i] WDFW 2006
[j] North American Waterfowl Management Plan 2004
[k] WDNR 2005, 2007
[l] USFWS 2005a

Table 4-2. BIDEH - Natural Plant Communities at Willapa Refuge: Characteristics, Natural Processes Involved in Sustaining Community and Limiting Factors.

Characteristics of the Community (Structure, Seral Stage, Species Composition)	Natural Processes Responsible for Sustaining Community Structure/ Composition	Limiting Factors
Upland Forest–Sitka Spruce Zone Forest		
Refuge forests consist of a small amount of late-successional forest with presence of large diameter downed logs and snags within forest habitat matrix of even-aged stands, previously managed for timber production. Two major low elevation coastal rainforest habitat types: 1) Sitka spruce dominant or co-dominant. Western hemlock often co-dominant, and western red cedar. Understory includes salal, oxalis, and sword fern. High diversity of mosses and lichens. 2) Western red cedar–western hemlock forests often contain nearly pure stands of hemlock and thrive in this environment where they are exposed to intense windstorms. Low abundance of Douglas fir (*Pseudotsuga menziesii*) and Sitka spruce. Potential resources of concern: marbled murrelet, bald eagle, Vaux's swift, pileated woodpecker, bats.	Climate characterized by hypermaritime (cool summers, very wet winters), abundant fog, no major snow pack. Natural disturbance windthrow, occasional intense windstorms. Catastrophic fires and extended droughts infrequent.	Loss of old-growth and mature forests due to commercial timber harvest. Loss of species diversity and forest complexity due to planting of monotypic stands for timber production. Conversion of habitat to residential areas. Forest fragmentation.
Riparian–Sitka Spruce Zone Forest		
Highly variable structure. High density of edges contributes to habitat and species diversity and productivity. 1) Early seral stage deciduous trees, such as red alder, typically younger forests or frequently disturbed areas. 2) Late seral stage Sitka spruce, western red cedar, western hemlock. Bottomland forest with dense shrub understory; forested streambanks. Potential resources of concern: Dunn's salamander, Van Dyke's salamander.	Functioning flood-plain: high-flow events shape stream channels and riparian vegetation (pulse disturbances). Wind and climate cycles (variable and cyclic).	Dike construction, land clearing for agricultural and urbanization. Timber harvest and roads. Sediment input, loss of large woody debris.
Riverine		
River and stream channels provide migration pathways for adult anadromous fish traveling to spawning grounds and juveniles traveling to the estuary and/or Pacific Ocean. Riverine habitat supports amphibians and invertebrates. Perennial and intermittent streams. Potential resources of concern: chum, coho, steelhead, cutthroat trout, western brook lamprey, Columbia torrent salamander, tailed frog, western pearlshell mussel.	Periodic flooding with flooding energy variable depending on location of stream/river in landscape; perennial water flows.	Loss of connectivity to estuary due to highway and dike construction. Hydrologic regime altera-tion, passage barriers, water quality issues (temperature and sedi-mentation), exotic species.
Palustrine Freshwater Wetlands		
Non-tidal wetlands dominated by trees, shrubs, persistent emergents, emergent mosses and lichens, and all such wetlands that occur in tidal areas where salinity is low (< 0.5 parts per thousand). Wetlands with permanent to semi-permanent standing water, often with fluctuating water table. Can support submerged, floating, rooted aquatic and emergent plants. Varying according to depth and contour of basin, duration of inundation, soil texture and permeability. Potential resources of concern: waterfowl, trumpeter swan, water pennywort, native amphibians.	Maintain freshwater inputs. Functioning floodplain: frequent but not prolonged flooding.	Habitat loss from dike construction/drainage. Land clearing for industrial, agricultural and residential develop-ment. Dam construction that reduced flooding and altered water regimes. Invasive species such as reed canarygrass, purple loosestrife, bullfrogs, and nutria.

Characteristics of the Community (Structure, Seral Stage, Species Composition)	**Natural Processes Responsible for Sustaining Community Structure/ Composition**	**Limiting Factors**
Estuarine		
Vast areas of eelgrass beds provide shelter for fish and invertebrates; food source for brant, waterfowl and waterbirds; fish spawning and nursery habitat; and shellfish habitat. Vegetated and unvegetated sand and mud flats provide foraging areas for shorebirds. Intertidal sand bars and bay islands provide roost sites for seabirds and haul-outs for marine mammals. Potential resources of concern: eelgrass beds, brant, brown pelican, shorebirds, waterfowl, marine mammals.	Tidal cycles. Eelgrass requires habitat where erosion and sedimentation are in equilibrium. Sediment transport and deposition.	Destruction of tidelands by diking, construction of bulkheads and piers. Dredging activity. Contaminants. Aquaculture. Exotic species: *Spartina*, Japanese eelgrass.
Salt Marsh		
Saltmarsh grasses, algae and phytoplankton are major producers in estuaries. Pickleweed (*Salicornia*), seashore salt grass, jaumea, alkali grass, sea arrow grass, sand-spurry, seaside plantain, salt marsh wort. Low to high marsh zones. Potential resources of concern: migratory waterfowl, dabbling ducks, Henderson's checkermallow, elk.	Sun, tides, salinity gradients.	Invasive species: *Spartina*, potentially New Zealand mudsnail. Diking, filling, conversion for agriculture. Logging of watershed.
Coastal Dunes and Beach		
Historically low hummock sand dune formations characterized by large areas of open sand; formed by sparsely vegetated native dune plant species. Invasive, non-native beachgrasses (*Ammophila breviligulata* and *A. arenaria*) planted to stabilize dune community have change dune morphology and native plant communities. Mild climate allows vegetation to establish easily and rapidly. Herbaceous beachgrass to shrub to permanent lodgepole pine forest. Potential resources of concern: western snowy plover, streaked horned lark, pink sandverbena, other rare native dune plants.	Coastal marine and wind processes. Sediment transport and deposition by ocean currents. High rainfall maintains high water table favorable for plant growth.	Dams on Columbia River have altered sediment loads. Jetties have altered sediment transport. Invasive non-native *Ammophila* beach-grasses, Scotch broom, gorse. Rapid succession to shrub, then climax lodgepole pine forest.
Grasslands		
Native grasslands occurred historically on the Long Beach Peninsula. Current habitat restoration on Refuge to create early successional, coastally-influenced grassland habitat for the Oregon silverspot butterfly. Potential resources of concern: Oregon silverspot butterfly, early blue violet.	Proximity to ocean, mild temperatures, high rainfall, fog. Maintain low, open grasslands by suppressing encroaching trees and shrubs. Wind transport of sand, small mammal activety, herbivory, fire.	Loss of habitat. Dune stabilization caused by the introduction and spread of nonnative beachgrass has encouraged rapid succession to forested habitats. *Viola adunca* out-competed by introduced grasses and herbs.

Table 4-3. Priority Resources of Concern for Willapa National Wildlife Refuge

Focal Species	Habitat Type [13, 16, 17, 22, 25]	Habitat Structure	Life History Requirement	Other Benefiting Species
Marbled murrelet	Late-successional forest	Mature forest: dominant trees 100-200 years with average tree diameters exceeding 21 inches. Old-growth forest: dominant overstory >200 years with a multilayered, multispecies canopy; Largest tree diameters range from 32 to >39 inches; Many large fallen trees and snags, trees of all ages, heavy ground cover, <80% canopy closure. In mature and old-growth forests large diameter trees (western hemlock, Sitka spruce, western red cedar, Douglas fir) with large flat moss-covered branches at least 7 inches in diameter that form a platform (for nesting). Branches at least 50 feet above the ground. Mean nest branch height of 120 feet. High canopy closure over nest branches.[2, 7, 8, 9, 10, 11]	Breeding (April–September)	Vaux's swift, pileated woodpecker, spotted owl, brown creeper, red crossbill, Pacific-slope flycatcher, northern Saw-whet owl, northern goshawk, bald eagle, band-tailed pigeon, winter wren, pine marten, long-legged myotis, long-eared myotis, tailed frog, Columbia torrent salamander, Cope's giant salamander, Dunn's salamander, Van Dyke's salamander
Canada goose	Short-grass fields	Short grasses (< 4 inch) preferred forage. Green forage, various grasses and grass-legume mixes make up majority of diet. Other essential habitat elements include water and sanctuary to sustain birds from fall arrival to departure in spring.[23]	Wintering, foraging	greater white-fronted goose, western meadowlark, northern harrier, red-tailed hawk, American kestrel, western screech owl, killdeer, Wilson's snipe
Yellow warbler	Riparian	Early seral-stage deciduous red alder riparian forest. >70% cover in shrub layers with subcanopy layer contributing >40% of total. Shrub layer cover 30%-60% (includes shrubs and saplings). Shrub layer height > 6.6 feet. Shrubs include willow and salmonberry.	Breeding, foraging	song sparrow, common yellowthroat, downy woodpecker, great blue heron, belted kingfisher, olive-sided flycatcher, Swainson's thrush, Wilson's warbler, willow flycatcher Roosevelt elk, red-legged frog
Winter wren	Riparian	Mid-late successional bottomland forest with complex vegetative structure and habitat attributes unique to older forests, such as large down logs and root wads. Large forest blocks with average of four downed logs per acre with dbh >24 inches and 50 feet long. Shrub cover > 60% within 9 feet of ground. Tree trunk surface area for foraging with a mean dbh >16 inches. Shrub species include evergreen huckleberry, red huckleberry, and sword fern.	Year-round, breeding, foraging	

Focal Species	Habitat Type [13, 16, 17, 22, 25]	Habitat Structure	Life History Requirement	Other Benefiting Species
Van Dyke's salaman-der	Riparian	Forested, shaded streambanks, seeps or moist, north-facing rocky habitats in forested areas. Splash zones of streams and moist, well-shaded substrates with stable microclimates. Native species including western red cedar, Sitka spruce, western hemlock, red alder, salal, salmonberry, huckleberry, red elderberry, sword fern, oxalis.[4, 5, 7, 24]	Year-round, breeding, foraging	
Coastal cutthroat trout	Riverine	Passage barrier free, gravelly coastal streams and small rivers with large woody debris, and estuaries. Stream and off-channel habitats. Cool well-oxygenated water, temperature <73˚F, intact riparian corridor. Fine to coarse gravel for spawning.[6, 7]	Resident and anadromous fish spawning, rearing, and foraging	Chinook salmon, chum salmon, coho salmon, steelhead, Cope's giant salamander, red-legged frog, western brook lamprey, western pearlshell mussel
Columbia torrent salaman-der	Riverine	Very cold, clear springs, shady seeps, headwater streams with large woody debris, and waterfall splash zones. May forage in moist forests adjacent to these areas. Loose rock or gravel substrates that are sediment free. Stable microclimates. Water temperatures cannot exceed 81.0˚F to 82.4˚F.[4, 5]	Lay eggs in rock crevices in seeps. Larvae and adults live in gravel or under small cobbles in silt free water that is flowing or seeping. Slow maturing.	failed frog, red-legged frog, Cope's giant salamander, invertebrates
Northern pintail	Palustrine	Emergent wetland. Seasonally flooded with medium depths (>3 feet) and shallow areas (<4-18 inches in depth), flooded from approx. October though June. 30%-70% cover of emergent vegetation, floating and submergent vegetation, native seed-bearing plants such as spike rushes, sedges, bulrushes, manna grass, sparganium, cattail and smartweeds.[12]	Foraging, wintering	mallard, wood duck, northern pintail, American wigeon, greater scaup, lesser scaup, northern harrier, great blue heron, Canada geese, trumpeter swan, Wilson's snipe, red-necked phalarope, belted kingfisher, rufous hummingbird, coho salmon, coastal cutthroat trout, northwestern salamander, water pennywort
Wood duck	Palustrine	Forested wetland. Shallow water wetlands, flooded beds of maturing moist-soil plants, and overflow floodplains. Cavities needed for nesting, trees or snags >12 inches in diameter. Also uses nest boxes.[3]	Year-round, breeding, foraging	
Red-legged frog	Palustrine	Freshwater marsh vegetation characterized by tall reeds, grasses, sedges, and floating aquatics. Shallow to medium water (1.5-6.5 feet) with emergent and/or submergent vegetation.[4]	Breeding, foraging	

Focal Species	**Habitat Type** [13, 16, 17, 22, 25]	**Habitat Structure**	**Life History Requirement**	**Other Benefiting Species**
Willow flycatcher	Palustrine	Scrub shrub wetland Patchy shrub layer; woody vegetation 3 to 12 feet tall with 80% cover and scattered herbaceous openings. Canopy tree (woody vegetation > 12 feet tall) covers < 20%. Native shrubs include: Hooker's willow, Pacific willow, Scouler's willow, Douglas' spirea.[1]	Breeding, foraging	
Brant	Estuarine	Vegetated aquatic beds consisting of intertidal and shallow subtidal shores colonized by eelgrass (*Zostera* spp.) Tidal cycle variation changes habitat from open water to vegetated mudflat. No *Spartina*.[15]	Foraging. Wintering and spring staging (October-April).	juvenile salmonids, Pacific herring, Dungeness crab, soft-shell clams, shorebirds, waterfowl, benthic invertebrates
Dunlin	Estuarine	Intertidal mudflats, both vegetated (eelgrass) and unvegetated. No *Spartina*.	Foraging, migrating, wintering	western sandpiper, sanderling, short-billed dowitcher, red knot, benthic invertebrates
Western grebe	Estuarine	Open water channel habitats used by surface and diving waterbirds.	Foraging and roosting, migrating	waterfowl, common loon, double-crested cormorant
Brown pelican	Estuarine	Dynamic intertidal sandbars within estuary used as roost sites. Sensitive to disturbance.	Non-breeding roost sites	harbor seal (major haul-out sites), seabirds, brant, western snowy plover, shorebirds, benthic invertebrates
New-comb's littorine snail	Salt marsh	Lives on stems of pickleweed (*Salicornia*) and on the substrate beneath the vegetation. Occurs just above high tide line, immersed by seawater only a few hours each year during flood tides. Habitat characterized by *Salicornia*, silverweed, yarrow, tufted hairgrass, seashore saltgrass, seacoast angelica, gumweed, seaside plantain, small spikerush, seaside arrowgrass, Lyngbye's sedge.[14]	Year-round	Henderson's checkermallow, great blue heron, waterbirds, migratory waterfowl
Western snowy plover	Coastal dune and beach	Sparsely vegetated beach or dune habitat, free of contiguous stands of introduced beachgrasses (*Ammophila* spp.) Large areas of open sand with native beach plants and shell patches/tidal debris for nest and chick concealment Nesting areas free of disturbance and excessive numbers of nest predators, particularly crows and ravens. Foraging areas, year-round that are free of frequent or prolonged disturbance.[19]	Breeding (March-September), foraging, wintering	dunlin, sanderlings, least sandpipers, western sandpipers, short-billed dowitcher, black-bellied plovers, pink sandverbena, yellow sandverbena, beach morning glory, footsteps of spring, gray beach pea, and other locally rare native

Focal Species	Habitat Type [13, 16, 17, 22, 25]	Habitat Structure	Life History Requirement	Other Benefiting Species
Streaked horned lark	Coastal dune and beach	Sparsely vegetated expanses of sand adjacent to the ocean; approximately 35% of area with no vegetation Ground layer dominated by sand (~68%) with little thatch Areas dominated by grasses (short annual grasses 0.6-8.7 inches) and forbs with few or no trees or shrubs.[20]	Breeding (March-September), foraging. Possibly year-round.	plants[21]
Oregon silverspot butterfly	Coastal prairie	Stabilized dune habitat has low relief, highly porous soils, less exposure to winds, than other habitat types. Habitat restoration and control of exotic vegetation critical. Caterpillar host plants and adult nectar sources two key components of habitat. Nectar species include: pearly everlasting, yarrow, California aster, dune goldenrod, dune thistle. Native nectar plants maintained at a density ≥ 5 flowering stems/m^2.[18]	Breeding, foraging, year-round	early blue violet (*Viola adunca*), red fescue, Douglas' aster, dune goldenrod, pearly everlasting, sedge

Table notes (citation number indicated in parentheses):
(13) The Washington GAP analysis lists the most important refuge habitats as: sandy beaches; late-seral low-elevation, west-side forest; freshwater and estuarine marsh.
(17) Washington's Comprehensive Wildlife Conservation Strategy classifies the top 20 habitat types for conservation. Priority 1 habitats include: bays and estuaries, herbaceous wetlands, marine nearshore, Westside lowland conifer-hardwood mature forest, Westside riparian-wetlands. Priority 2 habitats: Coastal dunes and beaches. Other habitats: Agriculture, Pasture and mixed environs; Open Water (lakes, rivers, streams).

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4.3 Habitats and Vegetation

The Willapa National Wildlife Refuge is located within the Sitka spruce vegetation zone (Franklin and Dyrness1988). Prior to settlement and development, the landscape was a mixture of coastal beaches and dunes, saltwater and freshwater marshes, freshwater wetlands, native grasslands and upland forests, including old-growth forests. These habitats remain, although their acreage has been reduced. Diking, draining, land clearing, and timber harvest has had effects on the natural landscape.

The current refuge habitats were mapped using GIS based on the interpretation and analysis of 2006 color infrared and true color ortho-corrected aerial photography. These habitats are depicted in Maps 5, 6, and 7, and the acreages of each are shown in Table 4-4.

Table 4-4. Habitat Types and Acreages within the Willapa National Wildlife Refuge

Habitat	Number of Acres
Sitka spruce zone forest	6,735.7
Estuarine open water	878
Intertidal flats	4,178.2
Salt marsh	1,636.2
Riverine	21.8
Seasonal, managed freshwater wetlands	317.3
Permanent/semi-permanent natural freshwater wetlands	610.1
Coastal dunes	1,581.2
Short-grass fields	250.5
Grasslands	33.4

The following are summaries of habitats and vegetative communities. The plant and animal species listed in this section are given as examples of common as well as priority species present but should not be considered a comprehensive list of all species present.

Willapa Bay is a major estuary on the Pacific Coast and at mean higher high tide encompasses approximately 70,400 acres (USFWS 1970). An estuary is defined as the area near the mouth of a river, or rivers, in the case of Willapa Bay, where oceanic tidal waters and freshwater currents collide and mix. Biologically, estuaries are among the most productive environments on earth and provide important habitat for a large variety of organisms. This high productivity is due basically to physical and biological processes unique to estuaries. Dissolved organic nutrients from detrital material enter the estuary from inflowing rivers. The saltwater wedge, pushed along the estuary bottom by the incoming tide, brings in other nutrients of marine origin. Currents and tides circulate fresh and salt water, distributing and, to a certain extent, trapping dissolved and suspended matter. Deposition of these substances fertilizes the estuary and plant life flourishes. This plant life includes vascular vegetation of estuarine marshes (grass, rush, sedge), benthic algae (diatoms), epibenthic algae, and eelgrass on intertidal sediments (USFWS 1986).

Some plants are fed upon directly by fish and wildlife but most die and enter the food chain in the form of detritus or partly decomposed plant material. This detritus, suspended in the water and deposited on the bottom, is a high-quality food for consumers because of its high nutritional value. A number of studies have shown that many species of fish and invertebrates feed wholly or partially on detritus. Therefore, detritus feeders are the critical link between plant production and the production of higher consumers. Consequently, the ultimate ecological value of primary production in marshes occurs when detritus of marsh plant origin enters the food web of the estuary (USFWS 1977).

Habitat components of estuaries include open water, intertidal mudflats, and salt marshes. These habitats are discussed separately below.

4.3.1 Upland Forest–Sitka Spruce Zone

The Sitka spruce (*Picea sitchensis*) forest zone, also known as the coastal temperate rain forest, occurs in a relatively narrow band extending along the North America coast from southeast Alaska to northern California. The maritime weather in the region is influenced by moist Pacific Ocean air and the coastal mountain ranges. Coastal weather is characterized by cool summers and warm, very wet winters. Fog occurs frequently along the outer coast year-round but is notable for the significant amount of summer precipitation it creates in the form of tree drip. The low elevation coastal rivers and forests of southwest Washington receive most of their annual water budget in the form of rain, since the region has no major winter snowpack. The relatively mild seasonal temperatures and plentiful moisture create a unique climate that is highly productive for plant and animal species. The abundant annual precipitation, relatively rich soils, and low rate of catastrophic fire disturbance allow late seral forests to develop (Franklin and Dyrness 1988). Summer drought is infrequent or of short duration. The main natural disturbance is windthrow, frequently occurring during winter storms. Historically occasional intense winter windstorms occurred with a frequency of once or twice every few decades, although their frequency has increased during this decade.

Sitka spruce is the major dominant climax tree species of this forest zone, and is most commonly associated with dominant and co-dominant western hemlock (*Tsuga heterophylla*). Many western hemlocks in these old-growth forests are infected with western hemlock dwarf mistletoe (*Arceuthobium tsugense* subsp. *tsugense*), a parasite that affects their growth but also provides important ecological functions, such as serving as a nesting platform for marbled murrelets (Hamer and Nelson 1995). Understory trees include a diverse mix of common overstory conifer species and hardwoods, primarily composed of red alder (*Alnus rubra*). Late-seral forests of this forest zone are characterized by overstory trees of large stature, exhibiting very large diameter boles, large limbs, and tall, deep crowns, often with broken and reiterated tops. The forests typically develop vertically and horizontally diverse canopies from multiple crown layers created by uneven aged stands, streams, gaps, or similar features that result in a complex spatial orientation. Sitka spruce is susceptible to windthrow, which can account for up to 80% of the mortality within stands. Regeneration from gap phase replacement, however, is rapid (Franklin 1988). Taylor (1990) found that *Picea* can persist at a stand scale if moderate to large gaps (equal to 800-1,000 m^2) are created every few decades as seen with the natural disturbance regime. Since *Picea* grow more quickly and have a longer life span that hemlock, they can remain the climax species.

Western red cedar (*Thuja plicata*) and, less frequently, Douglas fir (*Pseudotsuga menziesii*), are found as common overstory tree associates at more inland and slightly drier sites, along with western hemlock. Douglas fir tends to occur sporadically in old-growth forest remnants of the Willapa Hills, likely due to climatic conditions such as increased fog and precipitation and subsequent decreases in solar radiation along the coast that are not optimal for Douglas fir growth (Davis et al. 2009). In addition, Hansen et al. (2000) state that Douglas fir growth can be severely limited in this area due to infection by Swiss needle cast (*Phaeocryptopus gaeumannii*). Red alder is found as an overstory tree in some forests where clear-cut harvest formerly occurred, along riparian areas, and as an understory tree in younger conifer forests and areas of recent disturbance. Pacific yew (*Taxus brevifolia*), a conifer species associated with old-growth forests elsewhere (Busing et al. 1995), occur in low densities in these forests. Due to their natural rot resistance and robust architecture cedar trees can persist for extremely long periods of time, even surviving as trees from a previous forest stand cohort.

In the Willapa Hills of southwestern Washington, these coastal forests have also been extensively managed for timber production; today, less than 1% of the original old-growth forests remain as scattered remnant patches across the landscape (Davis et al. 2009). Managed forests are typically 20 to 60 years old and are made up of native tree species, primarily Douglas fir and western hemlock. Harvest of old-growth and mature forests for commercial timber and paper production has resulted in loss of species diversity and forest complexity on most of this landscape due to planting of even-aged, monotypic stands, and short harvest rotations. Conversion of habitat to residential and non-forest uses has accelerated forest fragmentation.

The structural complexity of these forests is a key to its importance as wildlife habitat. Sitka spruce provides good nesting and roosting habitat for avifauna (Smith 1980; Wiens 1975). Snags and live trees with broken tops provide nesting habitat for primary and secondary cavity nesters such as Vaux's swift, pileated woodpecker, and bats (Hemstrom and Logan 1986). The bald eagle uses primarily (greater than 90%) Sitka spruce for nesting trees on Admiralty Island (Meehan 1974) and also uses them as roosting trees to survey the incoming breakers for food

(Arno and Hammerly 1977). The peregrine falcon in coastal British Columbia uses Sitka spruce for platform nesting and secondary cavity nesting (Campbell et al. 1978). Marbled murrelets find the large diameter, often moss-covered limbs of mature spruce trees suitable platforms for nesting.

Refuge forests consist of a small amount of late-successional forest with presence of large-diameter downed logs and snags within forest habitat matrix of even-aged stands, previously managed for timber production. Two primary low elevation coastal rainforest habitat types exist at Willapa NWR: Sitka spruce forest and western hemlock–western red cedar.

4.3.1.1 Sitka Spruce Forest

This forest type has dominant and co-dominant Sitka spruce and western hemlock. Western red cedar and red alder may be found at low to moderate densities but are always present. Minor amounts of Douglas fir and grand fir (*Abies grandis*) can be present in some stands at mesic sites.

Diamond Point RNA is an 88-acre forested area at the northern tip of Long Island that was designated a research natural area in 1976. Diamond Point RNA preserves an example of second-growth Sitka spruce–western hemlock forest growing on an island in a coastal estuary. The natural area includes 48 acres of mature red alder and 40 acres of mature Sitka spruce/sword fern forest and Sitka spruce/salal forest. This area was logged near the turn of the century (Dyrness 1972).

4.3.1.2 Western Hemlock–Western Red Cedar

This forest type has dominant and co-dominant western red cedar and western hemlock. Minor amounts of Sitka spruce, Douglas fir, red alder, grand fir, and Pacific yew also occur. Mature western red cedar can average 8 to 11 feet dbh and reach 150 to 165 feet in height. Individual cedars may be up to 1,000 years old. Old-growth western hemlock may reach 5 to 6 feet dbh. The western hemlock has a higher mortality rate and shorter life span than cedar; therefore the hemlock is believed to cycle through old-growth stands four to five times more rapidly than the cedar does.

Understory shrub and herbaceous vegetation in these forest types typically include salal (*Gaultheria shallon*), evergreen huckleberry (*Vaccinium ovatum*), red huckleberry (*Vaccinium parvifolium*), oxalis (*Oxalis oregana*), and sword fern (*Polystichum munitum*). There is a high diversity and abundance of mosses and macrolichens from the canopy to the forest floor.

The 111-hectare (274-acre) Cedar Grove RNA on the Long Island Unit is one of several late-successional forests at Willapa NWR. It hosts an extremely rare plant community: western hemlock-western red cedar/evergreen huckleberry-salal. The western red cedar forest is in a climax condition, with some of the ancient cedar trees estimated to be 900 to over 1,000 years old. The stand's size, its island location in an estuarine bay, and its persistence make it one of the most unique forest habitats in the Pacific Northwest (Franklin 1984). The stand structure of the Cedar Grove RNA is also unusual in that it is quite uniform. This uniform condition is attributed to the absence of catastrophic fire. Although individual trees show signs of fire, the wet climate and island setting have apparently protected the area from a stand-destroying fire. The origin of is forest may date to the last major change in climate 4,000 years ago. Surrounding trees and topography have likely protected the stand from major wind events. This area was difficult to access by water and was therefore spared from logging in the early days. The remainder of Long Island has been logged one or more times in the last 100+ years (USFWS 1987).

4.3.2 Forested Wetland and Riparian Forest–Sitka Spruce Zone

Riparian and wetland forests are highly variable in their composition, size, and structure (Kauffman et al. 2001). Functioning floodplains are influenced by high-flow events that shape stream channels and riparian vegetation through a process of pulse disturbances. The high density of edges contributes to habitat and species diversity and productivity. Sitka spruce is the major dominant climax tree species of this forest type. It is most commonly associated with dominant and co-dominant western hemlock and understory red alder. Early seral stage deciduous trees, such as red alder, typically make up younger forests or frequently disturbed areas along stream bottom lands. Unlike similar coastal and riparian habitats found to the north on the Olympic Peninsula, Davis et al. (2009) found that big-leaf maple (*Acer macrophylla*), often the most common hardwood species, is essentially absent from this area.

The streamside forest is often dense with a shrubby understory and surrounded by a forest matrix. Forested wetlands are found along sloughs and coastal areas on the Refuge. Common understory vegetation includes vine maple (*Acer circinatum*), cascara buckhorn (*Rhamnus purshiana*), devil's club (*Oplopanax horridus*), salmonberry (*Rubus spectabilis*), skunk cabbage (*Lysichiton americanum*), sword fern, and lady fern (*Athyrium filix-femina*). There is typically a high diversity and abundance of mosses and macrolichens from the canopy to the forest floor.

Most riparian forests have been impacted directly and indirectly by adjacent timber harvests and road construction. Harvest of large-diameter trees or windthrow, resulting from high winds during severe winter storms crashing into trees after removal of adjacent forests, have created increases in sediment input and loss of large woody debris. Dike construction, land clearing for agricultural purposes, and urbanization has reduced the amount of coastal forested wetlands.

4.3.3 Estuarine Open Water

Open water refers to those areas that are continuously submerged. These habitats are referred to as deepwater habitats by Cowardin et al. (1979). Water is present in the channels even at low tide and they serve as a link between the ocean and tidal rivers and streams. Channel depths in Willapa Bay range from 30 to 50 feet with maximum depths of 75 to 77 feet below mean low water (Hedgpeth and Obrebski 1981). The open water channels provide habitat for fish and a variety of invertebrate animals and aquatic plants. Many of the fish species in the estuary are confined to open water channels as the tide falls. During high tide they disperse to the flooded mud flats and lower portions of salt marshes. Channels serve as migration pathways for adult salmon, lamprey, steelhead, coastal cutthroat trout, and other fish species on their way to rivers and streams to spawn, as well as for juveniles. Many fish species that spend their adult life in the ocean spend time as juveniles in the estuary. Deeper channels and holes are preferred habitat for white sturgeon. Clams, mussels, aquatic worms, and other small organisms are found on the bottom. Rooted aquatic plants are scarce in the main channels because of water depth and strong, erosive currents but are found in backwaters.

4.3.4 Intertidal Flats

Intertidal flats are those areas of mud or sandy mud that are affected by the rising and falling of the tides. Intertidal flats are often submerged, but are gradually exposed as the tide lowers. At low tide much of Willapa Bay is drained, exposing extensive mud flats. More than 50% of the total high tide surface area is exposed at low tide (Hedgpeth and Obrebski 1981; Sayce 1988). The intertidal zone is defined as the area above MLLW and below MHHW. Based on 2003 data, 84 square miles of the bay are intertidal (Coastal Resources Alliance 2007). These mud flats tend to be very soft in many locations due to the deposition of fine sediments combined with organic matter, water saturation, and bacterial influence (McConnaughey 1985). The substrate characteristics vary from being sandy in the northern region of the bay to silty clay in the southern region (O'Connell 2002). Typically vegetation is scarce, but beds of eelgrass are present within Willapa Bay. Intertidal flats support an abundance of invertebrates including oysters, clams, mussels, amphipods, polychaete and oligochaete worms, insect larvae, and nematodes. Foraging shorebirds follow the receding tide across the flats and fish and waterbirds frequent the flats when they are flooded. Organisms of intertidal flats must cope with the stress of currents, varied wave action, and tides. Intertidal life will also be affected by light level, temperature change, amounts of oxygen, salinity, and exposure to air and wind (McConnaughey 1985).

Native eelgrass (*Zostera marina*) is a seed-producing marine plant that provides food and habitat for a variety of organisms. Vast beds of eelgrass occur at the lower levels of the intertidal zone and are a staple food for brant, a sea goose that migrates through or winters in Willapa Bay. American wigeon, mallard, northern pintail, and canvasback also feed on eelgrass (Phillips 1984). Roots and stems of eelgrass assist in stabilization of mudflats. Blades of eelgrass are grazed and also support the growth of diatoms and small invertebrates that accumulate on the blades. Eelgrass also supplies detritus, which contributes to the food cycle (McConnaughey 1985). Eelgrass provides habitat for numerous species of mollusks and crustaceans, and serves as a nursery ground for juvenile, resident and migrating fish (Kikuchi 1980). It is used for refuge and feeding by salmon species and Pacific herring (Simenstad 1994). An exotic eelgrass, Japanese eelgrass (*Zostera japonica*), is also present in Willapa Bay. At the current time it is unknown whether this eelgrass species poses any threat to the Willapa Bay ecosystem. However, evidence exists that the expansion of *Z. japonica* has provided a major food source for migratory waterfowl (Boersma et al. 2006; Phillips 1984).

The upper edges of the intertidal flats are ringed by salt-tolerant plants called halopytes which serve as sediment traps and add much organic matter to the estuarine system (McConnaughey 1985).

A recent major ecological concern involved the substantial loss of high intertidal flats and native saltmarsh vegetation due to invasion by *Spartina alterniflora* (smooth cordgrass). *Spartina*, a non-native cordgrass that was accidently introduced to the Willapa Bay ecosystem from the East Coast in the late 1800s, formerly covered a large portion (>14,000 acres) of Willapa Bay's intertidal mudflats (Boersma et al. 2006). *Spartina* forms dense, monotypic stands, traps sediment, and alters natural hydrologic processes. The loss of most of Willapa Bay's intertidal mudflats and native saltmarsh communities was imminent. *Spartina* had and would have continued to have a devastating effect on use of the bay by shorebirds, brant and other waterfowl species, anadromous fish, and Willapa Bay's oyster and hard-shell clam aquaculture industry. However, due to eradication efforts by Federal, state, and county agencies as well as the efforts of the oyster industry and private landowners, and additional support by Washington State University, the University of Washington, and nongovernmental organizations, including TNC, *Spartina* is now nearly absent from Willapa Bay. The major portion of the intensive eradication effort took place from 2003 through 2008. Use of areas within the bay by shorebirds and waterfowl dramatically increased after removal of *Spartina* from tidal mudflats (Patten and O'Casey 2007).

4.3.5 Salt Marsh

Salt marsh occurs in the estuary where the ground is high enough (not flooded too deeply for too long) to support emergent herbaceous plants, but too low and wet to support shrubs or trees. Salt marshes are generally found from elevations of about MLLW to MHHW.

Saltmarsh grasses, algae, and phytoplankton are major producers in estuaries. Halophytes, plants that are adapted to salty conditions, including pickleweed (*Salicornia*), seashore salt grass, jaumea, alkali grass, sea arrow grass, sand-spurry, seaside plantain, and salt marsh wort, are found in the low to high marsh zones. Low marshes are those nearest the low-tide line which may be covered with each high tide. High marshes are generally only covered by the tide on very few occasions. Tufted hairgrass (*Deschampsia* sp.), Pacific silverweed, saltmarsh bulrush, and Lyngbye's sedge are found in high salt marshes.

Salt marshes provide an abundance of food for the invertebrates, fish, birds, and mammals of the estuary. The vegetation filters pollutants from the water. The plant seeds, roots, tubers, and leaves feed many thousands of ducks and geese. Plant matter from the marshes breaks down and is transported by tidal action into the bay. Decaying remains of plants are fed upon by larger organisms including filter feeders and so on up the food chain. Juvenile salmon and other fish find an abundance of food in the marshes, as well as shelter from strong currents and predators. Bald eagles, great blue herons, and other predators are attracted to the abundance of life. The productivity of the marshes is critical to the health of the estuary.

According to ONRC calculations, Willapa Bay originally contained approximately 14,620 acres of saltwater wetlands. Now there are 5,277 acres. This represents a 64% loss of estuarine wetlands (Coastal Resources Alliance 2007).

The Refuge desires to undertake a program of estuarine restoration (Appendix O) in select portions of the Refuge. This action will maximize and enhance the three above habitats.

4.3.6 Riverine

The Willapa National Wildlife Refuge has the responsibility for approximately 20 streams with fish populations. Both permanent and intermittent streams are represented on the Refuge and are classified as low- to medium-gradient streams and high-gradient streams, which are found on steep slopes.

Land use activities and previous land management practices have impacted wildlife habitat values in and along rivers and streams in the Willapa Bay watershed and contributed to the decline of fish runs. Stream processes in many areas have been altered. Degradation of streams, including those on the Refuge, has occurred historically. Problems include loss of connectivity to the estuary due to highway and dike construction, hydrologic regime alteration, presence of fish passage barriers, water quality issues (i.e., temperature and sedimentation), and presence of exotic species.

Refuge streams and rivers support runs of anadromous fish such as chum, coho and Chinook salmon, and cutthroat trout. Western brook lamprey are resident in some of the streams as are rare amphibians such as the Columbia torrent salamander and tailed frog. Transplanted populations of western pearlshell mussels are also present in several refuge streams.

Historically streams contained large amounts of woody debris that created a complex aquatic environment of riffles, pools, glides, runs and side channels. Habitat features of healthy riverine systems include:

1) Large woody debris: The presence of large woody debris (LWD) in a stream/river system is an important component which impacts channel formation and channel stability. LWD in a stream or river bed will cause changes in morphology of channels by slowing water velocity. This will trap sediments and create pools while causing riffles to form downstream. In high-energy streams, LWD will assist in the retention of spawning gravel as well as provide thermal and physical cover for fish and other species. Another benefit of LWD is providing habitat as well as nutrient sources for macroinvertebrates and microorganisms (Schuett-Hames et al. 1999).
2) Pool/riffle ratio: Healthy streams should have a pool/riffle ratio of at least 1:1 (Cheo and Murdoch 1991). This ratio is the number of pools and the number of riffles observed visually within a stream reach.

Another important component of a healthy riverine system is an intact and diverse riparian vegetation zone. Positive effects of a healthy riparian zone include (Applied Environmental Services 2002):

Stabilization of stream banks which reduces sedimentation and the effects of flooding:

1) Reduction of the addition of pollutants into the stream from runoff.
2) Control of stream temperatures by providing canopy shade.
3) Providing refuge for wildlife.
4) Addition of organic matter from leaf litter and fallen branches.
5) Addition of LWD from dead vegetation that falls and enters the stream.

Restoration of riverine habitat is a priority for the Refuge. The initial restoration project on the Refuge was at Headquarters Stream with the goal of re-establishing chum, coho, and sea-run cutthroat trout, which were extirpated from this stream in the late 1940s. Restoration activities were initiated in 1997. Physical improvements consisted of removing fish passage barriers (which included a tide gate, flash board risers, culverts, and a check dam), incorporation of LWD, and root wads within the stream, rehabilitating spawning beds and re-establishing a chum salmon run as well as cutthroat trout. Coho recolonized the stream when passage barriers were removed.

Stream and estuarine restoration is undertaken as a management action to restore historic ecological processes and functions to refuge streams and estuarine habitats to benefit anadromous fish populations and other stream-dependent wildlife. Refuge lands where stream and estuarine restoration is feasible stretch from the Naselle River, near the base of the Stanley Peninsula, to Tarlatt Slough, at the southern end of Willapa Bay and include Long Island. The Refuge restores stream habitat by re-establishing LWD complexes in a fashion that mimics natural LWD presumed to have been historically present in the stream. LWD complexes are placed in the existing stream channels by high line cabling or other heavy equipment use where feasible, keeping impacts to streamside habitat to a minimum. Complexes that contain root wads are preferred as this is a more natural condition. Channel structure is sometimes needed to be modified, fish barriers removed, and portions of the riparian zone restored by plantings. The Refuge has an environmental assessment for stream restoration that was signed in 2003.

As a management tool the Willapa NWR has had a reintroduction program for salmonids, including chum and coho salmon as well as sea-run cutthroat trout, since 1996.

Wild sea-run cutthroat trout have been introduced to several refuge streams, starting in December 2000 and continuing on an annual basis if fish are available. The fish are trapped incidental to salmon hatchery operations at the Naselle and Nemah River hatcheries, transported to the Refuge, and released in refuge streams. A small piece of caudal or adipose fin is clipped by WDFW personnel for DNA analysis. During the relocation process, fish are released in small groups along a length of the target stream, primarily in pools. Fish are placed in buckets and hand-carried to the stream site. On occasion, fresh or frozen salmon eggs are also placed in pools or broadcast as a food source for the cutthroat trout. Salmon carcasses are also received from local fish hatcheries and are placed along streams to enhance nutrient levels.

In addition, the Refuge maintains fish egg trays for egg reintroduction efforts for chum and coho salmon and conducts release of chum and coho fry. A chum restoration project was initiated in 1998 in cooperation with the Willapa Bay Regional Fisheries Enhancement Group and the WDFW.

4.3.7 Seasonal, Managed Freshwater Wetlands

The Lewis and Porter Point units, located on the southwestern shore of Willapa Bay, contain diked freshwater marshes and are managed for wintering waterfowl, primarily duck use. Since the 1980s, these units have been converted to freshwater marsh from poorly drained pastures. Marsh plants include bulrush, cattail, sedges, spikerush, bur-reed, beggarticks, juncus, smartweed, mannagrass, water pennywort, several species of pondweed, and duckweed. Native emergent and submerged aquatic plants are present as are non-native invasive species including reed canarygrass, tussock, and bog loosestrife. Lewis and Porter Point are drawn down through water control structures on a rotational basis. Draw-downs are conducted to accomplish a variety objectives including providing mudflat areas for moist soil vegetation to proliferate for waterfowl food sources; exposing impoundment beds to drying action in order to control reed canarygrass, tussock, and bog loosestrife infestations; and controlling non-native bullfrog populations. In addition to vegetation management via water manipulation, chemical control, mowing, and/or discing are utilized to control reed canarygrass and tussock. Water level manipulation is used to encourage seed set and proliferation of smartweed, beggarticks, and burr-reed. Exposed mudflats also provide foraging areas for shorebirds. Draw-downs are also timed to maximize the period for native amphibian development before the impoundment is completely dried out. Natural flooding in the fall provides access to smartweed and other waterfowl foods for migrating and wintering waterfowl. The Lewis and Porter Point impoundments are also fed by small streams originating in timber company properties. Water levels are maintained at the approximately 11.7 feet, except during draw-down. Fish ladders are incorporated into these systems to allow ingress and egress of fish species, which include coho salmon, sea-run cutthroat trout, and other native fish species. Small seasonal freshwater wetlands are maintained at the Riekkola and Tarlatt units. Use of refuge impoundments by waterbirds other than waterfowl, such as grebes, herons, bitterns, and rails, occurs. These shallow, vegetated wetlands provide breeding habitat for red-legged frogs, Pacific treefrogs, roughskin newts, and northwestern salamanders. River otters and non-native nutria also use impoundments.

4.3.8 Permanent/Semi-permanent Natural Freshwater Wetlands

Permanent and semi-permanent natural freshwater wetlands on the Refuge are diverse habitats and include swamps, marshes, seeps, springs, and seasonal wetlands. Also included in this category are beaver ponds, which have been constructed through dam building and maintained by these mammals in various refuge streams, creating open ponds and marshes which provide important ecological benefits to a variety of wildlife species.

Beavers are an important source of disturbance in natural ecosystems. By constructing dams and impounding streams, beavers considerably alter stream hydrology in a way that provides extensive benefits to fish as well as other organisms, resulting in a high species diversity supported by these systems (Rossell et al. 2005). Cutthroat trout make extensive use of beaver ponds for overwintering and feeding (Johnson et al. 1999), and coho often use these areas as winter habitat (Narver 1978 in McMahon 1983). Beaver ponds on Willapa NWR streams provide winter habitat for both juvenile cutthroat and coho. Maintaining beaver ponds on these streams will benefit cutthroat and coho by providing winter habitat as well as rearing and feeding areas (Pollock et al. 2004; USFWS 2004a).

Beaver ponds create habitat complexity and an abundance of woody debris, and they often contain snags standing in open water. These snags are important nesting habitat for wood ducks, tree swallows, and woodpeckers. They are also used as hunting perches by a variety of raptors.

There are a few small freshwater ponds on Long Island. Extensive sloughs have developed on the eastern shore of the island and penetrate westerly for a considerable distance into the interior. Lewis Slough at the north end has almost bisected the island.

Freshwater marsh and bog communities scattered throughout Long Island’s drainages make up about 0.2% of the land surface. Plant species associated with these wetlands include skunk cabbage, yellow pond lily, pondweeds, bladderworts, grasses, sedges, and rushes.

Freshwater wetlands and surrounding vegetation support a variety of birds such as great blue herons, marsh wrens, common yellowthroats, and song sparrows.

Interdunal freshwater wetlands are found at the Leadbetter Unit of the Refuge on the north end of the Long Beach Peninsula and are of relatively high ecological integrity when compared to what remains of these habitats in Washington. The deflation plain and dune troughs that contain this habitat are composed of five recognized plant communities and occur in relationship to a moisture gradient from seasonally wet and seasonally dry to permanently flooded. These include areas which remain moist, areas which flood through the spring, and areas that are flooded year round (Caicco 1989). Slough sedge and Pacific silverweed are found in the moister zones of these habitats. These interdunal freshwater wetlands provide habitat for waterfowl, waterbirds, songbirds, amphibians, and invertebrates.

4.3.8.1 Visitor/Administrative and Maintenance Site

Two types of wetlands have been delineated on the property: one large estuarine wetland along Tarlatt Slough, and several depressional emergent wetlands are found in a central and narrow strip generally running north and south through western portion of the site near Sandridge Road. The depressional wetlands on-site appear to coincide with the Yaquina loamy fine sand soil mapping unit, which is somewhat poorly drained and appears to have a water table closer to the surface. Vegetation characteristic of wetlands and evidence of wet soils can be readily observed on the site in the designated wetland areas.

Dominant species within the estuarine wetland include slough sedge (*Carex obnupta*), skunk cabbage (*Lysichiton americanum*), common cattail (*Typha latifolia*), duckweed (*Callitrichaceae heterophylla*), Nootka rose (*Rosa nutkana*), Hooker willow (*Salix hookeriana*), soft rush (*Juncus effusus*), reed canarygrass (*Phalaris arundicacea*), red alder, water parsley (*Oenanthe sarmentosa*), western red cedar, small-fruited bulrush (*Scirpus microcarpus*), salmonberry, and creeping buttercup (*Ranunculus repens*). The large estuarine wetland meets the criteria for Category I rating, according to WDOE standards described in the Wetland Rating Form for Western Washington (WDOE 2004). Category I wetlands represent the highest quality wetlands in the State of Washington. They provide life support function for threatened or endangered species, they are nurseries of the ocean, and they provide shelter and food for fish, birds, and wildlife (Key Environmental Solutions 2010).

Dominant species within the depressional emergent wetlands include soft rush, other rushes (*Juncus* sp.), slough sedge (*Carex obnupta*), tussock sedge (*Carex stricta*), reed canarygrass (*Phalaris arundicacea*), velvet grass (*Holcus lanatus*), and creeping buttercup (*Ranunculus repens*). The depressional wetlands are one-stratum emergent wetlands and generally appear to be degraded, probably due to past land use practices, such as agriculture, including pasturing. These wetlands meet the basic criteria for a Category IV wetland rating (Key Environmental Solutions 2010).

Pacific County Critical Areas and Resources Land Ordinance No. 147 (CARL) will require the issuance of a development permit for work within or adjacent to all wetlands on site. CARL establishes buffers around all wetlands, utilizing the WDOE Washington State Wetlands Rating System for Western Washington (WDOE 2004). Buffer widths are determined by the wetland quality rating, with higher quality wetlands requiring greater buffer protection zones. The Category I wetlands will have a designated 100-foot buffer zone, whereas a Category IV wetlands will have a 25-foot buffer protection zone. The wetlands found on the site will also be subject to Federal and state removal/fill wetland regulations if impacted.

4.3.9 Coastal Dunes and Beaches

Sand beaches with associated dunes dominate the southern Washington Pacific coastline, while the northern coast is more rugged and rocky with steep headlands and numerous offshore islands and rocks. Willapa Bay and Grays Harbor are two large bays located along the outer coast in the southern half of the state. Historically low hummock sand dune formations characterized by large areas of open sand, formed by sparsely vegetated native dune plant species. Coastal marine and wind processes worked to maintain native plant communities in early successional stages on the outer prism of many of these beaches. Where dunes were more stable and blowouts less frequent, a mosaic of native prairie and dune grasslands, freshwater lakes, swamps, bogs, and spruce-dominated forests developed. High rainfall maintained high water tables favorable for plant growth.

Invasive, non-native beach grasses (*Ammophila breviligulata* and *A. arenaria*) planted to stabilize dune community have change dune morphology and native plant communities. Mild climate allows vegetation to establish easily and rapidly. Accelerated succession due to fire suppression progresses from herbaceous beachgrass, to shrub (often invasive non-natives such as Scotch broom and common gorse), to pioneer lodgepole pine or climax Sitka spruce forest. The Columbia River once created extensive sediment transport and ocean currents influenced by a log-shore drift deposited sediment continually nourishing the coastal sand beaches. Dams on the Columbia River have altered sediment loads, and jetties at the river mouth and entrances to the bays have altered sediment transport.

The endangered pink sandverbena (*Abronia umbellata*) and other rare native dune plants like yellow sandverbena (*Abronia latifolia*), gray beach pea (*Lathyrus littoralis*) and beach morning glory (*Convolvulus soldanella*) are found along the sparsely vegetated sand beaches and coastal dunes within the Refuge where the spread of non-native beachgrass is controlled or kept in low densities due to the influence of naturally occurring erosion processes.

The Leadbetter Point Unit lies at the northern tip of the Long Beach Peninsula, at the mouth of Willapa Bay, in Pacific County, Washington. The Long Beach Peninsula separates the Pacific Ocean from Willapa Bay. The west side of the area is characterized by open windswept beaches backed by low vegetated dunes. The tip of the peninsula was largely barren sand, and the east side consists of a narrow beach with a few small, sheltered openings cut into the beachgrass by high water in winter. A small, isolated portion of beach exists to the east, on Willapa Bay, and is referred to as Grassy Island although it is attached to the peninsula.

The northern end of the Long Beach Peninsula was in a state of gradual northward accretion from at least 1965 to 1999. Invasion of American beachgrass and European beachgrass has followed accretion, progressively filling in the dunes behind the sand spit. In conjunction with slowed accretion in more recent years, the vegetation line has moved westward and the vegetation-to-water distance has decreased (Phipps 1990) resulting in a narrower beach and probably less suitable plover habitat. Recent maps from the Washington State Department of Transportation show that the tip of Leadbetter Point has been gradually eroding since mapping efforts began in 1999. As the tip has eroded, the peninsula to the southwest has gotten wider. Leadbetter Point is one of the northern-most breeding sites for the western snowy plover (*Charadrius alexandrinus nivosus*) on the Pacific Coast (Jaques 2001).

The unique natural elements protected at Leadbetter Point include salt marsh, native dunegrass, lodgepole pine (shore pine) forest, shrub/lodgepole pine (shore pine), and open beach habitats. Leadbetter Point contains high-quality examples of high-salinity Virginia glasswort/inland saltgrass marsh, low salinity marsh, and transition zone wetlands. Flora associated with the marshes are of primary significance, as are the dune grassland and deflation plain communities. Pockets of native plants within the secondary dune, deflation plains, and dune troughs are also significant ecological features and are of high quality compared to these remaining plant communities in Washington. The open beach and dune grassland communities of Leadbetter Point have been significantly impacted by the invasion and naturalization of two non-native beach grasses. The salt marsh has been invaded by smooth cordgrass, an eastern salt marsh species, although efforts to control cordgrass in recent years have essentially eliminated it from Leadbetter Point. Selective removal or control of plant species not native to Leadbetter Point, including *Spartina*, Scotch broom, and common gorse, was an approved management activity at the time the RNA was established. Removal and control of the non-native beach grasses has been approved and work has been done as part of the management of habitat for the federally threatened/state endangered western snowy plover (Caicco 1989; Willapa NWR files).

4.3.10 Grasslands and Short-grass Fields

Native grasslands occurred historically on the Long Beach Peninsula. Currently there are very few of these native plant communities remaining. Where grasslands still exist they are often pastures of introduces grasses, and sedges in wetter areas, managed as livestock rangeland, golf courses and residential lawns. Willapa NWR is planning to develop a habitat restoration project to create early successional, coastally influenced grassland habitat for the Oregon silverspot butterfly. WDFW has already implemented a similar project at two small sites on state land on the Long Beach Peninsula.

Proximity to the salt spray from the ocean, mild temperatures, high rainfall, and fog have maintained the low-growing, open natural grasslands by suppressing encroaching trees and shrubs. Natural processes responsible for sustaining the community structure and composition are wind transport of sand, small mammal activity, herbivory, and fire.

Habitat loss has resulted from dune stabilization caused by the introduction and spread of non-native beachgrass that encourages rapid succession to forested habitats. The early blue violet (*Viola adunca*), a host plant of the Oregon silverspot butterfly larvae, and other native grasses and forbs, are out-competed by the introduced grasses and herbs and shaded out by weedy shrubs and expanding pioneer lodgepole pine forests. As coastal areas become stabilized and developed, the influence of natural processes that sustain native habitats is reduced or eliminated.

The Refuge currently has several managed short-grass pastures in the South Bay Units totaling 250.5 acres.

4.4 Fish

Coastal rivers and streams within the Refuge provide habitat for several anadromous salmon species, including coho (*Oncorhynchus kisutch*), Chinook (*O. tshawytcha*), and chum salmon (*O. keta*), and cutthroat trout (*O. clarki clarki*). The Bear River estuary provides rearing habitat for juvenile fish, as well as a staging area for adult anadromous fish preparing to move into and out of Bear River. Chum, Chinook, and coho salmon are all found in the Bear River. The small unnamed stream near the headquarters, often referred to as the Headquarters Stream, has during a numbers of years, experienced a fall run of chum salmon. This stream also contains rearing habitat for coho and Chinook salmon and coastal cutthroat trout and contains resident sculpin (*Cottus* spp). Other streams on the Refuge currently support chum and coho runs. The unnamed streams in the Lewis and Porter Point units support sculpin and coastal cutthroat trout. Fish ladders at the Lewis and Porter Point water control structures allow anadromous fish passage.

Federal species of concern found on the Refuge include coastal cutthroat trout, Pacific lamprey, and river lamprey. Healthy populations of both cutthroat and coho as well as other fish species have been documented in several refuge streams. Fish surveys are conducted either by trapping, walking along a stream, or conducting snorkel surveys. Electrofishing of streams is also conducted by trained individuals. Reproductive surveys have also been conducted and cutthroat trout as well as coho and chum salmon spawning and production of fry have been documented. Sticklebacks are found in refuge freshwater impoundments and streams.

4.4.1 Salmonids

Chinook, coho, and chum salmon, steelhead, and sea-run cutthroat trout use the Willapa Bay estuary as a feeding and nursery area, as well as a migration route to spawning areas in tributary streams. Occasionally pink salmon occur in the bay.

Salmon often account for 80%-90% of the finfish caught in the Willapa Bay area; however, their numbers are declining (The Willapa Alliance 1998a). Along the Washington coast, the largest chum populations are found within the rivers of Grays Harbor and Willapa Bay (WDFW 2000). Willapa Bay historically supported large chum runs and contained excellent chum habitat (Stewart and Associates 2007). However, currently chum runs are critically low (Applied Environmental Services 2001; R. Craig, Willapa Bay Regional Fisheries Enhancement Group, pers. com.; The Willapa Alliance 1998b). Since 1960 the average return of chum salmon is approximately one-third of that recorded prior to that year. The majority of the salmon commercially caught in Willapa Bay were chum, historically averaging 50% of the total salmon catch. Recently chum have accounted for less than 1% of the total commercial catch in Willapa Bay. Returns of Chinook and coho have also fallen to approximately one-half of the catch levels recorded in the 1900s (The Willapa Alliance 1998a).

Although life histories vary considerably among and within species of Pacific salmon (see Groot and Margolis 1991), the general life cycle for Pacific salmon consists of adult spawning in fresh water and subsequent death of adults, egg development and juvenile rearing, juvenile migration to salt water, growth and maturation in salt water, and adult migration to freshwater spawning habitats (National Research Council [NRC] 1996). Adult salmon primarily spawn in the fall, however, the season that Chinook salmon return to fresh water prior to spawning is used to describe specific “runs” (e.g., fall-, spring-, summer-run). Most Chinook in Willapa Bay return in the fall. Two life histories of Chinook salmon, stream- and ocean-type, are also distinguished by the residency of juveniles in fresh water (Bottom et al. 2005; Fresh et al. 2003; Healey 1991; NRC 1996). Stream-type fish spend one to two years in streams and rivers prior to migrating to saltwater, whereas ocean-type fish migrate in their first year after spending up to a few months in streams or rivers. Ocean-type fish also rear in lower reaches of rivers and estuaries much more than stream-type fish. Juvenile chum salmon migrate to salt water either immediately or within a few weeks after emergence, and coho salmon generally spend a year rearing in fresh water before migrating (NRC 1996).

Steelhead and coastal cutthroat trout exhibit substantial variability in their life histories (Behnke 1992; Burgner et al. 1992; Hall et al. 1997). Both species spawn during late winter through the spring. Adult steelhead that return to fresh water fully mature during late fall through spring are considered winter-run fish, whereas those that are sexually undeveloped and return during late spring through early fall are considered summer-run fish (Withler 1966). Anadromous individuals of both species may spend one to six years in freshwater with most migrating after at least two years (Burgner et al. 1992; Trotter 1997). Steelhead migrate to the open ocean and spend one to four years before returning to spawn, whereas coastal cutthroat trout migrate to estuaries and near-shore areas for a matter of months before returning to fresh water. Unlike salmon, steelhead and coastal cutthroat trout may survive after spawning and return to saltwater to forage and make multiple spawning runs. In addition, coastal cutthroat trout exhibiting resident, fluvial (i.e., migrating to larger rivers only), and anadromous life histories are thought to occur in some streams. Although sea-run cutthroat can spawn several times, resident cutthroat appear to spawn only once (The Willapa Alliance 1998a).

Although the presence of salmonids in the Willapa Bay estuary has seasonal patterns (e.g., peak juvenile abundance in spring and early summer), adults and juveniles consisting of various species, runs, and life history strategies may be present throughout the year. Habitats used directly by salmonids at the Refuge consist of tidally influenced sloughs, marshes, floodplains, as well as tidally influenced and non-tidally influenced portions of streams and rivers for spawning and rearing. These habitats also indirectly provide benefits to salmonids through production and export of nutrients, organic matter, and invertebrates, which contribute to the estuary’s food web.

The various species and their periods of adult migration are: Chinook salmon (July-October), coho salmon (July-November), chum salmon (October-November), steelhead (November-March), and sea-run cutthroat trout (July-December).

Young fish of varied species pass to or through the bay when only a few days to a couple of years old. Migration of Chinook salmon occurs during May-July, coho salmon during April-June, chum salmon during January-May, steelhead during April-June, and sea-run cutthroat trout during April-June. Migration of coho yearling salmon, steelhead, and cutthroat trout also occurs during early fall freshets. Salmon and steelhead juveniles can be found in the bay throughout the year (USFWS 1970).

Stream restoration activities have occurred on the Refuge, specifically for salmonid species. The Refuge has had success in reintroducing and enhancing salmonid populations in various streams on the Refuge and restoring physical attributes of streams that have been destroyed or severely impacted by historical land use in the past. Most of the refuge streams have been affected by historic blocks to fish passage and logging impacts. Restoration methods such elimination of fish passage barriers, placement of large woody debris, nutrient enhancement and restoration of extirpated or reduced salmonid populations via the use of egg trays, remote incubation, fry introduction of chum and coho salmon, and adult transplantation of cutthroat trout have occurred. Restoration activities started in 1997 at Headquarters Stream. This project was aimed at re-establishing chum, coho and sea-run cutthroat trout, which were extirpated in the late 1940s. After physical restoration of the stream bed occurred, chum eggs were received, which were hatched in a remote site incubator. Returning adult chum spawners were documented in 2001, 2002, and 2003. Chum fry emergence was also documented in 2004 in Headquarters Stream although adult spawners were not observed.

Stream restoration activities have since occurred in numerous other refuge streams with additional streams targeted for these activities in the future. Reintroduction/enhancement efforts for salmonid species have occurred in the Cedar Grove Stream on Long Island and on the mainland, including Porter Point, Lewis impoundments/streams, North Creek, Chum Creek, Lost Creek, and Teal Slough. Major partners in these endeavors include the Willapa Bay Regional Fisheries Enhancement Group and the WDFW.

Fish ladder installation at Lewis and Porter Point has facilitated fish access to two spawning streams.

4.4.2 Forage Fishes

This group includes anchovies, herring, and smelt, important forage species in Willapa Bay for other fish.

Pacific herring use Willapa Bay as a spawning and nursery ground. The eggs are adhesive and can be found on rocks, piling, seaweed, and eelgrass during January and February, where they remain until hatching. Immature herring are found in the bay during the spring, summer, and fall months.

Northern anchovies, although spawning in the ocean, are plentiful in the bay during the period June through September.

Longfin and silver smelt occur in the area. In general, the longfin smelt are in deeper water, while silver smelt inhabit the plankton-rich tidal flats. Longfin smelt spawn in the brackish and lower freshwater reaches of tributary streams, while silver smelt spawn on coarse sandy beaches.

American shad adults migrate through the bay during the late spring and early summer on their way to upstream spawning areas (USFWS 1970).

4.4.3 Sturgeon

Sturgeon are found in Willapa Bay. White sturgeon are primarily limited to the Willapa and Naselle River areas. It is believed that adults of this species move upstream in late winter and early spring to spawn (USFWS 1970).

4.4.4 Other Fishes

Starry flounder, sand dab, several species of sole, sea and surf perches, rock and bottom fishes (black cod, flounder, ling cod, rockfish true cod), and related species use the bay as a nursery area. Starry flounder are abundant throughout the tideflat and shallow water areas.

Young of the numerous species of rock and bottom fishes, sole, sea perch, etc., use the bay as a nursery area. As these fish mature, they migrate to the deep water areas and ocean front (USFWS 1970).

Lamprey species found in Willapa Bay include the two anadromous species, Pacific lamprey and river lamprey. These lamprey species spawn in fresh water. An entirely freshwater species, the western brook lamprey, has been documented in freshwater streams/rivers on the Refuge including the Bear River, Teal Slough stream, South Creek, North Creek, Chum Creek, and Lost Creek. River lamprey and Pacific lamprey have been documented in the Bear River (M. Johnson, Pacific County Conservation District, pers. com.)

4.5 Birds

The diverse habitats found at Willapa NWR support a large number of resident and migratory birds. Over 200 bird species have been documented on the Refuge. At the northern tip of the Long Beach Peninsula at Leadbetter Point, shorebirds including plovers, sandpipers, dunlin, sanderlings and others, exceed 100,000 annually during the peak spring migration. This site and the estuarine habitats within Willapa Bay make up one of the most significant shorebird areas in North America. Willapa Bay is also an important wintering ground for geese and ducks, many of which breed in Alaska and northern Canada. Great blue heron and several gull species are also common along the coast at Willapa. Coniferous forests on Long Island and in the Refuge along the eastern shores of the bay provide food, shelter, and nesting structure for the marbled murrelet, neotropical song birds, woodpeckers, owls, and raptors. The upland and estuarine grasslands and early successional, coastally influenced grasslands also support a number of resident and seasonal birds. Pelagic seabirds such as shearwaters, fulmars, jaegers, and albatrosses occur in the adjacent coastal Pacific waters but rarely make landfall within the Refuge. Key focal species that breed, overwinter, or regularly use the Refuge as a stopover during migration are discussed in more detail in the following section.

4.5.1 Waterbirds

4.5.1.1 Common Loon (*Gavia immer*)

The NAWCP classifies the common loon as a species of moderate concern meaning populations are either a) declining with moderate threats or distributions; b) stable with known or potential threats and moderate to restricted distributions; or c) relatively small with relatively restricted distributions. The common loon is not classified as a federally listed species at this time, because there is no evidence of a declining population or a substantial change in distribution. The WDFW classifies the common loon as a sensitive species because it is “vulnerable or declining and is likely to become endangered or threatened throughout a significant portion of its range within the state without cooperative management or removal of threats" (Washington Administrative Code [WAC] 232-12-297, Section 2.6).

Because historic records are somewhat unreliable and surveys have not been comprehensive, it is not known if the population is currently stable, increasing, or decreasing (Richardson et al. 2000). Evers (2004) describes the overall population as "healthy and robust" and states the "results from winter counts indicate a steady increasing trend in the number of loons and long-term recovery in the overall breeding population since the mid-1900s." However, a finding of the Marshbird Workshop held in 2005 estimated significant potential threats exist to common loons that have not actually occurred to a majority of population. Although threats such as shoreline development, human disturbance, predation, oil spills, harmful algal blooms, bycatch from commercial gillnetting, lead poisoning, and overfishing of forage fish have been identified, the severity of these threats to the breeding population is not well understood (Evers 2004; Marshbird Workshop 2005; McIntyre and Barr 1997; Richardson et al. 2000). Numbers of known nests have increased over the past 15 years, but this increase may be a result of increased survey effort (Richardson et al. 2000). New information on these and other issues affecting common loons will be needed to better understand their current status.

Suitable nesting habitat for common loons does not exist at Willapa NWR, and migrating loons rarely make landfall within the Refuge, although they are regular inhabitants of the surrounding marine waters.

4.5.1.2 Aleutian Cackling Goose (*Branta hutchinsii leucopareia*)

The Aleutian cackling goose was classified as an endangered species in 1967, primarily due to a declining population caused by predation on their nesting grounds from introduced arctic and red foxes. The species listing status was changed to threatened in 1991. A revised Federal recovery plan outlined three major delisting criteria: 1) maintain a wild population of at least 7,500 animals; 2) re-establish self-sustaining populations of geese on three former breeding areas; and 3) maintain adequate migration and wintering habitats. In 2001 the Aleutian cackling goose was removed from the Federal endangered and threatened species list, because all the major delisting criteria had been exceeded. Since that time the population has continued to increase and now numbers over 70,000 based on winter surveys conducted in 2003-2004 (Pacific Flyway Council 2005).

Willapa NWR and the fields and farm pastures adjoining Willapa Bay are the primary stopover habitat in Washington State for Aleutian cackling geese during the fall migration from September to late November. Peak counts at Willapa during the mid 1990s averaged from 300 to 400 birds (Hays 1997; Kraege 2005). Winter goose survey numbers in Willapa Bay were much lower, representing less than 1% of the geese examined, from 2000 until 2004 when surveys were curtailed. Low numbers are typically seen during the northern migration in February and March each year. The highest number of spring migrating Aleutian cackling geese in Washington through the mid 1990s was 52 birds recorded in Willapa Bay by Pitkin and Lowe (1995). The 2008 calculated population index for Aleutian cackling geese in the Pacific Flyway was 193,321. The most recent three-year average population equals about 179,000, slightly below the Flyway objective of 250,000 birds set by the Pacific Flyway Council.

The increase of cackling geese, which are recovering from historic population lows, has complicated management in the wintering area for dusky Canada geese. Cacklers wintered mainly in California prior to the 1980s, but as the population recovered, its wintering range shifted northward to overlap the range of the dusky. With increasing goose numbers, complaints of crop depredation by all Canada geese have increased significantly.

4.5.1.3 Brant, Pacific population (*Branta bernicla nigricans*)

A primary rationale for creating Willapa NWR in 1937 was conservation of migratory and wintering populations of brant. Brant are one of the most abundant waterbird species passing through Willapa Bay during annual migrations. Brant utilize eelgrass (*Zostera marina*) beds as a primary food source while in Willapa Bay, often numbering in the thousands of birds. Use of the bay is greatest during the northern spring migration, with peak bird numbers observed from March through May, with use typically highest in April (Figure 4-1). Brant also winter in the area from late October to early May. Total numbers of wintering birds are lower than in the spring, averaging several thousand, but overall there is a lesser degree of interannual variation (Wilson and Atkinson 1995). Historically the brant population was much higher than at present.

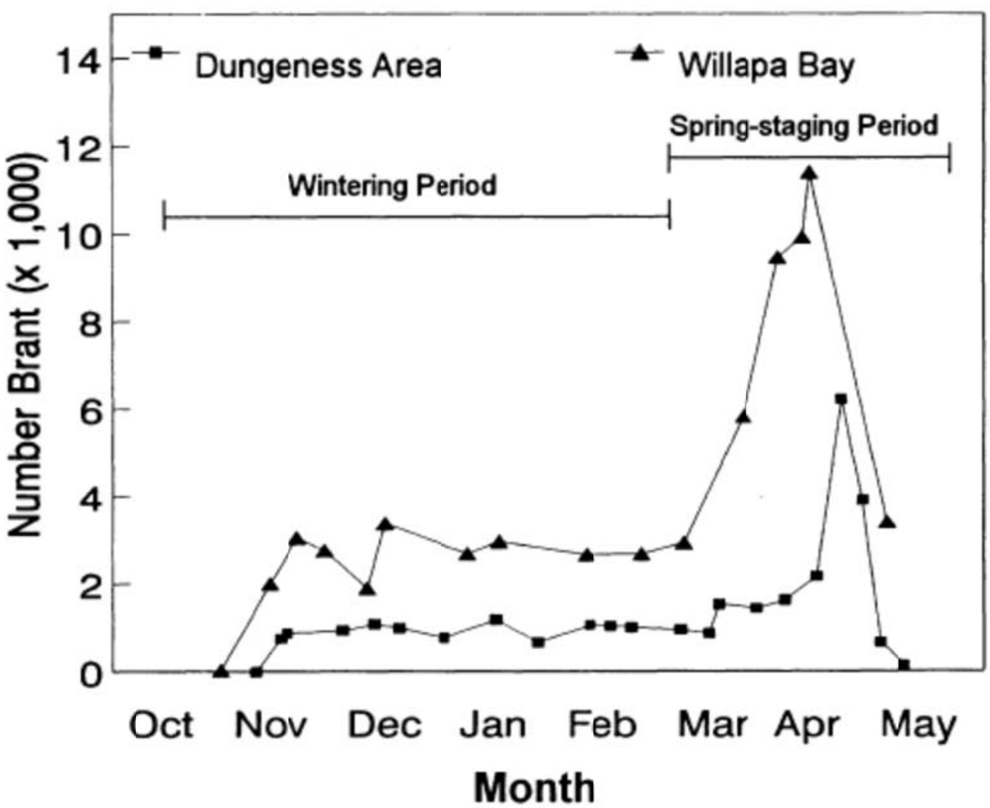


Figure 4-1. Typical brant use in Willapa Bay and Dungeness Bay, Washington (data from surveys conducted during the 1989-1990 season).

The total area in Willapa Bay vegetated by eelgrass has also declined since the mid 1980s, partly due to the spread of the *Spartina altinaflora*. With the success of recent *Spartina* control efforts, eelgrass is expected to return to some areas of the bay. Recent winter use has been primarily confined to the northern bay, but extensive eelgrass beds exist along the western side of Long Island within the Presidential Proclamation Boundary.

Brant harvest in the Pacific Flyway states for 2007 was estimated at 2,800 birds, with Washington State making up slightly less than 20% of the total rate of harvest. The 2008 population estimate based on an index derived from midwinter surveys totals 24,972.

4.5.1.4 Dusky Canada Goose (*Branta canadensis occidentalis*)

A goal of the Pacific Flyway Management Plan is to maintain and enhance the dusky Canada goose population for all of its values to society (USFWS 1992b). The objectives of the plan include achieving and maintaining a wintering population of between 10,000 to 20,000; maintaining wintering habitats in sufficient quantity and quality; and managing wintering habitat to provide optimum food, water, and sanctuary conditions, and to provide optimum geographical distribution. On the wintering grounds, the dusky population has declined from historic levels while the total number of Canada geese has reached record highs (Pacific Flyway Council 2008).

The primary wintering area is in the Willamette Valley of western Oregon and on the floodplain of the lower Columbia River in western Oregon and Washington. Although used to a lesser degree, Willapa Bay is considered to be part of the primary dusky wintering range. A limited number of dusky wintering surveys are conducted in Willapa Bay. Surveys totaling approximately 200 to 1,200 dusky Canada geese are typical on the bay during the fall, winter, and early spring. While not a large number, it is significant considering the small size of the population.

Enumeration and comparison to prior survey results is complicated by resident western Canada geese that have hybridized with introduced dusky geese. These geese are not Alaska-breeding birds. They are descendents of a captive breeding program initiated at Willapa NWR in 1958, when 40 dusky goslings were relocated from the Copper River Delta to the Refuge. The flock grew to about 400 by the mid-1970s, when the program was discontinued. Although recent estimates of flock size are not available, each year on Miller Sands Island in Oregon approximately 40 nests of dark Canada geese are recorded. Since 1999, approximately 1,200 dark Canada geese have been banded and collared on Miller Sands Island (Pacific Flyway Council 2008). Harvest of unmarked hybridized form of western Canada-dusky geese are tallied as dusky geese at check stations and counted toward unit closure thresholds. Continued marking of this small population would reduce the unintended inclusion of these birds in permit zone harvest quotas for dusky geese. However, implementing strategies that allow harvest of abundant subspecies of Canada geese, while protecting dusky geese, is very time-consuming, controversial, and expensive. Dusky geese are more vulnerable to hunting, apparently due to their behavior and habitat use patterns, making control of their harvest difficult (Pacific Flyway Council 2008). Hunting and harvest management is discussed in further detail in Chapter 5.

4.5.1.5 Brown Pelican (*Pelecanus occidentalis*)

In 1970 brown pelicans were added to the Federal list of endangered and threatened wildlife as an endangered species in all but the U.S. Atlantic coast states, Florida, and Alabama. On November 17, 2009, the USFWS published a rule to remove the brown pelican from this list due to recovery (74 FR 59444). The delisting became effective within 30 days of the rule date. The Service concluded that the primary reason for severe declines in the brown pelican population in the United States, and for designating the species as endangered, was DDT contamination in the 1960s and early 1970s. Banning of DDT, along with other recovery actions, has resulted in increased population numbers and reproductive success, and information now indicates that major threats to brown pelicans have been reduced, managed, or eliminated. A draft post-delisting monitoring plan has been developed and will be put into effect in the Gulf of Mexico and coastal California.

Brown pelicans typically begin to arrive locally in June. They are seen numbering in the thousands along the outer coast of the Leadbetter Unit in August and September. Brown pelicans primarily use the Refuge for day roosting or loafing and resting, while feeding on northern anchovy and other small nearshore fishes. Pelicans can also be found on pilings and on sandbars and seasonally inundated sandy islands in estuaries and at the mouths of rivers and large streams. The Columbia River estuary and the northeastern coastal Pacific waters may serve as an important feeding area during years when prey is less abundant in the southern reaches of the California Current System. Over 22,000 pelicans were documented using the East Sand Island night roost on the lower Columbia River in July 2009 (Jaques pers. com.) This number is about twice that observed in previous summers and is a new high record for that site overall. Pelicans were also observed by refuge staff occurring in larger than normal numbers along the Pacific coast beaches during summer 2009 (Ritchie pers. com.) Additional data suggest that pelicans bypassed many of their usual California breeding and foraging sites on the way north during the spring and summer of 2009. This pattern is most often observed during El Niño years when food resources become scarce at accustomed foraging areas adjacent to breeding sites.

Recommendations and recovery actions identified in the California Brown Pelican Recovery Plan (USFWS 1983) were considered in the development of this CCP and are described in further detail in Section 4.9.

4.5.2 Raptors

4.5.2.1 Bald Eagle (*Haliaeetus leucocephalus*)

The bald eagle is classified in the BCC and represents one of the Service's highest conservation priorities. The bald eagle was formerly listed under the ESA, primarily due to population declines caused by reproductive failures linked to DDT, and nesting and roosting habitat loss resulting from timber harvest and urban development. Productivity levels are high and the population continues to increase. With observed population growth, the bald eagle was delisted in 2008 but is still protected under the Bald and Golden Eagle Protection Act and the Migratory Bird Treaty Act. A monitoring plan has been prepared to track recovery efficacy (USFWS 2007b).

Bald eagles are found year-round at Willapa NWR. Three bald eagle territories encompass coastal portions of the Refuge in south Willapa Bay. Nests of two of these territories occur on the Long Island Unit of Willapa NWR. Adult and sub-adult bald eagles, including a resident pair, can be seen along the outer coast at Leadbetter Point any month of the year. Bald eagles are opportunistic foragers. Eagles in the Willapa Bay region feed on waterbirds, marine mammals, salmondids, and marine fish and invertebrates. Eagles also scavenge fish and animal carcasses in upland areas, along rivers and larger creeks, and on the coast.

4.5.2.2 Northern Goshawk (*Accipiter gentilis*)

Northern goshawks can occur in all forested regions of Washington. Northern goshawks are considered opportunistic foragers (Beebe 1974), feeding on a variety of small mammals, gallinaceous birds, and forest birds. As of 2003, there were 338 documented breeding territories in the state (WDFW, unpublished data). The exact number of northern goshawks is not known, because monitoring is not currently being conducted. The number of historical breeding sites lost due to habitat alteration and the number of new territories in suitable habitat are also unknown. Less than 1% of recent breeding records have been recorded from the Puget Trough area and southwest Washington (Desimone and Hays 2004). The northern goshawk is a species identified on the BCC list. It is also listed as a Washington State candidate species.

Harvest and fragmentation of forestland have been identified as factors limiting goshawk populations. Although the effects of timber harvesting on goshawks in the United States are not fully understood, there is evidence to suggest that harvest impacts nest site selection (Crocker-Bedford 1990; Desimone 1997; Finn et al. 2002a, 2002b; Reynolds 1989; Ward et al. 1992; Woodbridge and Detrich 1994), and potentially, nesting rates (Crocker-Bedford 1990, 1995). In addition, nesting goshawks appear to be largely absent from some extensive forested landscapes in western Washington that have been intensively managed on shorter rotations (WDFW, unpublished data). Fragmentation of suitable habitat potentially increases interaction with competing raptors (e.g., red-tailed hawks [*Buteo jamaicensis*], great horned owls [*Bubo virginianus*]) (Crocker-Bedford 1990; Crocker-Bedford and Chaney 1988; Kenward 1996; Moore and Henny 1983).

Northern goshawks are not known to occur on the Refuge. However, some current forestlands contain suitable habitat, and much of the restored upland forests will also support suitable habitat for northern goshawks. The existing Willapa NWR forest management plan uses thinning prescriptions that reflect a balance of different forest age classes to promote forest growth and the development of habitat complexity. A principal objective is restoring ecological function to refuge forests by creating a natural distribution of stand structure, composition, and successional stages while promoting old-growth/late successional characteristics to benefit forest dependent wildlife.

4.5.2.3 Peregrine Falcon (*Falco peregrinus pealei*)

In Washington, peregrine falcons reached a low of four pairs in 1980. Similar to the bald eagle, a decline in the North American peregrine falcon population was primarily caused by reproductive failures linked to the effects of DDT. In 2000, 56 pairs were counted, doubling the number counted just seven years prior. Peregrine falcons can now be found in most parts of the state where there are cliffs or structures for nesting and sufficient prey. Peregrines feed on a variety of smaller birds that are usually captured on-the-wing. Hunting territories may extend to a radius of 19-24 km (12-15 miles) from nest sites (Towry 1987). The population is still small and is highly vulnerable to disturbance and environmental contaminants, but productivity levels are high and the population continues to increase. As a result of this recovery, the Federal government has down-listed them in August 1999 from endangered to sensitive.

The peregrine falcon is classified in the BCC and represents one of the Service's highest conservation priorities. Peregrines are found year-round at Willapa NWR but more regularly occur from October through April. In winter and fall, peregrines spend much of their time foraging in areas with large shorebird or waterfowl concentrations, especially in coastal areas (Dekker 1995). They are only known to use the Leadbetter Unit but may use other coastal areas within Willapa Bay. Suitable peregrine falcon nesting habitat does not occur within the Refuge.

4.5.3 Shorebirds

4.5.3.1 Red Knot (*Calidris canutus roselaari*)

Red knots migrate from the Arctic to as far as the southern tip of South America and back each year. A one-way trip can be about 9,000 miles and involves stops at accustomed staging areas along the way for feeding and resting. There is concern that their population has decreased substantially in recent years, especially the eastern North American (Atlantic) subspecies *C. c. rufa*, which has been designated as a Federal candidate species. The western North American subspecies *C. c. roselaari* is thought to breed in northwest Alaska and Russia's Wrangel Island and winters along the west coasts of North America, and possibly Central America and northeastern South America. The winter range and important wintering areas of this subspecies are virtually unknown (Buchanan 2006). Although *C. c. roselaari* is not as much at risk, it is considered a species of concern due to dramatically declining numbers (Buchanan 2006; Morrison et al. 2006). Niles et al. (2008) estimate the *C. c. roselaari* population to be <10,000 and therefore vulnerable. They recommend that both subspecies be listed because of their small, declining populations and the threats they currently face. *C. c. roselaari* regularly use the estuarine habitats in Willapa Bay during their spring and fall migration, but it is not currently known how significant Willapa Bay habitats are to migrating red knots.

4.5.3.2 Western Snowy Plover, Pacific coast population (*Charadrius alexandrinus nivosus*)

On March 5, 1993, the Pacific coast population of the western snowy plover was listed as threatened under provisions of the ESA. The Pacific coast population is defined as those individuals that nest within 50 miles of the Pacific Ocean on the mainland coast, peninsulas, offshore islands, bays, estuaries, or rivers of the United States and Baja California, Mexico (USFWS 2007a). Prior to Federal listing, the WDFW designated the western snowy plover as endangered in 1981. The western snowy plover population has shown an overall declining trend during the last century. Reasons for this decline, and the severity of threats, vary by region and location, but are primarily due to habitat loss and degradation.

Western snowy plover are year-round residents on the Refuge, however most birds migrate south subsequent the breeding season. Adults typically begin breeding in Washington in late March, while most young have fledged by mid-August. Of the six Washington locations identified in the recovery plan as breeding areas, only two are currently occupied, the largest is located at the Leadbetter Point Unit of Willapa NWR. Disturbance of nesting plovers at Leadbetter occurs to a lesser degree than elsewhere along the southern Washington coast. The spatial extent of suitable habitat and relative isolation of the Leadbetter site make it of paramount importance to snowy plover recovery in Washington State. Current western snowy plover population and productivity continue to be below thresholds set as recovery objectives.

Recommendations and recovery actions identified in the western snow plover recovery plan were considered in the development of this CCP, and are described in further detail in Section 4.9.2.

4.5.4 Seabirds

4.5.4.1 Marbled Murrelet (*Brachyramphus marmoratus*)

The marbled murrelet is federally listed as a threatened species in California, Oregon, and Washington. The State of Washington has also designated the marbled murrelet as a threatened species. The marbled murrelet is a year-round resident on Washington marine coastal waters within several kilometers of the shoreline. The majority of nesting stands in Washington have been discovered within 63 km (39 miles) of marine waters. Marbled murrelets require suitable canopy structures for nesting that are primarily found in the mature and old-growth coniferous and mixed species forest stands of western Washington. Removal of these forests, primarily by timber harvesting and urbanization, is the principal factor contributing to the decline of the marbled murrelet and is the most significant impediment to recovery of the species (USFWS 1997a). Habitat fragmentation resulting in increased densities of nest predators, and prey availability, are also probable limits to long-term productivity and survival. Adult mortality caused by predation, impacts from the effects of oil spills, mortality due to entanglement in fishing gear, chronic water pollution, aquaculture, and disturbance at nesting and foraging sites have also been identified as potential limiting factors. The current overall estimate for the listed population (California, Oregon, and Washington) is >18,000. Trend data indicate an annual decline of between 2.4% to 4.3% (Falxa et al. 2009).

Coniferous forests at Willapa NWR support several stands known to be used for nesting by marbled murrelets. Suitable nesting habitats occur on the Long Island, Headquarters, and Teal Slough units, including two of the RNAs on the Refuge, the 111-hectare (274-acre) Cedar Grove RNA and the 36-hectare (88-acre) Diamond Point RNA. These low elevation coastal forestlands consist of old-growth and mature western red cedar, Sitka spruce, western hemlock, and Douglas fir trees with large-diameter limbs, abundant canopy epiphytes, and open crowns. These structurally complex stands are formed where a diversity of tree sizes create multi-layered canopies with small naturally occurring gaps and stand-level crown defects (e.g., wind breakage and dwarf mistletoe deformation) that develop preferred nesting conditions. Forests with suitable marbled murrelet habitat are very limited in southwestern Washington and northwestern Oregon. The Refuge represents the most significant habitat on Federal land within the Western Washington Lowland Province.

Recommendations and recovery actions identified in the marbled murrelet recovery plan (USFWS 1997a) were considered in the development of this CCP and are described in further detail in Section 4.9.3.

4.5.5 Land Birds

4.5.5.1 Streaked Horned Lark (*Eremophila alpestris strigata*)

The streaked horned lark subspecies represents a small endemic population that breeds and winters in only a few locations in Oregon and Washington. It is perhaps the most endangered bird in Washington State (Rogers 2000). Historically its range extended further north into southwestern British Columbia and as far south as the Rogue River Valley in Oregon. The population has declined dramatically, and the range contracted significantly. This is primarily attributed to the loss of native prairies, coastal grasslands, and sparsely vegetated beaches as a result of general development, agricultural conversion, and encroachment by forests and introduced beach grasses. Although systematic range-wide surveys are incomplete, it is estimated that fewer than 1,000 birds remain in the entire population (Pearson and Altman 2005).

Streaked horned lark have been found at Leadbetter Point during surveys conducted during the breeding seasons in 1999 and 2000 (MacLaren and Cummins 2000; Rogers 1999). Breeding surveys have been conducted in collaboration with WDFW subsequent to habitat restoration efforts began by the Refuge in 2001. Several nests have been found each year. Three nests were found in 2009, but up to 10 territories were estimated to be occupied. Currently the streaked horned lark population and productivity continues to be below thresholds indentified in the range-wide assessment. Nest predation has implemented in this reduced productivity. Pearson et al. (2005) noted that most wintering birds (72%) were in the Willamette Valley, with 20% along the lower Columbia, 8% on the Washington coast, and 1% on south Puget Sound sites. Based on re-sightings of color-banded individuals, many birds on the Washington coast and lower Columbia seem to be resident or move between these two areas (Pearson et al. 2005).

Recommendations and proposed conservation strategies identified in the Species Assessment Form and the Candidate Notice of Review for the streaked horned lark (66 FR 54810) and the Range-wide Streaked Horned Lark Assessment (Pearson and Altman 2005) were considered in the development of this CCP and are described in further detail in Section 4.9.4.

4.5.6 Rare or Extirpated Species

4.5.6.1 Northern Spotted Owl (*Strix occidentalis caurina*)

The northern spotted owl was listed under the ESA as threatened on June 26, 1990, (USFWS 1990) because of widespread loss of suitable habitat across the spotted owl's range and the inadequacy of existing regulatory mechanisms to conserve the spotted owl (USFWS 2008a). The final northern spotted owl recovery plan was subsequently published in May 2008. Since the subspecies was listed, the northern spotted owl population has continued to decline, especially in the northern portions of its range. Spotted owls have become rare in certain areas of their historic range, such as British Columbia, southwestern Washington, and the northern coastal ranges of Oregon (USFWS 2008a).

The spotted owl inhabits structurally complex, late seral and old-growth coniferous forests in the Pacific Northwest and northern California. Historically much of the lowland coastal forests and mid-elevation forests of the Cascade and coastal mountain ranges provided spotted owl habitat.

Much of that forestland was harvested for lumber and paper production. "Ideally, blocks of habitat should be dispersed in a pattern corresponding to a species' full geographic distribution. This distribution is the key hedge against major catastrophes that could otherwise extinguish the sole remaining population of a once wide-spread species" (Thomas et al. 1990). However, the spotted owl recovery plan excludes the Western Washington Lowland Province from the Managed Owl Conservation Area approach because it is assumed that low population numbers are not essential to the species recovery.

Spotted owls historically inhabited forests located within the present day boundaries of the Refuge. A spotted owl pair that nested in the Cedar Grove RNA forest was last observed there in 1985. The following year barred owls were observed occupying the nest. An established spotted owl management circle also encompasses the Teal Slough Unit and most of the Headquarters Unit of the Refuge. This territory was most recently known to be occupied in 1998 when a survey documented a pair of adults and one juvenile spotted owl. Despite the de-emphasis on spotted owl recovery in southwestern Washington, applicable recommendations and recovery actions identified in the northern spotted owl recovery plan (USFWS 2008a) were considered in the development of this CCP. These actions are described in further detail in Section 4.9.5.

4.5.6.2 California Condor (*Gymnogyps californianus*)

California condors are listed as endangered in California, but those occurring outside of California are listed as a non-essential experimental population under Section 10 (j) of the ESA. For purposes of this subsection, the term "experimental population" means any population (including any offspring arising solely there from) authorized by the Secretary of the Interior for release under paragraph (2), but only when, and at such times as, the population is wholly separate geographically from non-experimental populations of the same species. In 1996 a non-essential experimental population of California condors was established in northern Arizona. Since that time condors released in northern Arizona have exceeded the non-essential experimental area by flying to Wyoming; several points in central and western Utah; Colorado; and elsewhere in Arizona. The current 10 (j) area was expanded to include parts of Arizona, Nevada, and Utah.

Willapa NWR does not, and probably never did, provide suitable condor nesting habitat. But since condors have wide-ranging foraging patterns they may have scavenged large mammal carcasses within the area that now includes the Refuge. This is especially true for the Pacific coast portion of the Leadbetter Unit, where dead and dying marine mammals regularly wash ashore. During the winter of 1805-1806 Meriwether Lewis documented and captured California condors along the Columbia River. A condor was observed feeding on a whale carcass along the Pacific Coast near the mouth of the river by the exploration party. The last credible sighting of condors in the Pacific Northwest was in Oregon in the early 1900s. In the future, wide-ranging condor flights resulting from an increasing population may find birds moving into areas not currently used. However, expansion of the nonessential experimental area into the Pacific Northwest is not being considered at this time.

4.6 Mammals

Forty-five species of native mammals have been documented on the Willapa NWR. Mammals that inhabit the various habitats on the Refuge include Roosevelt elk (*Cervus elaphus*), black-tailed deer (*Odocoileus hemionus*), bobcat (*Lynx rufus*), black bear (*Ursus americanus*), mountain lion (*Felis concolor*), coyote (*Canis latrans*), Virginia opossum (*Didelphis virginiana*), raccoon (*Procyon lotor*), porcupine (*Erethizon dorsatum*), striped skunk (*Mephitis mephitis*), snowshoe hare (*Lepus americanus*), mink (*Mustela vison*), river otter (*Lutra canadensis*), beaver (*Castor canadensis*), mountain beaver (*Aplodontia rufa*), Pacific jumping mouse (*Zapus trinotatus*), long-tailed weasel (*Mustela frenata*), northern flying squirrel (*Glaucomys sabrinus*), Townsend's chipmunk (*Eutamias townsendi*), bushy-tailed wood rat (*Neotoma cinerea*), and various species of shrews, moles, mice, and voles. Harbor seals (*Phoca vitulina*) are seen in the bay and the Bear River. Nutria (*Myocastor coypus*) is a non-native mammal that inhabits wetland areas on the Refuge.

The Roosevelt elk is a subspecies that is darker and larger than the Rocky Mountain elk. Habitat on the Refuge includes open fields and fresh and salt water marshes as well as forested areas and clearings in forests. An estimate of the elk population in the late 1970s on Long Island was 40 to 45 animals. Populations of elk in western Washington are variable, ranging from less than 1 elk per square mile to12 elk per square mile (USFWS 1978).

Although a population estimate does not exist for the entire refuge, a study in 1973-1975 estimated the bear population on Long Island to be approximately 30 animals (Lindzey 1976).

Willapa NWR is in an area of high species richness for bats, which tend to have their greatest species numbers in low-elevation forests. The Refuge's combination of late-seral, low-elevation forests combined with wetlands create ideal habitat for a number of bat species (Cassidy et al. 1997). Eight bat species are known to occur on the Refuge, consisting of the little brown myotis (*Myotis lucifugus*), big brown bat (*Eptesicus fuscus*), Yuma myotis (*M. yumanensis*), long-eared myotis (*M. evotis*), long-legged myotis (*M. volans*), California myotis (*M. californicus*), silver-haired bat (*Lasionycteris noctivagans*), and the hoary bat (*Lasiurus cinereus*). Many of these bat species roost and forage in forested areas and several frequently use snags, stumps and downed logs as day roosts or maternity roosts. The Yuma myotis, long-eared myotis, and long-legged myotis are Federal species of concern.

4.7 Reptiles and Amphibians

The cool, wet climate of the Willapa Hills makes the area a "hotspot" of amphibian diversity in Washington. Willapa NWR is particularly noteworthy for the number of amphibian species it supports. It has more amphibians than any other NWR in Washington (13 of 24 native species).

Federal species of concern found on the Refuge include the tailed frog, Columbia torrent salamander, and Van Dyke's salamander. The Refuge supports the greatest number of state-listed amphibians (three of the six) of any NWR in Washington: the Columbia torrent Salamander, Dunn's salamander, and Van Dyke's salamander, all of which are state candidate species. Willapa NWR is the only NWR in Washington on which they occur (Cassidy et al. 1997). The Columbia torrent salamander has a limited range in both Washington and Oregon and relies on mid- and late-seral conifer forest. Dunn's salamander, although it apparently has less stringent habitat requirements, also has a limited range in Washington, and Willapa NWR supplies most of its protected area. Other amphibians on the Refuge with less limited distribution, but are associated with late-seral forests, are the Van Dyke's salamander and the tailed frog (Cassidy et al. 1997).

Long Island and wet areas amid similar forested areas on the Refuge's mainland are rich in amphibian species. Eighty percent of the amphibian species in Washington are considered obligates of stream- or wetland-related riparian habitat (Knutson et al. 1997). Eight species of salamander have been found on Long Island: ensatina (*Ensatina eschscholtzii*), Pacific giant (*Dicamptodon tenebrosus*), northwestern (*Ambystoma gracile*), Columbia torrent (*Ryacotriton kezeri*), western red-backed (*Plethodon vehiculum*), Van Dyke's (*P. vandykei*), and Dunn's (*P. dunni*) salamander, and rough-skinned newt (*Taricha granulosa*). Cope's giant salamander (*D. copei*) may occur on the island as well. Many of the species found on Long Island also occur on the mainland within the Refuge and surrounding lands. Some of these amphibian species spend a large part of their life near streams and wet environments within the forest uplands. The Refuge has red-legged frog (*Rana aurora*), Pacific tree frog (*Pseudacris regilla*), and tailed frog (*Ascaphus truei*) in wet habitats, such as marshes, streams, ponds, and seeps. Bullfrogs (*Rana catesbeiana*) are an introduced species in the Pacific Northwest, and a control program is in place for this species as they compete with the native frog species and consume native amphibians and young waterfowl. Bullfrogs breed in the managed seasonal wetlands. Since bullfrog tadpoles require two years to mature, the seasonal wetlands are drawn down at least every two years and screens are put in place at the outlet to strand bullfrog tadpoles. The timing of the draw-downs are also targeted for mid-July to give the native amphibians, which mature earlier than bullfrogs, time to metamorphose.

Willapa NWR is less of a haven for reptiles than amphibians. Northwestern garter snakes (*Thamnophis ordinoides*) are found in meadows, along forest edges, and in disturbed areas. Common garter snakes (*T. sirtalis*) are common in pastures, forests, and freshwater marshes, and near riparian areas. The high number of amphibian species and low number of reptile species on the Refuge is a direct reflection of the relative amphibian and reptile composition of the wet, cold Sitka Spruce zone (Cassidy et al. 1997).

Marine turtles have been observed offshore and mortalities have occasionally washed on shore. The following species may rarely occur in the ocean adjacent to the Refuge: green sea turtle, loggerhead sea turtle, leatherback sea turtle, and olive ridley sea turtle.

4.8 Invertebrates

4.8.1 Shellfish

The Pacific (Japanese) oyster and the native Olympic oyster (to a lesser extent) are found in the intertidal waters of Willapa Bay, mostly in private oyster beds. The Japanese oyster was introduced into Willapa Bay in 1928 and is the foundation of the bay's most important commercial fishery (USFWS 1978).

Hardshell clams, including the native littleneck, butter, gaper, cockle, and Manila (exotic) clams, are present in a porous mixture of sand, gravel, and mud within the tidal zone. The softshell clam occurs throughout the bay tidelands and is most frequently found in muddy or sandy bottoms in the upper tidal areas and in the brackish water areas of tributary streams. Razor clams, mainly thought of as inhabiting the open coast sandy beaches, are found in Willapa Bay. They occur where environmental characteristics resemble those of the coastal sandy beaches (USFWS 1970).

Dungeness crabs occur throughout Willapa Bay. Immature crabs can be found in abundance on most of the flats year round, suggesting that Willapa Bay is an important nursery area for this species. These crabs occur further up the bay with the summer intrusion of salt water (USFWS 1970). The red crab is also found in the bay as well as a non-native species, the European green crab. Other exotic invertebrate species found within the waters of Willapa Bay include Atlantic and Japanese oyster drills, Japanese nestling crab, Japanese anemone, Atlantic mudsnail, Atlantic sponge, Atlantic barnacle, the Black and Caspian Sea hydroid, a terebellid worm, and several exotic amphipods and botryllid tunicates (Cohen et al. 2001).

Burrowing and free-swimming species of shrimp are found in the bay. The free-swimming species move into shallow waters and tide flats with the incoming tide and return to deeper channels at low tide. These detritus feeders are an important diet element to all fish large enough to consume them (USFWS 1970).

4.8.2 Gastropods

Freshwater snails of the genus *Juga* have been documented on the Refuge.

The Newcomb's littorine snail is a Federal species of concern and a state candidate species. This particular species has not been documented on the Refuge but does occur in other saltmarsh habitat in Willapa Bay similar to that on the Refuge. The Newcomb's littorine snail lives on the stems of pickleweed (*Salicornia*) and on the substrate beneath the vegetation. This snail occurs just above high tide line, immersed by seawater only a few hours each year during flood tides.

Habitat for this species is characterized by pickleweed, silverweed, yarrow, tufted hairgrass, seashore saltgrass, seacoast angelica, gumweed, seaside plantain, small spikerush, seaside arrowgrass, and Lyngbye's sedge.

4.8.3 Native Freshwater Mussels

Native freshwater mussels have been declining in North America to the point that nearly three-quarters of the 297 known species are imperiled and 35 are thought to have gone extinct in the last century (Nedeau et al. 2009; Stein et al. 2000).

The western pearlshell mussel (*Margaritifera falcata*) is found in Pacific drainages from California to British Columbia and southern Alaska (Nedeau et al. 2009). This freshwater bivalve requires cold, well-oxygenated, low-gradient streams. The western pearlshell is capable of living over 100 years. This mussel species has been documented in the Naselle and Bear rivers and some tributaries of these systems. Several small streams on the Refuge contain suitable habitat for this mussel and may have contained some small populations historically that were more than likely affected by land uses which altered stream processes and increased sedimentation, including timber harvest, road building, and stream cleaning efforts. Also, reproduction of this species requires salmonid hosts (temporarily used by the mussel's parasitic larvae), which were eliminated or reduced due to degraded habitat and previous fish passage barriers (usually associated with dikes and road building) on some streams on the Refuge. After the restoration of physical attributes of streams that had been destroyed or severely impacted by historical land use in the past, removal of fish passage barriers, and the reintroduction or enhancement of extirpated or reduced salmonid populations, the Refuge embarked on a mussel transfer program.

Populations of western pearlshell mussel have been transferred to four small streams on the Refuge in 2007, 2008, and 2009. These transfers were done under permits from the WDFW, as the donor population was located off-refuge. The western pearlshell mussel is a state-monitored species.

4.8.4 Other Invertebrates

The tidal flats and shallows support abundant populations of other invertebrates that are an important part of the estuary's food chain. Intertidal flats support an abundance of other invertebrates, including amphipods, polychaete and oligochaete worms, insect larvae, and nematodes. The amphipod *Corophium salmonis* is a major food item of juvenile salmon and other small fish (Arvai et al. 2002; Bottom 1984). *Cororphium* and other amphipods, along with a wide variety of benthic worms and other invertebrates, are an essential food source for migrating western sandpipers and other shorebirds (Wilson 1994).

In a 2002 study, a density of 288,538 invertebrates/m^2 were surveyed in an unvegetated mudflat transect. Unvegetated transects had species richness of up to 26 invertebrate species (O'Connell 2002).

Mosquito sampling was conducted at various refuge locations in 2005, 2006, and 2007, as part of the Washington Department of Health's state-wide West Nile virus surveillance. Twelve species were identified. At least eight of the species found on the Refuge are potential vectors of West Nile virus. However, the virus itself has not been detected in the local area.

A survey of forest arthropods was conducted as part of a larger study of both old-growth and regrowth forests on the Refuge (Davis et al. 2009).

A survey of stream macroinvertebrates was completed on several refuge streams. The highest number of taxa recorded in a single stream on this survey was 41 (Conklin 2003). Mayflies, stoneflies, and caddisflies are common aquatic macroinvertebrates in refuge streams.

Although the federally threatened Oregon silverspot butterfly is currently extirpated from Washington, the Refuge is actively involved in restoring habitat for this species (see Sections 4.3 and 4.9)

4.9 Federally Threatened and Endangered Species

The Service has prepared recovery plans that are intended to serve as guidance documents for agencies, landowners, and the public. Each plan includes recommendations for actions considered necessary to satisfy the biological needs and ensure the recovery of the listed species. These plans also emphasize opportunities for improved management of listed species on Federal and state lands. Recommended actions generally include protection, enhancement, and restoration of those habitats deemed important for recovery, monitoring, research, and public outreach. Recovery plans for federally listed species that occur at Willapa include:

Recovery Plan for the California Brown Pelican (USFWS 1983)
Recovery Plan for the Pacific Coast Population of the Western Snowy Plover (USFWS 2007a)
Recovery Plan for the Marbled Murrelet (USFWS 1997a)
Range-wide Streaked Horned Lark Assessment and Preliminary Conservation Strategy (Pearson and Altman 2005)
Revised Recovery Plan for the Northern Spotted Owl (USFWS 2008a)
Revised Recovery Plan for the Oregon Silverspot Butterfly (USFWS 2001a)

The recommendations provided in the recovery plans for these listed species considered during the development of this CCP are described here. Species known to currently breed on lands administered by the Refuge are denoted with an asterisk (*). Reference to specific recovery action sections in the species recovery plans appear within parenthesis in the Recovery Action sections toward the end of each species account.

4.9.1 Brown Pelican (*Pelecanus occidentalis*)

On November 17, 2009, the USFWS published a rule to remove the brown pelican from the Federal list of endangered and threatened wildlife due to recovery (74 FR 59444). A draft post-delisting monitoring plan has been developed and will be put into effect in the Gulf of Mexico and coastal California. Although no new management and monitoring plans are proposed under this CCP, the Refuge will continue to provide pelicans a protected, undisturbed area for day roosting, loafing, resting, and feeding in nearshore waters at Leadbetter Point and Willapa Bay.

4.9.2 Western Snowy Plover, Pacific Coast Population* (*Charadrius alexandrinus nivosus*)

The western snowy plover is a small (15-17 cm long, 34-58 g) shorebird with pale brown upperparts, white underparts, and gray to blackish legs. They have bilateral upper breast patches and breeding males have dark facial markings. On March 5, 1993, the Pacific coast population of the western snowy plover was listed as threatened under provisions of the ESA. The Pacific coast population is defined as those individuals that nest within 50 miles of the Pacific Ocean on the mainland coast, peninsulas, offshore islands, bays, estuaries, or rivers of the United States and Baja California, Mexico (USFWS 2007a). The current Pacific coast breeding population extends from Midway Beach, Washington, to Bahia Magdalena, Baja California, Mexico. The snowy plover winters mainly in coastal areas from southern Washington to Central America. This coastal population nests primarily above the high tide line on a variety of beach and dune types including coastal beaches, sand spits, dune-backed beaches, sparsely vegetated dunes, beaches at creek and river mouths, and bluff-backed beaches (USFWS 2007a). In addition, it also nests on sandy river bars, salt pans at lagoons and estuaries, salt pond levees, dry salt ponds, and on dredge spoils (USFWS 2007a). In winter, snowy plovers are found on many of the beaches used for nesting as well as on beaches where they do not nest (USFWS 2007a). Prior to Federal listing, the WDFW designated the snowy plover as endangered in 1981.

Western snowy plover are year-round residents on the Refuge, however most birds migrate south after the breeding season. Adults typically begin breeding in Washington in late March, while most young have fledged by mid August. Of the six Washington locations identified in the recovery plan as breeding areas, only two are currently occupied; the largest is located at the Leadbetter Point Unit of Willapa NWR. Disturbance of nesting plovers at Leadbetter occurs to a lesser degree than elsewhere along the southern Washington coast. The spatial extent of suitable habitat and relative isolation of the Leadbetter site make it of paramount importance to snowy plover recovery in Washington State.

The Federal Recovery Plan for the Western Snowy Plover designates Washington and Oregon as Recovery Unit 1. The primary recovery criteria for this unit are maintaining 250 breeding adults for 10 years, and a five-year average productivity of at least 1.0 fledged chick per adult male (USFWS 2007a). Deriving this metric for Washington requires an estimate of both the number of breeding adult males and the number of chicks fledged. Pearson et al. (2009) estimated that the number of young fledged per adult male was 0.71 (95% Confidence Interval = 0.55-0.96; Figure 4-2). This estimate suggests that the plover population in Washington should be declining and is not being maintained by local production (Nur et al. 1999). The recovery plan calls for development and implementation of mechanisms that ensure long-term protection and management of breeding, wintering, and migration areas in Recovery Unit 1 (USFWS 2007a). Current population and productivity levels continue to be below thresholds set as recovery objectives.

According to the Washington State Recovery Plan for the Snowy Plover (WDFW 1995), the plover will be considered for down-listing to threatened status when the state supports a four-year average of at least 25 breeding pairs, and fledges at least one young per pair per year at two or more nesting areas with secure habitat. State delisting will be considered when the average population reaches 40 breeding pairs at three or more secure nesting areas. Currently there are only 35 known snowy plover breeding pairs at two occupied nesting sites in Washington. Pearson et al. (2009) report that adult population counts are declining for the 2006-2009 period.

Both Federal and state recovery plans require monitoring of breeding adults and monitoring of fledging success to assess progress toward these recovery goals. Monitoring is also necessary to evaluate the impact of conservation actions on plover populations such as the use of wire nest exclosures to exclude potential predators and the effectiveness of habitat restoration efforts. To provide the information needed to assess recovery progress and to assess the effectiveness of conservation actions, the Refuge is coordinating its monitoring efforts with Washington and Oregon Departments of Fish and Wildlife and Washington State Parks and Recreation Commission.

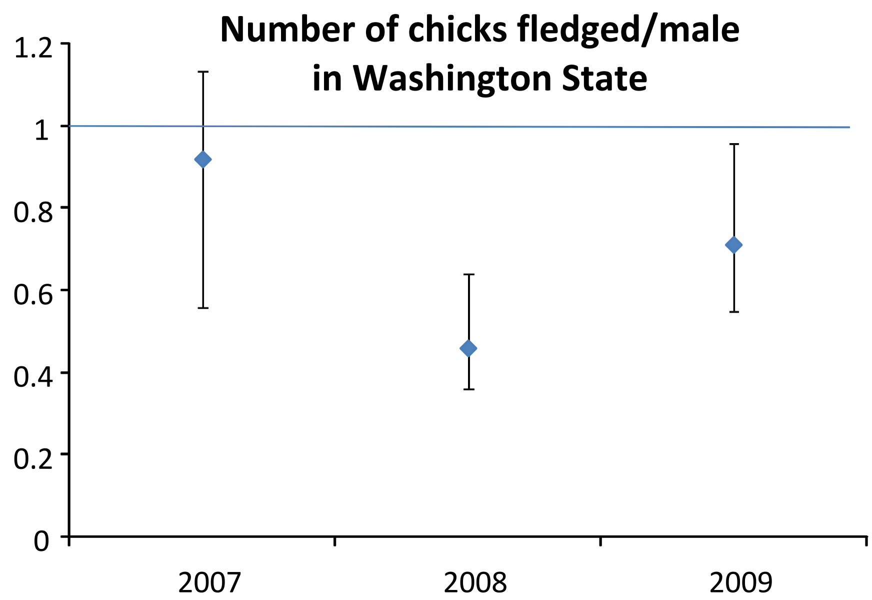


Figure 4-2. Number of snowy plover chicks fledged per adult male from 2007-2009 for all Washington nesting sites combined. Population modeling indicates that one chick fledged per male is needed on average to maintain a stable population (from Pearson et al. 2009).

4.9.2.1 Limiting Factors

According to the USFWS (2007a), "Habitat degradation caused by human disturbance, urban development, introduced beachgrass (*Ammophila* spp.), and expanding predator populations have resulted in a decline in active nesting areas and in the size of the breeding and wintering populations." In Washington, predators eating plover eggs, inclement weather, shoreline modification, dune stabilization, and recreational activities have been attributed to reduced nest success and have been cited as the causes of local population declines (WDFW 1995).

The western snowy plover population has shown an overall declining trend during the last century. Reasons for this decline and the severity of threats vary by region and location, but are primarily due to habitat loss and degradation. The principal cause of habitat loss in Washington is from previous efforts to stabilize the naturally shifting sand along coastal beaches. Introduction of invasive beachgrasses has been used as an effective means of dune stabilization that preceded development of coastal beachfront areas. The invasive, non-native beach grasses (*Ammophila breviligulata* and *A. arenaria*) planted to stabilize dune community have changed dune morphology and native plant communities. Mild climate allows vegetation to establish easily and rapidly. Once established the grass forms a thick root mat and dense canopy that crowds out native vegetation. Accelerated succession due to fire suppression progresses from herbaceous beachgrass, to shrub (often invasive non-natives such as Scotch broom and common gorse), to pioneer lodgepole pine or climax Sitka spruce forest.

The northern end of the Long Beach Peninsula was in a state of gradual northward accretion from at least 1965 to 1999. Invasion of beachgrass has followed accretion, progressively filling in the dunes behind the sand spit. In conjunction with slowed accretion in more recent years, the vegetation line has moved westward and the vegetation-to-water distance has decreased (Phipps 1990) resulting in a narrower beach and probably less suitable plover habitat. Recent maps from the Washington State Department of Transportation show that the tip of Leadbetter Point has been gradually eroding since mapping efforts began in 1999. As the tip has eroded, the peninsula to the southwest has gotten wider. Leadbetter Point is one of the northern-most breeding sites for the western snowy plover on the Pacific Coast (Jaques 2001).

The habitat restoration area at Leadbetter Point was initiated in 2002. It now encompasses 121 acres, where oystershell has been added to 54 acres of total area. Ongoing restoration and maintenance activities conducted included 1) maintaining the 121-acre restoration area mechanically and through the use of herbicide; 2) widening cuts in the high foredune to least 24 feet; alleyways are cleared to the bare sand beach and disked and compacted in an attempt to better control non-native beachgrass; 3) in September 2009, an additional 63 acres were treated with an aerial herbicide application including the primary foredune and a portion of the outer beach west of the foredune; and 4) between 5 to 10 acres of additional oystershell are added annually to the restoration area to provide camouflage for ground nesting birds and to reduce blowing sand. Treating and maintaining the restoration area is necessary to stop the advancement and narrowing of the outer beach by the colonization of non-native beachgrass. This activity will widen the bare sand potion of the outer beach, allowing additional habitat for nesting. The Leadbetter habitat restoration area supports the only known population of pink sandverbena (*Abronia umbellata*) in Washington State; this plant species was thought to be extirpated in the state until its rediscovery in 2006. Pink sandverbena seed was collected and broadcast in transects within the restoration area and on the outer beach. Pink sandverbena seeds will be collected and broadcast and/or propagated, and additional seed will be placed in long-term seed storage at the Berry Botanical Garden for conservation. A collaborative partnership has begun with the Shoalwater Bay Tribe to propagate additional pink sandverbena plants.

Disturbance at nesting sites and increasing rates of predation often follow in areas with expanding developments and increased human use. Studies have shown that human-related disturbance has negative affects on hatching success of snowy plovers (Schulz and Stock 1993; Warriner et al. 1986) and has reduced snowy plover chick survival by as much as 72% (Ruhlen et al. 2003). Disturbances to wintering snowy plovers are 16 times higher at a public beach than at a protected beach, and humans, dogs, American crows, and other birds are the main sources of disturbance (Lafferty 2001). In addition, snowy plover feeding rates declined in response to disturbance (Lafferty 2001). Human disturbance has also been shown to negatively affect hatching rates and chick survival for various plover species (Buick and Paton 1989; Dowling and Weston 1999; Flemming et al. 1988).

Because human activities in and around plover breeding areas can impact nest success and have been cited as the causes of local population declines, the Refuge and Washington State Parks have restricted beach access through the use of 1) complete motorized vehicle driving closures, except during razor clam seasons; 2) signs that are seasonally placed along the upper portion of the beach demarcating nesting areas closed to public entry; 3) symbolic fencing placed seasonally along beach access trails on refuge lands at Leadbetter Point to direct people toward the wet sand and away from plover nesting habitat; and 4) restrictions prohibiting dogs on refuge lands. Prohibitions also include restricting removal of native plants, driftwood, and alteration of other habitat features; fireworks; and certain recreational activities such as kite flying. These prohibitions also aid the Refuge in minimizing disturbance in plover habitat.

Predation by native and introduced species has been identified as a leading cause of reproductive failure of the western snowy plover (USFWS 2007a). Pearson et al. (2009) reported that predation was the primary source (58%) of plover nest failure in Washington in 2009. Crows and ravens are recognized as important predators of eggs and juvenile plovers and larks (Liebezeit and George 2002; Powell et al. 2002; USFWS 2002b; Wilson-Jacobs and Dorsey 1985). Based on studies in Oregon between 1990 and 2000, corvids (ravens and crows) caused at least 64 plover nest failures (USDA APHIS 2002). Predation was also the most frequent cause of streaked horned lark nest failure (69%) in Washington at sites in south Puget Sound in 2002-2004, while causing 46% of failures at two coastal and one river island sites in 2004 (Pearson and Hopey 2005). Liebezeit and George (2002) provide a detailed review of corvids importance as predators. The Western Snowy Plover Recovery Plan and annual survey and population monitoring reports offer additional data on plover predation (Lauten et al. 2009; Pearson et al. 2009; USFWS 2007a).

Development of a predator management strategy would maximize adult survival and juvenile recruitment of western snowy plover to achieve population objectives for species recovery by reducing the threat posed by certain problem avian and mammalian predators. This plan would be a comprehensive conservation strategy that addresses a range of management actions, from vegetation control and nesting habitat enhancement to nonlethal and lethal control, when necessary. The most effective, selective, and humane techniques available to deter or remove individual predators or species that threaten nesting, breeding, or foraging snowy plovers or horned larks would be implemented. Predator management is identified in Section 2.4.6.1, Section 2.5, and Appendix L as one of several actions to be implemented in support of listed species occurring on the Refuge.

4.9.2.2 Recovery Actions

The following recovery actions are being implemented locally to help achieve the desired target population levels for western snowy plover within the Oregon/Washington Recovery Unit.

Monitor breeding and wintering population and habitats to determine efficacy of recovery actions and to maximize survival and productivity (1.1, 1.2, and 1.3).
Manage breeding and wintering habitat to ameliorate or eliminate threats and to maximize survival and productivity (2.1, 2.2, 2.3, and 2.4). These actions include maintaining and enhancing existing breeding and wintering habitat, preventing sources of disturbance at nesting sites, enforcement of regulations designed to protect areas used by breeding plovers, and prevention of excessive predation through an integrated predator management strategy.
Develop and implement a management plan to protect western snowy plovers and their habitat on Federal lands (3.3.1).
Develop cooperative program and partnership with the Washington State Parks and Recreation Commission (3.6).
Undertake scientific investigations that facilitate recovery efforts (4.1.1, 4.2, 4.4 and 4.6).
Undertake public information and education programs (5).

4.9.3 Marbled Murrelet* (*Brachyramphus marmoratus*)

The marbled murrelet is federally listed as a threatened species in California, Oregon, and Washington. The State of Washington has also designated the marbled murrelet as a threatened species. The marbled murrelet is a year-round resident on Washington marine coastal waters within several kilometers of the shoreline. The majority of nesting stands in Washington have been discovered within 63 km (39 mi) of marine waters. Marbled murrelets require suitable canopy structures for nesting that are primarily found in the mature and old-growth coniferous and mixed species forest stands of western Washington. Removal of these forests, primarily by timber harvesting and urbanization, is the principal factor contributing to the decline of the marbled murrelet, and is the most significant impediment to recovery of the species (USFWS 1997a). Habitat fragmentation resulting in increased densities of nest predators, and prey availability, are also probable limits to long-term productivity and survival. Adult mortality caused by predation, impacts from the effects of oil spills, mortality due to entanglement in fishing gear, chronic water pollution, aquaculture, and disturbance at nesting and foraging sites have also been identified as potential limiting factors.

In Washington State nesting habitat is found in the Sitka spruce and western hemlock forest zones. Douglas fir also contributes to the likelihood that habitat will be suitable for murrelet nesting, although there have been no nesting sites found within the coastal Douglas fir zone in Washington. The Sitka spruce and western hemlock forest zones in Washington include lower elevation forests comprising western hemlock (*Tsuga heterophylla*), Douglas fir (*Pseudotsuga menziesii*), Sitka spruce (*Picea sitchensis*) and western red cedar (*Thuja plicata*). The availability of nesting structures in a forest canopy is the principal determining factor in stands with high levels of murrelet activity. Nest selection is highly dependent upon the availability of potential nesting surfaces, or platforms (Nelson 1997). Kuletz et al. (1995) and Hamer (1995) found that in Alaska and Washington, respectively, the number of potential nest platforms was an important attribute in murrelet forest habitats. The suitability of a stand is enhanced by processes which contribute to the number of potential nesting platforms. Suitable forest stands can consist of trees exhibiting potential nesting platforms in the form of: large lateral limbs; large or moderate sized limbs with an abundance of epiphytes (especially mosses); branches creating a fork with the space between bridged by canopy litter or accumulated moss; a high incidence of dwarf mistletoe (*Arceuthobium* spp.) infestation; or an abundance of canopy defects due to damage caused by environmental conditions (ice, lightning, wind), insects, or other processes that create growth abnormalities.

Trees typically require 200 to 250 years or more to attain attributes necessary for marbled murrelet nesting (USFWS 1996). This is generally the time needed to develop limbs of a sufficient diameter to support a nest. Marbled murrelet nests are often located in the largest trees in the stand (Jordan and Hughes 1995; Singer et al. 1995). In a sample of 47 nests, Hamer and Nelson (1995) found all to be in trees larger than 88 cm (35 inches) dbh. However, younger stands of coastal redwood (*Sequoia sempervirens*), western hemlock stands with an abundance of dwarf mistletoe, or stands with numerous older legacy trees remaining from a previous stand can develop characteristics of nesting habitat at a younger age. A nesting stand consisting of predominantly 80- to 120-year-old western hemlock trees was found in 1995 in the Tillamook State Forest, Oregon. This stand originated following a large-scale fire but contains scattered pockets of older trees that survived the fire. This stand also has a high incidence of mistletoe in the younger trees. In 1996 a nest was found in western Oregon in a 65-year-old western hemlock tree severely infected with dwarf mistletoe. An analysis of unpublished data collected in southwestern Washington and the west Olympic Peninsula by the WDFW indicates a significant number of occupied stands have at least one tree of 90 cm (36 inches) dbh or greater per acre, and with a minimum of two platforms.

Moss enhances the suitability of a stand by increasing the potential nesting surface area on tree limbs, thus providing murrelets with more nesting opportunities. A majority of the known nests are found on moss-covered limbs (Nelson 1997; Ritchie 1998). Burger (1995) found that high murrelet activity in British Columbia was often associated with forest sites exhibiting well-developed epiphytic mosses. Nests are also located on larger limbs with little or no moss. In these cases canopy litter of conifer needles, bark, twigs, detritus, and dust constitutes the nesting substrate. No nesting materials are brought to the nest by the adult murrelets (Nelson 1997).

Dwarf mistletoe can enhance the suitability of a stand by promoting the development of platforms and cover in the form of enlarged diameter limbs and witches brooms. This can be a particularly significant factor in mature stands with low density of large diameter trees. There are seven taxa of dwarf mistletoe occurring in Washington; however, the western hemlock dwarf mistletoe (*Arceuthobium tsugense* subsp. *tsugense*) and the mountain hemlock dwarf mistletoe (*Arceuthobium tsugense* subsp. *mertensianae*) are the only identified taxa occurring west of the Cascade Mountains in Washington (Hawksworth and Wiens 1996). Western hemlock dwarf mistletoe occurs from sea level to about 1,250 m (4,100 feet), the common principal host being western hemlock. Silver and grand fir are considered occasional hosts. Rare hosts are Douglas fir, Engelmann spruce, and mountain hemlock. Principal hosts of the mountain hemlock dwarf mistletoe are mountain hemlock and silver fir. The distributional range is thought to be limited to elevations greater than 1,200 m (3,900 feet) and thus beyond the elevational range of most known marbled murrelet nest stands. Nine percent of 37 marbled murrelet nests examined in the Pacific Northwest were on mistletoe infected limbs (Hamer and Nelson 1995).

A sample of 41 nests in the Pacific Northwest by Hamer and Nelson (1995) found a mean limb diameter of 32 cm (13 inches). They also report a mean nest height of 45 m (148 feet) in a sample of 45 nests. The majority of these nests have been located in the upper half of the tree crown. Nest limb diameters in Washington range from 14 to 50 cm (5-20 inches); limb heights from 20 to 53 m (66-174 feet). Nests have been located on limbs as small as 10 cm (4 inches) in Oregon.

Other factors which appear to contribute to the suitability of habitat for marbled murrelet nesting are cover, access to the canopy, stand size, and location on the landscape. Cover at an overstory canopy level may be important but has been shown to be highly variable. Cover directly above and adjacent to the nest, however, appears to be an important attribute. Occupied stands in Washington have a mean canopy cover of 81% (Hamer 1995) and 87% of all nests in the Pacific Northwest had greater than 74% immediate overhead cover (Hamer and Nelson 1995). Canopy cover of stands elsewhere is highly variable, ranging from 15 to 100% in Oregon (S.K. Nelson, pers. com.)

Stand access by marbled murrelets can be influenced by stem density of dominant trees; total stem density; natural and artificial openings and flight corridors created by multiple crown layers in uneven aged stands, streams, trails, or similar features; canopy integrity and spatial orientation; and slope. In a sample of 30 nest trees, Hamer and Nelson (1995) found the mean distance from a nest to an opening to be 92 m (302 feet). Singer et al. (1995) identified flight corridors in gaps beneath the dominant canopy used by murrelets to enter and exit their nests. The crowns of trees on steep slopes may be more accessible to murrelets than those on flatter terrain; however, there currently are no statistically significant data to show more secondary or sub-dominant trees may be accessible in these circumstances.

Stand size may influence the quality of the stand by affecting the amount of available interior habitat, nest predation and disturbance levels. Marbled murrelets are considered to be one of the bird species in the Pacific Northwest most sensitive to forest fragmentation (Hansen and Urban 1992). Bryant (1994), Rudnicky and Hunter (1993), Small and Hunter (1988), and Wilcove (1985) have demonstrated that avian nests are adversely impacted by fragmentation and the associated edge effects. A critical review by Paton (1994) concluded that sufficient data show predation rates decrease as habitat patch size and distance from edge increases. I n contrast, Vander Haegen and DeGraaf (1996) did not find that fragmentation resulted in higher predation rates on nests of ground and shrub nesting passerines in Maine. They did, however, conclude that proximity to a forest edge coincides with greater nest predation rates. An avifauna nest predation study by Naef (1996) conducted in Washington also found no clear relationship between nest predation and stand size. She suggests that vegetation structural factors in interior coniferous forests may have more of an influence than stand size alone. Reduced levels of predation were shown to occur where nests were higher in a tree, further from a recently disturbed edge, and in mature stands with higher and deeper canopies. Chen et al. (1992) found several microclimatic differences between forest interiors and edges. Interior forest habitats experience reduced daily temperature fluctuations, lower daily high temperatures, and lower wind speeds than forest edges. Interior forests may also provide better visual and sound screening from adjacent sources of human disturbance than forest edges.

Predation rates at marbled murrelet nests have been found to be extremely high in some areas. Nelson and Hamer (1995) noted that 57% of the marbled murrelet nests examined (n=8) in Washington, Oregon, and California, failed as a result of predation. They also found that reproductive success was correlated to distance from an edge. They report that all but one successful nest was greater than 55 m (180 feet) from an edge. Marzluff et al. (1997), in a preliminary report, indicate that landscape fragmentation and proximity to human activity may influence predation by corvids on marbled murrelet nests. Naef (1996) also found that stand context in relation to the disturbance of the surrounding matrix was an important influencing factor in avian nest predation, especially at stand edges. Small and Hunter (1988) found that nest predation of songbirds was highest in small forest patches completely surrounded by clearings.

Distance from marine waters and the location of nearby habitats may also affect suitability. Stands that lie further from feeding areas probably require the adults to expend more energy to provision the nest. Newly fledged chicks may have a greater likelihood of successfully reaching the marine waters if their nest is closer to the coast. Suitable nesting habitat adjacent to or near an occupied stand, possibly offers more opportunities for recruitment as the population expands. This condition may also help maintain localized breeding productivity if a catastrophic event such as a wildfire or wind storm destroys a nesting stand.

4.9.3.1 Limiting Factors

Marbled murrelets require suitable canopy structures primarily found in mature and old-growth forest stands for nesting. Elimination of these forests, primarily by timber harvesting and urbanization, is the principal factor contributing to the decline of the marbled murrelet and the most significant impediment to recovery of the species (USFWS 1997a). Habitat fragmentation resulting in increased densities of nest predators, and prey availability also probably limits long-term productivity and survival of the marbled murrelet. Adult mortality caused by predation, impacts from the effects of oil spills, mortality due to entanglement in fishing gear, chronic water pollution, aquaculture, and disturbance at nesting and foraging sites have also been identified as potential limiting factors.

The life span of marbled murrelets is unknown, but other members of the Alcid family have been shown to live from five to 32 years (De Santo and Nelson 1995). A marbled murrelet banded in British Columbia in 1991 was recaptured in 1997 (Lougheed and Lougheed 1998). Adult and first-year juvenile survivorship based on data from other alcids is estimated to be 81%-88% and 70%, respectively (Beissinger 1995). Marbled murrelets are thought to reach breeding maturity in two to four years (De Santo and Nelson 1995). Marbled murrelets have a low rate of reproductive success. Breeding pairs produce a single offspring during reproductive years. Murrelets may not nest every year, especially when food resources are limited (Nelson 1997). Beissinger (1995) reports surveys to determine productivity have found adult to juvenile ratios from 4% to 5% in British Columbia and Oregon. Stein and Nysewander (1995) found adult to juvenile ratios from 8% to 9% in Puget Sound. In the western Straits of Juan de Fuca along the Washington coast, Thompson (1997) found that juveniles made up 17% of the murrelets observed. Corrections for possible environmental factors and biases in survey methodology will likely lead to refined estimates in the near future.

Population trend modeling suggests an annual decline of 4% to 7% in the total North American population, but the potential rate of decline could be twice as large (Beissinger 1995). The combination of low demographic potential, small population size, and increased risk resulting from anthropogenic factors could lead to extirpation of the marbled murrelet in portions of its current range. The current overall estimate for the listed population (California, Oregon, and Washington) is less than 18,000. Trend data indicate an annual decline of between 2.4% to 4.3% (Falxa et al. 2009).

The Federal Recovery Plan for the Marbled Murrelet (USFWS 1997a) identifies the primary cause of population decline as loss of older forests and associated nest sites. It states that protection of suitable nesting habitat and nest sites on Federal, state, and private lands are essential toward maintaining a well-dispersed population across the landscape. Management of some mature age class forest stands to provide replacement habitat for increasing the population and contributing additional potential nesting sites is also critical to recovery of the species. The importance of surveys to locate nest sites and identify suitable habitats is recognized at both the Federal and state level. To allow for protection of unsurveyed potential nesting sites, the Washington Forest Practices Board (1997) requires landowners with greater than 200 ha (500 acres) of land within 80 km (50 miles) of salt water to survey suitable habitats prior to harvest. Several land management approaches are also available to protect habitat such as Federal habitat conservation plans, and state landscape and site management plans.

Habitat fragmentation appears to result in increased densities of nest predators. Predation rates at marbled murrelet nests have been found to be extremely high in some areas. Fragmentation of conifer and mixed-species forests may contribute to these predation rates (Nelson and Hamer 1995). Forests with increasingly complex structural architecture are desirable features that should be retained or enhanced in forest ecosystems (Naef 1996). Corvids are thought to forage using visual cues and have been identified as a primary marbled murrelet nest predator. A more complex forest has larger canopy mass in multi-dimensions that can help to conceal the location of nests from such visual predators (Rudnicky and Hunter 1993; Wilcove 1985; Yahner and Cypher 1987). Interior portions of forests mitigate the effects of surrounding ambient and severe environmental conditions and may provide better visual and sound screening from adjacent sources of human disturbance than forest edges.

Human disturbance of marbled murrelets is not well documented but has been shown to elicit differing levels of response from foraging and nesting birds. Kuletz (1996) reported numbers of murrelets counted on the water in Alaska were negatively correlated to the number of boats and low-flying aircraft in the area. Response to boats and low flying traffic has also been reported by others. Strong (1995) felt that birds were very sensitive to his vessel while passing within 50 m (164 feet). A literature review by Long and Ralph (1998) found that human activities can impact nesting success of seabirds and waterfowl, especially during the period when a nest site is chosen and during incubation. Henson and Grant (1991) report that passing vehicles caused the most observable response when they had loud engines, such as motorcycles, or were stopped along a road. Washington state and Federal regulations restrict heavy equipment, and Federal regulations also apply to small power equipment, used during the breeding season adjacent to nesting stands. Long and Ralph (1998) cite unpublished data that indicate murrelets did not appear to respond to aircraft or helicopters flying overhead, except when they were at an altitude below 152 m (500 feet). However, based on recommendations from a panel of wildlife biologists and resource specialists, the Washington Forest Practices Board adopted rules (WFPB 1997) that restricts aircraft flight below 400 m (1,300 feet) over known marbled murrelet nest sites anytime during the breeding season or within 0.4 km (0.3 mile) during periods of daily peak activity. Federal restrictions applied in California limit aircraft flight below 152 m (500 feet). The effects of rotor-wash should also be considered when assessing the potential impacts from helicopter operations. Factors to consider whenever addressing concerns of potential disturbance to nesting marbled murrelets are the changes in noise or visual activity levels above ambient conditions, the timing of source activities in relation to nesting chronology, type of disturbance, and the duration and frequency of the disturbance. Studies of predation and disturbance in the Pacific Northwest with direct applications to marbled murrelets are ongoing, so the measurable effects of timber harvests and other human activities remain undetermined.

4.9.3.2 Recovery Actions

Recovery actions identified for the marbled murrelet and addressed through management activities at Willapa NWR are:

Protect terrestrial habitat essential for marbled murrelet recovery (2.1).
Incorporate management recommendations for protected areas. These include short-term actions to stabilize and increase the population, such as maintaining and enhancing occupied nesting habitat and surround buffer areas, protecting unoccupied suitable habitat in larger contiguous

blocks, and minimizing disturbance and activities that could elevate nest predation (3.1). Implementation of long-term actions having consequential effects on population growth are identified in Section 3.2.
Increasing the amount and quality of suitable nesting habitat by decreasing fragmentation, protecting recruitment habitat to buffer existing habitat and provide future replacement habitat, and using silvicultural techniques to accelerate development of new habitats are means indentified to improve the amount and quality of available habitat, especially in regions and landscapes with a scarcity of suitable habitat, such as found in southwestern Washington.

4.9.4 Streaked Horned Lark* (*Eremophila alpestris strigata*)

The endemic subspecies of the Pacific coastal form of horned lark is found only in western Oregon and Washington. Rogers (2000) proposes that the streaked horn lark may be the most endangered bird in Washington. Horned larks are small ground-dwelling passerines with black occipital feather tuffs, or horns. Their plumage is also marked with a black breast band, lores, and cheek patches that contrast with a yellow eyebrow stripe, ear coverts, and chin. The nape, back, rump, and upper tail is brown streaked with dusky brown to black (Beason 1995).

Larks inhabit native prairies but have also adapted to nesting in low growing and sparsely vegetated grasslands at airports, coastal sand dune habitats, and on dredge spoil islands. The streaked horned lark was once abundant on Puget Sound prairies. As its population and distribution has decreased significantly with the decline in habitat, it is now restricted to a few large open grassland sites and islands in Washington (Stinson 2005) and several sites in Oregon. The streaked horned lark is currently a candidate for listing under the ESA. Candidate species will be listed at some point in the future, unless adequate conservation measures preclude the need for listing.

4.9.4.1 Limiting Factors

As with the western snowy plover, loss and fragmentation of prairie habitats to urban development; introduced beachgrass (*Ammophila* spp.); invasion by turf-forming grasses, shrubs, and taller vegetation; and expanding predator populations have resulted in a decline in active nesting areas and in the size of the breeding and wintering populations. Habitat succession and invasion of non-native plants at prairies have accelerated with the suppression of wild fires. Nearly all the remaining prairie sites in western Washington are degraded to some extent by exotic forbs, grasses, and woody plants, creating unfavorable conditions for lark use (Stinson 2005). Aircraft strikes at airport breeding sites and disturbance and habitat destruction from recreational vehicles at beach sites have also been implicated as causes leading to the population decline.

4.9.4.2 Recovery Actions

The streaked horned lark preliminary conservation strategy (Pearson and Altman 2005) outlines regional priorities for developing recovery actions aimed at avoiding continued population declines and potential future listing. The following actions identified for the Washington coast are currently implemented at Willapa NWR, or would be under Alternatives 2 and 3 of this CCP.

Control invasive beachgrass at known breeding sites.
Limit human and vehicle access to nesting sites and activities that disturb breeding larks, such as off-leash dogs, fireworks, and kite flying.
Reduce the amount of food available to known nest predators like crows and ravens.
Investigate methods for reducing nest predation rates.
Develop and implement a population monitoring strategy that includes a direct or indirect measure of fitness (reproduction and survival).
Develop educational signs along beach access points informing the public about the sensitivity of nesting larks and plovers to specific recreational activities.

4.9.5 Northern Spotted Owl (*Strix occidentalis caurina*)

The northern spotted owl was listed under the ESA as threatened on June 26, 1990 (55 FR 26114 26194) because of widespread loss of suitable habitat across the spotted owl's range and the inadequacy of existing regulatory mechanisms to conserve the spotted owl (USFWS 2008a). The final northern spotted owl recovery plan was subsequently published in May 2008. Since the subspecies was listed the northern spotted owl population has continued to decline, especially in the northern portions of its range. Spotted owls have become rare in certain areas of their historic range, such as British Columbia, southwestern Washington, and the northern coastal ranges of Oregon (USFWS 2008a). Spotted owls, along with marbled murrelets and Vaux's swifts, are the avian species most closely associated with old-growth coniferous forests in the Pacific Northwest (Ruggiero et al. 1991).

Spotted owls historically inhabited forests located within the present day boundaries of the Refuge. A spotted owl pair that nested in the Cedar Grove RNA forest was last observed there in 1985. The following year barred owls were observed occupying the nest. An established spotted owl management circle also encompasses the Teal Slough Unit and most of the Headquarters Unit of the Refuge. This territory was most recently known to be occupied in 1998 when a survey documented a pair of adults and one juvenile spotted owl. Despite the de-emphasis on spotted owl recovery in southwestern Washington, applicable recommendations and recovery actions identified in the northern spotted owl recovery plan were considered in the development of this CCP.

4.9.5.1 Limiting Factors

The spotted owl inhabits structurally complex, late-seral and old-growth coniferous forests in the Pacific Northwest and northern California. Trees typically require 200 to 250 years or more to grow to a size large enough for spotted owls to use. Unless the tree bole or tree top has been damaged, it may take at least that long or longer for the tree to die and become a snag or develop enough heart rot to produce a suitable nest cavity. Late-seral forests used by northern spotted owls are characterized by overstory trees of large stature, exhibiting very large diameter boles, large limbs, and tall, deep crowns, often with broken and reiterated tops. The forests typically develop vertically and horizontally diverse canopies from multiple crown layers created by uneven aged stands, streams, gaps, or similar features that result in a complex spatial orientation. Standing dead trees, or snags, and downed trees decaying on the forest floor provide shelter and breeding habitat for owls and their prey.

Historically much of the lowland coastal forests and mid-elevation forests of the Cascade and coastal mountain ranges provided spotted owl habitat. Much of that forestland was harvested for lumber and paper production. Many of the remaining suitable forest patches in southwestern and coastal Washington are too small and fragmented to provide functional habitat for spotted owls. "Ideally, blocks of habitat should be dispersed in a pattern corresponding to a species' full geographic distribution. This distribution is the key hedge against major catastrophes that could otherwise extinguish the sole remaining population of a once wide-spread species" (Thomas et al. 1990). However, the spotted owl recovery plan excludes the Western Washington Lowland Province from the Managed Owl Conservation Area approach because it is assumed that low population numbers are not essential to the species recovery.

4.9.5.2 Recovery Actions

Despite the de-emphasis on spotted owl recovery in southwestern Washington, applicable recommendations and recovery actions identified in the northern spotted owl recovery plan are being considered in the management activities at Willapa NWR.

All older and more structurally complex multi-layered confer forests on Federal lands are to be maintained in the western biogeographical provinces.
Restore ecological function to west-side forests by creating a natural distribution of stand structure, composition, and successional stages while promoting old-growth/late successional characteristics to benefit forest dependent wildlife. Carey (2003a, 2003b, 2007) provides a comprehensive review of west-side coniferous forest restoration and results of experimental application of these concepts. Important considerations mentioned in the northern spotted owl recovery plan (USFWS 2008a) include: 1) retention of biological legacies, 2) ensuring multi-tree-species regeneration and multi-tree-species management through precommercial thinning, 3) managing for spatial heterogeneity in canopies and understory vegetation site types through commercial thinning or application of fire, 4) management of decadence processes, including maintaining dead and decadent trees, coarse woody debris, creating cavity trees, and maintenance of large old trees with significant decay, etc., 5) management of forests on long to indefinite rotations, and other methods.

4.9.6 Oregon Silverspot Butterfly (*Speyeria zerene hippolyta*)

The Oregon silverspot butterfly is a medium-sized, orange- and brown-colored butterfly with black veins and spots on their upper wing surface. The namesake bright metallic silver spots are found on the underside of the wings. The historic range of the Oregon silverspot butterfly extended along the Oregon and Washington coasts from Westport, Washington, south to around Heceta Head in Oregon, and in a separate coastal area north of Crescent City in Del Norte County, California.

Two types of coastal dune habitat inhabited by the Oregon silverspot butterfly are referred to as salt spay meadows, such as those found on the central Oregon coast, and stabilized coastal dunes that are found on the Long Beach Peninsula, Clatsop Plains, and at Lake Earl in Del Norte County, California. All suitable habitats are coastal meadow or prairies that support native forbs (used by the adults as a source of nectar) and the early blue violet (which provides food for the larvae). The Oregon silverspot butterfly was listed as a threatened species on October 15, 1980, because of the small population, limited distribution, and continued loss of habitat. Critical habitat was also designated in coastal Oregon at the time of listing (45 FR 44935). Subsequently a revised recovery plan was published in August of 2001 (USFWS 2001a).

4.9.6.1 Limiting Factors

By the early 1980s most historical populations of the Oregon silverspot butterfly were extirpated (USFWS 2001a). The last Oregon silverspot butterfly found in Washington was in 1990 on the Long Beach Peninsula (WDFW 1993). The primary cause of its decline is habitat loss and degradation as a result of urban development, agricultural conversion, invasive non-native vegetation, recreational off-road vehicle use, and natural succession. Direct mortality from collisions with vehicles and pesticide use are also a factors implemented in the reduction of populations. Loss of early successional meadows that support suitable conditions for the larval host plant, the early blue violet (*Viola adunca*), has severely limited the amount of butterfly habitat to a handful of sites on the central Oregon coast and one site in Del Norte County, California. In Washington most violet habitats are threatened by the presence of heavy grass thatch and invasion by woody vegetation that shade out or restrict violet growth (Pyle 1985).

4.9.6.2 Recovery Actions

Recovery actions identified for the Oregon silverspot butterfly and addressed through management activities at Willapa NWR are:

Design habitat areas for the Long Beach population (1.1).
Develop a management plan for protected habitats in the Long Beach Habitat Conservation Area (1.1.5).
As habitat rehabilitation efforts proceed, contribute to the understanding of factors that affect population dynamics and persistence. These factors include control of exotic grasses, trees, and brush, establishment of early blue violets and nectaring plants, and refining habitat requirements at sites managed as butterfly habitat (2.2).

4.10 Special Designation Areas

4.10.1 Formally Designated Natural Areas

The Refuge has three state-registered natural areas that are in the RNA category. These RNAs are administered by the Service to 1) preserve examples of all significant natural ecosystems for comparison with those influenced by humans; 2) to provide educational and research areas for ecological and environmental studies; and 3) to preserve the genetic and behavioral diversity of native and endangered plants and animals. As directed in this program, RNAs must be reasonably protected from any influence that could alter or disrupt the characteristic phenomena for which the area was established. Management practices, such as prescribed burning and chemical control of plants, may be conducted only where necessary to preserve vegetation and as directed in a plan approved by the regional director.

4.10.1.1 Diamond Point Research Natural Area

Diamond Point RNA is an 88-acre forested area at the northern tip of Long Island that was designated an RNA in 1976. Diamond Point RNA preserves an example of second-growth Sitka spruce–western hemlock forest growing on an island in a coastal estuary. The natural area includes 48 acres of mature red alder and 40 acres of mature Sitka spruce/sword fern forest and Sitka spruce/salal forest. This area was logged around the beginning of the twentieth century (Dyrness 1972).

4.10.1.2 Cedar Grove Research Natural Area

Cedar Grove RNA encompasses 264 acres and is located in the southern portion of Long Island. This RNA is an example of an old-growth western red cedar–western hemlock/evergreen huckleberry–salal forest.

The Cedar Grove is unique, representing a forest association which has not been identified anywhere else in the Pacific Northwest. Other forests with similar composition have been destroyed by logging, fire, or windthrow (Franklin 1984).

The structure of the Cedar Grove is unusual in that it is quite uniform. Western red cedars average 8 to 11 feet dbh and reach 150 to 165 feet in height. Individual cedars may be up to 1,000 years old. Old-growth western hemlock may reach 5-6 feet dbh. All sizes and age classes of western red cedar and western hemlock indicate that these two species are continuing to reproduce and maintain their positions in the stand, possibly representing a climax condition. The western hemlock has a higher mortality rate and shorter life span than the cedar, therefore the hemlock is believed to cycle through the stand 4 to 5 times more rapidly than the cedar.

The uniform structure of the Cedar Grove has been attributed to the absence of catastrophic fire in the stand. Individual trees show signs of fire, but the wet climate and island setting have apparently protected the area from a stand-destroying fire. This forest may have developed unscathed since the last major change in climate 4,000 years ago. The trees surrounding the Cedar Grove, and its topography have probably protected it from major wind events. This area was difficult to access by water and was therefore spared from logging in the early days. The rest of Long Island has been logged one or more times in the last 100+ years (USFWS 1987).

The three-quarter-mile Trail of Ancient Cedars loops through the northern edge of the Cedar Grove RNA.

4.10.1.3 Leadbetter Point Research Natural Area

Leadbetter Point RNA, located at the northern tip of the Long Beach Peninsula, was put on the Washington Register of Natural Areas in 1989. The original designation included 1,705 acres of the peninsula tip, Grassy Island, and the marsh between the island and peninsula tip; however, the Leadbetter Point Unit is now approximately 1,742 acres due to sand accretion at the peninsula tip. This area represents the highest quality, largest coastal sand dune ecosystem in Washington State. The unique natural elements protected at Leadbetter Point include salt marsh, native dunegrass, lodgepole pine (shore pine) forest, shrub/lodgepole pine (shore pine), and open beach habitats. Leadbetter Point contains high-quality examples of high salinity Virginia glasswort/inland saltgrass marsh, low salinity marsh, and transition zone wetlands. Flora associated with the marshes are of primary significance, as are the dune grassland and deflation plain communities. Pockets of native plants within the secondary dune, deflation plains, and dune troughs are also significant ecological features and are of high quality compared to these remaining plant communities in Washington. The open beach and dune grassland communities of Leadbetter have been significantly impacted by the invasion and naturalization of two non-native beachgrasses. The salt marsh has been invaded by smooth cordgrass, an eastern salt marsh species, although efforts to control cordgrass in recent years have essentially eliminated it from Leadbetter Point. Selective removal or control of plant species not native to Leadbetter Point, including *Spartina*, Scotch broom, and common gorse, was an approved management activity at the time the RNA was established. Removal and control of the non-native beachgrasses has been approved and work has been done as part of the management of habitat for the federally threatened/state endangered western snowy plover (Caicco 1989;Willapa NWR files).

4.10.2 Important Bird Areas (IBAs)

Two areas on the Refuge have been officially identified as Important Bird Areas (IBAs): Leadbetter Point and South Willapa Bay. The Important Bird Areas Program is a global effort to identify and conserve areas that are vital to birds and biodiversity. IBAs are key sites for conservation and do one (or more) of three things:

Hold significant numbers of one or more globally threatened species.
Are one of a set of sites that together hold a suite of restricted-range species or biome-restricted species.
Have exceptionally large numbers of migratory or congregatory species.

As of 2009, approximately 11,000 sites in 200 countries and territories have been identified as IBAs.

4.11 Effects to Species and Habitats

4.11.1 Effects Common to All Alternatives (IPM)

Potential effects to the biological and physical environment associated with the proposed site-, time-, and target-specific use of pesticides. (Pesticide Use Proposals [PUPs]) on the Refuge would be evaluated using scientific information and analyses documented in "Chemical Profiles" in Appendix H.) These profiles provide quantitative assessment/screening tools and threshold values to evaluate potential effects to species groups (birds, mammals, and fish) and environmental quality (water, soil, and air). PUPs (including appropriate BMPs) would be approved where the Chemical Profiles provide scientific evidence that potential impacts to refuge biological resources and its physical environment are likely to be only minor, temporary, or localized in nature. Along with the selective use of pesticides, PUPs would also describe other appropriate IPM strategies (biological, physical, mechanical, and cultural methods) to eradicate, control, or contain pest species in order to achieve resource management objectives.

The effects of these non-pesticide IPM strategies (e.g., mowing) to address pest species on the Refuge would be similar to those effects described elsewhere within this chapter, where they are discussed specifically as habitat management techniques to achieve resource management objectives on the Refuge. For example, the effects of mowing to control invasive plants in an improved pasture would be similar to those effects summarized for mowing, where it would be specifically used to provide short-grass foraging habitat for wintering geese.

Based on scientific information and analyses documented in Chemical Profiles (see Appendix H), pesticides allowed for use on the Refuge would be of relatively low risk to non-target organisms as a result of low toxicity or short persistence in the environment. Thus, potential impacts to refuge resources and neighboring natural resources from pesticide applications would be expected to be minor, temporary, or localized in nature.

4.11.2 Effects to Fish

All three alternatives include stream restoration and reintroduction/enhancement of fish populations, which are occurring under the current management of the Refuge. Stream restoration will continue to improve habitat structure and conditions for fish. Improved water quality (e.g., dissolved oxygen), habitat structure, and access (as any fish passage barriers are removed) are expected to benefit fish, especially adult and juvenile salmon, cutthroat trout, western brook lamprey and other native fish, including freshwater and estuarine species. Reintroduction/enhancement of fish will establish or bolster fish populations and ensure that healthy populations exist in suitable habitat. Both long-term and temporary effects may occur under each alternative. Temporary effects to fish species include those from construction activities such as large woody debris placement as part of stream and river restoration and construction activities associated with estuarine restoration, including dike removal and channel modification. Long-term effects to fish species may occur due to changes in habitat abundance and diversity and changes in primary production which affect the food chain.

Alternative 1 proposes no changes in current refuge wildlife management, habitat management, public use programs and other refuge programs. This alternative would still result in additional positive benefits to fish populations as improvements would continue to be made even under the no change scenario, including stream and river restoration activities and reintroduction/enhancement of fish populations. Thus its effects on fish would be expected to be positive, resulting in an increase in salmonid as well as other native fish populations.

Alternative 2 (Preferred Alternative) proposes maximum estuarine restoration and expanded public use. Current stream and river restoration activities and reintroduction/enhancement of fish populations would be continued and would be expected to have the same positive effects as in Alternative 1. Establishing additional estuarine habitat, specifically 0.2 acre of open water, 11 acres of intertidal flats, and 749 acres of salt marsh by removing dikes, would increase this valuable habitat which benefits estuarine dependent fish species including juvenile salmon. Through this alternative, managed pasture would be reduced. Managed wetlands, though reduced, would still provide habitat for native fish, such as threespine stickleback that thrive in shallow water. The habitat enhancements proposed in Alternative 2 would benefit native fish, more substantially than Alternative 1. Estuarine habitat restoration would positively affect native fish, but the overall benefits to fish populations are expected to be difficult to detect because of the relatively small amount of refuge-owned habitat involved, compared to the entire estuary.

Alternative 2 also proposes refuge expansion. Securing additional habitat in the Nemah/Naselle, South Bay, and East Hills areas would provide more protection to the Willapa Bay estuary and result in positive benefits for fish species. Under refuge ownership the land can be managed to enhance and improve value for wildlife and contribute to maintaining the health and integrity of the larger Willapa Bay ecosystem.

Divesting property at Cape Shoalwater is expected to have no effect on fish resources as this unit of the Refuge is currently submerged. Divesting property at Wheaton may or may not have an effect on freshwater fish species depending on the land uses of the new owner of the property.

Other proposals under Alternative 2 concern restoration of additional coastal dune habitat, establishing habitat for the Oregon silverspot butterfly and reintroduction of the Oregon silverspot butterfly once enough suitable habitat has been restored. These actions will not affect fish species or their habitat.

A predator control program would be initiated and target predators of the federally threatened western snowy plover. This action will not affect fish species or their habitat.

Alternative 2 also proposes improvements/additions to the public use program. No changes in public uses would affect fish with the possible exception of establishment of a boat launch access point (car-top boats only) to access South Bay for waterfowl hunting. Construction of the boat launch may result in temporary effects to fish and habitat at the shoreline site. This action also may result in a slight increase in motorized boat use and resultant water pollution in this area. Pollution could be caused by both routine oil and gas consumption and possible accidental leakage. Any effects to fish or their habitat will be of a temporary, localized short-term nature.

Overall, Alternative 2 would result in beneficial effects to fish. Estuarine restoration would have an intermediate positive effect and an increase in acreage of estuarine habitat would result.

Alternative 3 is similar to Alternative 2, but more limited in scope. The amount of estuarine habitat restoration would be less than in Alternative 2, also reducing maximum possible benefits to fish. Acres of managed wetland remaining would be greater than that in Alternative 2. The area open to waterfowl hunting would be increased in South Bay under Alternative 3, but in a more limited manner than that proposed in Alternative 2. This may result in a slight increase in motorized boat use and resultant water pollution in South Bay. The predator control program would be reduced from that in Alternative 2 to include only avian predators. This activity would have no effect on fish species or their habitat.

4.11.3 Effects to Birds

The large area of open water in Willapa Bay provides necessary resting and foraging habitat for waterfowl, shorebirds, marsh birds, and wading birds. The expansive intertidal mudflats of the Bay are among its most differentiating and defining features. The intertidal zone supports a variety of habitats including mud and sand flats, oyster reefs, salt marsh habitat, and eelgrass meadows. Its mudflats are among the 10 most important foraging areas for migratory birds along the Pacific Flyway (Coastal Resources Alliance 2007). In the Pacific Northwest a large portion of estuarine habitat has been lost to diking, channelization, dredging, and filling. Washington is estimated to have lost between 45% and 62% of its pre-settlement estuarine habitat (Aitkin 1998). In Willapa Bay about 30% of the original estuarine wetlands have been diked or filled (Hedgpeth and Obrebski 1981). A portion of refuge salt marsh habitat was eliminated when dikes were constructed in the late 1940s and early 1950s to create pasture lands and freshwater wetlands. It was believed this would enhance overall waterfowl use of the Refuge and increase land available for agricultural production.

Intertidal mudflats and salt marshes are particularly valuable habitat for migratory birds, juvenile fishes, eelgrass, and clams (Proctor et al. 1980). Such areas on the Refuge have annually provided important feeding habitat for over 20,000 migrating ducks, tens of thousands of shorebirds, and thousands of migrating geese annually. Refuge tidelands are essential to sustaining an estimated 2.2 million duck, 400,000 Canada goose, 200,000 brant, and over 2 million shorebird use-days associated with the southern portion of Willapa Bay (USFWS 1997b). Extensive eelgrass (*Zostera* spp.) beds on intertidal mudflats are an important food source for Pacific brant.

Forest habitats benefit a diverse assemblage of bird species, including many raptors and land birds. Live trees provide good nesting and roosting habitat for avifauna. Snags and live trees with broken tops provide nesting and foraging habitat for primary and secondary cavity nesters. Northern goshawk, marbled murrelet, pileated woodpecker, Vaux's swift, and olive-sided flycatcher are among the many birds that inhabit refuge forests for feeding, roosting, and nesting.

In the Willapa Hills of southwestern Washington, coastal and upland forests have been extensively managed for timber production; today, less than 1% of the original old-growth forests remain as scattered remnant patches across the landscape (Davis et al. 2009). Managed forests are typically 20 to 60 years old and are made up of primarily Douglas fir and western hemlock. Harvest of old-growth and mature forests for commercial timber and paper production have resulted in loss of species diversity and forest complexity on most of this landscape. This is due in part to the practice of clear-cut logging and planting of even-aged, monotypic stands that are managed on short harvest rotations. Conversion of habitat to residential and non-forest uses has accelerated forest fragmentation.

The unique natural elements protected at Leadbetter Point include salt marsh, native dunegrass, lodgepole pine (shore pine) forest, shrub/lodgepole pine, and open beach habitats. The Leadbetter Point Unit contains high-quality examples of high salinity Virginia glasswort/inland saltgrass marsh, low salinity marsh, and transition zone wetlands. Flora associated with the marshes are of primary significance, as are the dune grassland and deflation plain communities. Pockets of native plants within the secondary dune, deflation plains, and dune troughs are also significant ecological features and are of high quality compared to these remaining plant communities in Washington. The open beach and dune grassland communities of Leadbetter Point have been significantly impacted by the invasion and naturalization of two non-native beach grasses. The salt marsh has been invaded by smooth cordgrass, an eastern salt marsh species, although efforts to control cordgrass in recent years have essentially eliminated it from Leadbetter Point. Removal and control of the non-native beach grasses is ongoing and is a component of habitat management for the western snowy plover (Caicco 1989; Willapa NWR files). In addition to the loss of nesting habitat, avian nest predation is currently recognized as a significant limiting factor in western snowy plover and streaked horned lark fecundity.

Willapa Bay has been proposed as a site of international significance supporting >100,000 shorebirds or 15% of the Pacific Flyway total (Drut and Buchanan 2000). The Refuge provides breeding, wintering, and/or stopover habitat for most of the shorebirds identified as having primary importance within the region. Twenty species of highest concern for which coastal habitats in the Northern Pacific Coast Region are especially important are supported on this Refuge including the federally threatened/state endangered western snowy plover. Leadbetter Point also serves an important role as a nesting site for streaked horned larks.

4.11.3.1 Waterbirds

Waterbirds as discussed in this section include all birds other than raptors, shorebirds, seabirds, and land birds. Waterbirds include loons, grebes, pelicans, wading birds (e.g., herons, egrets, and bitterns), geese, ducks, and swans.

Alternative 1 would result in no change in current refuge management programs. The existing habitats and habitat management practices would be maintained. The amount of estuarine habitats, open water, intertidal flats, and salt marsh currently managed by the Refuge in South Bay will remain unchanged. The established cordgrass management program will be continued. These habitats benefit Pacific brant (*Branta bernicla nigricans*), and other geese and duck species. The Refuge would continue to manage 250 acres of short-grass fields to provide food for wintering geese and American wigeon (*Anas americana*). The existing 927 acres of natural and seasonally maintained freshwater marsh habitat at the Porter Point and Tarlatt units would be managed to benefit wintering ducks, geese, and other waterbirds. Existing riparian forests and forested wetland areas that provide nest sites for wood ducks (*Aix sponsa*), hooded (*Lophodytes cucullatus*) and common mergansers (*Mergus merganser*), and great blue herons (*Ardea herodias*) would be maintained.

Management would emphasize maintaining all habitats in their existing state and continuing existing management practices related to waterbirds. No additional estuarine tidelands, freshwater wetlands, or short-grass fields would be acquired or restored. Public use programs, including waterfowl hunting (ducks, geese, coots, and snipe), would continue at present levels. Hunting pressure and disturbance would remain focused in the regulated goose hunt area on the Tarlatt Unit and at existing areas on the Leadbetter and Porter Point units. Thus, under Alternative 1 there would be no change in the effects to waterbirds.

Alternative 2 would maintain existing refuge habitats and habitat management practices, with the following exceptions. The Refuge currently has 878 acres of open water and channel habitat. Under this alternative, open water and channel habitat within the Refuge would be increased by 0.2 acre. Existing intertidal flat habitat covers 4,178 acres within the Refuge. This alternative would result in an increase of 11 acres of intertidal flat habitat. The Refuge presently has 1,636 acres of salt marsh habitat that, under this alternative, will be increased by 749 acres. The increase in estuarine habitats managed by the Refuge will be accomplished by breaching or removing dikes in the Lewis, Porter Point, and Riekkola units, resulting in a reduction of 300 acres of seasonally managed wetlands. Subsequent to dike removal and estuarine restoration the remaining 17 acres of seasonally managed wetlands will be located solely at the Tarlatt Unit.

This alternative would re-establish tidal connection and natural functions to 760 acres of estuarine habitats in the South Bay. Estuaries are known to be one of the most productive and ecologically diverse habitat types (Correll 1978; Milne and Dunnet 1972; Odum 1971). Estuarine restoration would create the potential for eelgrass to colonize restored intertidal mudflats, thus increasing the overall amount of this important food source for Pacific brant. The newly restored intertidal and salt marsh habitats would also benefit fish and marine invertebrates like mollusks and zooplankton and result in improved forage for a number of resident and migratory waterbirds like grebes and seaducks. Estuarine marshes benefit other goose and duck species by providing cover, forage, and nesting habitat. In a recent survey goose utilization was compared between two types of habitats: salt marsh (Porter Point Unit) and pasture lands (Riekkola Unit). Migratory goose use of these areas as foraging habitat revealed a greater preference for the salt marsh than that of the adjacent managed pastures protected by dikes. Goose use of the salt marsh occurred regardless of the level of water coverage by the tides. Survey data suggest that migrating geese use salt marsh on average 8.6 times more than on the Riekkola Unit pastures (Patten et al. 2008). Waterbirds use of seasonally managed freshwater wetlands on the Refuge would decrease because of the reduction in overall area of this type of habitat.

The conversion from freshwater to estuarine habitat would change the type but not the amount of foraging habitat available to waterbirds, mostly affecting dabbling duck species. Any habitat manipulation results in benefits to some species and disadvantages to others. In this alternative many more species would benefit than would be impacted. The overall effect of these habitat changes would be minor and positive because of the relatively small acreage involved. In addition, any proposed refuge boundary expansion and acquisition of lands adjacent to Willapa Bay would provide a higher level of protection for habitats used by waterbirds.

There are 2,894 acres currently available for waterfowl hunting on the Refuge at the Leadbetter Unit and in South Bay. Under this alternative, in South Bay only, waterfowl hunting (goose included) would be expanded to 6,058 acres through estuarine restoration and opening of currently closed waters. The increase in allowable hunting area and number of days open to hunting would disperse the hunting pressure and reduce the amount of disturbance. The Presidential Proclamation Boundary area would remain closed to waterfowl hunting. All other existing hunting and fishing opportunities will remain unchanged or expanded to include elk and deer hunting in South Bay and East Hills, and elk hunting only at Leadbetter Point. There should be little if any disturbance or effect to waterbirds from expansion of the hunting program, since many of these areas are already hunted (marine waters of Willapa Bay) or are not utilized by waterbirds (upland forests), except for roosting great blue herons.

The habitat enhancements and potential refuge boundary expansion proposed in Alternative 2 would benefit most waterbirds, but some more than others. There could be some disturbance resulting from construction and restoration activities, but projects having the greatest potential for disturbance would be scheduled before most waterbirds arrive in the late fall and winter. Patten and Norelius (2009) concluded that removal of the tidal dike around the Reikkola Unit should not result in a net loss of habitat for waterfowl. Duck usage is likely to increase. Goose usage is expected to be the same or increase due to the creation of transitional salt marsh habitat and no loss of sheltered habitat. Overall there is expected to be a beneficial effect to waterbirds from the enhanced tidal flow and improved quality of the estuarine habitat.

Alternative 3 would be similar to Alternative 1 in that existing habitats and habitat management practices would be maintained, with exception of the following. In this alternative, the Refuge would pursue estuarine (intertidal and salt marsh) restoration at a reduced level. The proposed amount of open water and channel habitat within the Refuge would remain unchanged. There would be some increase in the amount of intertidal flat habitat, but it would be less than the 11 acres proposed in Alternative 2. Also, the amount of salt marsh habitat would be increased to 429 acres, instead of the 749 acres called for in Alternative 2. Restoration would result in breaching or removing dikes only in the Lewis and Porter Point units. Twenty-five acres of seasonally managed wetlands would continue to be maintained at the Tarlatt Unit.

This alternative would have some benefit to geese, ducks, and other waterbirds like great blue herons that use salt marshes, but there would be a minimal increase in the amount of habitat available to species like Pacific brant that use open water and intertidal areas. There may be minor negative effects to wildlife from the proposed limited changes to the hunting program in this alternative. Any effects from refuge boundary expansion would be the same as for Alternative 2. Overall the effects to waterbirds would be beneficial, but to a lesser degree than Alternative 2.

4.11.3.2 Raptors

Alternative 1 proposes no changes in refuge wildlife or habitat management practices. The existing refuge habitats would be maintained, with the exception that all of the Refuge's young-seral upland forest would be thinned as part of the Refuge forest restoration plan. That plan aims to restore ecological function to refuge forests by creating a natural distribution of stand structure, composition, and successional stages while promoting old-growth/late successional characteristics to benefit forest dependent wildlife. As the treated forests mature they will provide nest and perch sites for many raptor species, as well as foraging areas for woodland hunters like the northern goshawk (*Accipiter gentilis*), merlin (*Falco columbarius*), and Cooper's and sharp-shinned hawks (*Accipiter cooperii* and *A. striatus*, respectively). The existing bald eagle habitat (tidal marshes and tidelands, freshwater wetlands, late-successional coastal and riparian forest) would be maintained in its current state. There would be no changes in the refuge public use or hunting programs. Alternative 1 would be neutral in its effects on raptors.

Alternative 2 would be similar to Alternative 1 with regard to raptors in that existing habitats and habitat management practices would be maintained, with the following exceptions. Converting some current grassland to salt marsh would reduce the overall extent of grassland habitat for raptors such as the northern harrier (*Circus cyaneus*), white-tailed kite (*Elanus leucurus*), red-shouldered hawk (*Buteo lineatus*), red-tailed hawk (*Buteo jamaicensis*) and American kestrel (*Falco sparverius*) to use on the Refuge. However, these raptors also forage in salt marshes, which would be increased in area. Although the species composition of their prey would change, the diversity would likely increase. Thirty-three acres of short-grass field would continue to be managed through a mowing program. Construction of a new visitor station, offices, and maintenance facilities would result in an additional minor reduction in the amount of refuge grasslands. Abandonment and restoration of the old refuge headquarters site would result in more undisturbed habitat being available for forest-dwelling raptor use.

Conversion of 300 acres of seasonally managed wetlands would change the type but not the amount of foraging habitat available to bald eagles (*Haliaeetus leucocephalus*) and peregrine falcons (*Falco peregrinus*). The estuarine habitat proposed to replace the freshwater wetlands at the Lewis, Porter Point, and Riekkola units would likely support a more diverse community of bird species for raptors to feed on. There would be no change in the amount of naturally occurring freshwater wetlands on the Refuge under this proposal. Some trees at the coastal edge of forests adjacent to the estuarine restoration at the Lewis, Porter Point, and Riekkola units may be killed if salt water tidally inundates their root zone. Bald eagles forage near water bodies from shorelines, often from perches in super-dominant trees adjacent to winter waterfowl concentration areas (Buehler 2000). They use live conifer and deciduous trees, but dead trees are preferred (Stalmaster 1987). Thus, there may be an increase in preferred bald eagle foraging habitat as a result of this alternative. Overall effects of these habitat changes would be minor and positive because of the relatively small acreage involved and the relative abundance of similar habitats in the vicinity of the Refuge. Any proposed refuge boundary expansion and acquisition of upland forestlands and coastal habitats adjacent to Willapa Bay would provide a higher level of protection for areas used by raptors.

Predator management at Leadbetter Point aims to maximize adult survival and juvenile recruitment of western snowy plovers and streaked horned larks to achieve population objectives for species recovery. Those raptor species requiring management because of conflicts with endangered species would be impacted by removal of a few problem individuals. The adverse effects of predator management on the local and range-wide population of the affected raptor species would be insignificant. The northern harrier, merlin, peregrine falcon, and American kestrel are recognized potential predators of both juvenile and adult plover and larks. All occur at the Leadbetter Point Unit. Although not known to be predators at Leadbetter Point, snowy owls (*Nyctea scandiaca*) and short-eared owls (*Asio flammeus*) may opportunistically feed on shorebirds or land birds on an infrequent basis.

Specific local population data for raptors are currently unavailable. An initial step in the predator management plan would be implementation of a monitoring program to ensure that any impacts on raptor populations can be assessed more precisely. The Refuge monitoring program would also reveal more information on the magnitude and extent of threats that raptors pose to plovers and larks at Leadbetter Point. Under the proposed predator management plan, any individual raptor could be controlled when they pose a threat to endangered species, as determined by the Refuge Manager, Refuge Biologist, or a qualified predator control contractor (e.g., USDA APHIS Wildlife Services). Actions affecting raptors would only be taken after consulting with the Refuge Manager and the Refuge Biologist. The only raptors currently suspected to be potential predation risks at Leadbetter Point are the northern harrier and American kestrel.

Control of any raptor species would only focus on problem predators, which are defined in this context as individuals that belong to species known to prey on western snowy plovers or streaked horned larks and that exhibit hunting behavior in nesting areas. Once an individual problem bird is identified, the most effective, selective, and humane tools available to deter, relocate, or in very limited circumstances if necessary, lethally remove that individual would be implemented.

Live captured raptors would be removed from the site and held in a licensed/permitted rehabilitation/holding center until they can be released back into the wild. Release would occur after the endangered species nesting season is completed and an appropriate release site has been approved by the Refuge Manager and the Refuge Biologist. Raptors would be banded prior to release. As plover and lark numbers increase and their populations stabilize, raptors would be allowed a more natural interaction with the local species of concern and active predator management would be de-emphasized. A comprehensive, step-down predator management plan for the Leadbetter Point Unit can be found in Appendix L.

Proposed changes to the refuge hunting program would have little effect on raptors. These birds would not be targeted by hunters, and all species are protected by state and Federal regulations. The presence of hunters could cause some disturbance, but it would be minor and temporary. Nesting would not be affected because applicable hunting seasons take place in fall and winter, outside the nesting season. Therefore, overall this alternative would have a negligible effect on raptors. Any benefits would likely be small and indirect, except that refuge boundary expansion would have a positive effect on raptors. Effects to raptors under this alternative would be minor and on a small spatial and temporal scale.

Alternative 3 would be similar to Alternative 2, but estuarine (intertidal and salt marsh) restoration would occur at a reduced level. Overall, there would be a neutral effect on raptors. Any benefits would likely be small and indirect, except that refuge boundary expansion would have a positive effect on raptors. Effects to raptors under this alternative would be minor and on a small spatial and temporal scale as discussed under Alternative 2.

4.11.3.3 Shorebirds

Shorebirds (Order Charadriiformes; plovers, oystercatchers, stilts and avocets, sandpipers and allies) represent a group of species which use a variety of habitats during annual spring and fall migrations to and from breeding grounds. Many of the most critical habitats used by shorebirds are associated with wetlands or coastal habitats. Thus, shorebirds may be important indicators of ecosystem status. Because shorebirds aggregate in limited areas in large numbers during critical periods of their life cycles, habitat loss and degradation is a major threat. Addressing these threats and other issues in a coordinated fashion is a key to effectively conserving shorebird populations at the national and international scale (Drut and Buchanan. 2000).

Alternative 1 would result in no change in current refuge management programs. The existing habitats and habitat management practices would be continued. The total amount of sparsely vegetated sand beach and dune habitats would remain unchanged, except accounting for any natural erosion, accretion, or inundation of coastal beaches within the Refuge. The current Leadbetter Point restoration strategy would continue to be implemented. Additionally the beach and WSPHRA would continue to be closed to all public entry during the snowy plover breeding season. Thus, under Alternative 1 there would be no change in the effects to shorebirds.

Alternative 2 would result in an increase in the amount of open water and channel habitat by 0.2 acre; the Refuge currently has 878 acres of open water and channel habitat. Existing intertidal flat habitat covers 4,178 acres within the Refuge. This alternative would result in an increase of 11 acres of intertidal flat habitat. The Refuge presently has 1,636 acres of salt marsh habitat that, under this alternative, would be increased by 749 acres on refuge lands. The increase in estuarine habitats managed by the Refuge would be accomplished by breaching or removing dikes in the Lewis, Porter Point, and Riekkola units resulting in a reduction of 300 acres of seasonally managed wetlands. Shorebird use of existing pastures is infrequent and minimal.

This alternative would re-establish tidal connection and natural functions to 760 acres of estuarine habitats in the South Bay. Estuaries are known to be one of the most productive and ecologically diverse habitat types (Correll 1978; Milne and Dunnet 1972; Odum 1971). Estuarine restoration would create the potential for eelgrass (*Zostera* spp.) to colonize restored intertidal mudflats. Estuarine marshes and eelgrass beds would benefit fish and marine invertebrates like zooplankton, aquatic insects, mollusks, and other benthic organisms, potentially resulting in an increase in food for resident shorebirds.

The conversion from freshwater to estuarine habitat would change the type but not the amount of foraging habitat available to shorebirds, mostly affecting species like yellowlegs and phalaropes. However, due to the small amount of available habitat, and infrequent use by shorebirds, the impact to these species would be negligible. Any habitat manipulation results in benefits to some species and disadvantages to others. In this alternative many more species would benefit than would be impacted. The overall effect of these habitat changes would be minor and positive because of the relatively small acreage involved. In addition, any proposed refuge boundary expansion and acquisition of lands adjacent to Willapa Bay could provide a higher level of protection for habitats used by shorebirds.

Predator management at Leadbetter Point aims to maximize adult survival and juvenile recruitment of western snowy plovers and streaked horned larks to achieve population objectives for species recovery. Those wildlife species requiring management because of conflicts with endangered species would be impacted by removal of a few problem individuals. The adverse effects of predator management on the local and range-wide population of the affected species would be insignificant. There are a number of species recognized as potential predators of snowy plover eggs, chicks, and adults. They include crows, ravens, hawks, falcons, owls, coyote, fox, weasel, and mice (Liebezeit and George 2002; Powell et al. 2002; USFWS 2002b, 2007a). Most avian predators and some of the recognized mammalian predators occur at the Leadbetter Point Unit.

Specific local population data for predator species are currently unavailable. An initial step in the predator management plan would include a monitoring program to ensure that any impacts on native predator populations can be assessed more precisely. The Refuge monitoring program could also reveal more information on the magnitude and extent of threats that predators pose to plovers at Leadbetter Point. Under the proposed predator management plan, any individual predator could be controlled when they pose a threat to endangered species, as determined by the Refuge Manager, Refuge Biologist, or a qualified predator control contractor (e.g., USDA APHIS Wildlife Services). Actions affecting any predators would only be taken after consulting with the Refuge Manager and the Refuge Biologist. American and northwestern crows, common raven, northern harrier, American kestrel, peregrine falcon, coyote, and mice are currently suspected to be potential predation risks at Leadbetter Point. Elk are also implicated as having an impact on ground-nesting birds.

Control of any wildlife species that are known to prey on western snowy plovers and that exhibit hunting behavior in nesting areas could be authorized. The most effective, selective, and humane tools available to deter, relocate, or in very limited circumstances if necessary, lethally remove that individual would be implemented. Those species requiring management because of conflicts with endangered species would be impacted by removal. The adverse effects of predator management on the local and range-wide population of the affected target predator species would be insignificant. However, other species such as the killdeer (*Charadrius vociferous*) would also benefit from reduce nest predation pressure. As plover and lark numbers increase and their populations stabilize, native wildlife would be allowed a more natural interaction with the local species of concern and active predator management would be de-emphasized. A comprehensive, predator management plan for the Leadbetter Point Unit can be found in Appendix L.

There are 2,894 acres currently available for waterfowl hunting on the Refuge at the Leadbetter Unit and in South Bay. Under this alternative, in the South Bay only, waterfowl hunting (goose included) would be expanded to 6,058 acres through estuarine restoration and opening of currently closed waters. The increase in allowable hunting area and number of days open to hunting would disperse the hunting pressure and reduce the amount of disturbance created. The Presidential Proclamation Boundary area would remain closed to waterfowl hunting. All other existing hunting and fishing opportunities would remain unchanged, or expanded to include elk and deer hunting in South Bay and East Hills, and elk hunting only at Leadbetter Point. The proposed regulated elk hunt at Leadbetter Point would occur in the fall as such would occur after the snowy plover and streaked horned lark nesting seasons. There should be little if any disturbance or effect to shorebirds from expansion of the hunting program, since many of these areas are already hunted (marine waters of Willapa Bay) or are not used by shorebirds (upland forests).

The habitat enhancements and potential refuge boundary expansion proposed in Alternative 2 would benefit most shorebirds that utilize Willapa Bay, but some more than others. Shorebirds rapidly utilized Spartina-affected tideland following a successful control effort in Willapa Bay. Long-term data from Paten and O'Casey (2008) indicate shorebird counts increased from zero to >400 ha within a few years of treatment in a portion of the south bay. It was estimated that overall shorebird usage of Porter Point and Tarlatt Slough areas of South Bay, which was formally 4000 acre of solid Spartina meadow, has increased from ~40,000 shorebirds to ~1,000,000 following WNWR's successful control effort. Reestablishing tidal flow and natural sediment transport would further increase the quality and quantity of the estuarine habitat, and provide additional foraging areas to accommodate increasing shorebird use. Western snowy plover would benefit from instituting a comprehensive predator management plan. There could be some disturbance resulting from dike removal and estuary restoration activities, but projects having the greatest potential for disturbance would be scheduled before most waterbirds arrive in the late fall and winter. Addition of a regulated elk hunt at Leadbetter Point should help lessen the impacts on ground nesting birds from an expanding elk herd. Overall there is expected to be a beneficial effect to shorebirds resulting from this alternative.

Alternative 3 would be similar to Alternative 2, but estuarine (intertidal and salt marsh) restoration would occur at a reduced level. The proposed amount of open water and channel habitat within the Refuge would remain unchanged. There would be some increase in the amount of intertidal flat habitat, but it would be less than the 11 acres proposed in Alternative 2.

Also, the amount of salt marsh habitat would be increased to 429 acres, instead of the 749 acres called for in Alternative 2. Restoration would result in breaching or removing dikes only in the Lewis and Porter Point units. Any effects from refuge boundary expansion would be positive and the same as Alternative 2.

Effects to shorebirds, particularly western snowy plovers, would be positive but to a lesser degree than Alternative 2, because predator management would only address avian nest predators. Effects from other types of predators would not be addressed. However, impacts from the expanding Leadbetter Point elk herd would be managed through a regulated hunt as in Alternative 2. Although it is expected that avian predator management alone would have a positive effect on western snowy plover fecundity and adult survival, a limited predator management program could reduce its effectiveness and extend the time needed to reach recovery objectives for western snowy plover.

As a result, the overall effects on shorebirds from this alternative would be beneficial, but to a lesser degree than Alternative 2.

4.11.3.4 Seabirds

Seabirds such as shearwaters, fulmars, jaegers, and albatrosses occur in the adjacent coastal Pacific waters. These seabirds are classified as pelagic since they spend most of their time in the open ocean. They rarely make landfall within the Refuge. Although Willapa NWR adheres to regional seabird management guidelines, most local seabird habitats lie outside of the Refuge boundaries. There are some exceptions. Brown pelicans, Caspian terns, and several species of gulls tend to congregate on open sandy beaches, sandy islands, and sand bars within the Refuge, and in estuaries and large river mouths such as the Columbia River. They, along with cormorants, return to land regularly to roost, during both the breeding and non-breeding seasons. Roosting allows birds to rest, preen, and dry their plumage. The other notable exception at Willapa NWR is the marbled murrelet, which can be found nesting on limbs in older conifer trees on some of the refuge forestlands. Marbled murrelets may also be seen infrequently, and in low numbers, foraging in Willapa Bay.

Alternative 1 would result in no change in current refuge management programs. The existing habitats and habitat management practices would be continued. The total amount of sparsely vegetated sand beach and dune habitats would remain unchanged, except accounting for any natural erosion, accretion, or inundation of coastal beaches within the Refuge. The current upland forest restoration and Leadbetter Point restoration plans would continue to be implemented. Thus, under Alternative 1 there would be no change in the effects to seabirds.

Alternative 2 would result in an increase in the amount of open water and channel habitat by 0.2 acre; the Refuge currently has 878 acres of open water and channel habitat. Existing intertidal flat habitat covers 4,178 acres within the Refuge. This alternative would result in an increase of 11 acres of intertidal flat habitat. The Refuge presently has 1,636 acres of salt marsh habitat that, under this alternative, would be increased by 749 acres. The increase in estuarine habitats managed by the Refuge would be accomplished by breaching or removing dikes in the Lewis, Porter Point, and Riekkola units resulting in a reduction of 300 acres of seasonally managed wetlands.

This alternative would re-establish tidal connection and natural functions to 760 acres of estuarine habitats in the South Bay. Estuaries are known to be one of the most productive and ecologically diverse habitat types (Correll 1978; Milne and Dunnet 1972; Odum 1971). Estuarine restoration would create the potential for eelgrass (*Zostera* spp.) to colonize restored intertidal mudflats. Estuarine marshes and eelgrass beds would benefit fish and marine invertebrates like zooplankton, mollusks, and other benthic organisms, potentially resulting in an increase in food for resident seabirds. There is expected to be a minor-level decline in water quality due to increased suspended sediments during, and for a short time after, deconstruction of existing dikes and the estuarine restoration activities proposed under this alternative. Timing much of the earthwork around low tidal periods, using silt fencing, and other best management practices would be employed to reduce the amount of sediment entering the bay. The impact to birds feeding in the adjacent waters would be negligible.

Predator management at Leadbetter Point aims to maximize adult survival and juvenile recruitment of western snowy plovers to achieve population objectives identified in the recovery plan. Predator management would also help achieve conservation objectives identified for streaked horned larks. Those seabird species requiring management because of conflicts with endangered species would be impacted by removal of a few problem individuals. The adverse effects of predator management on the local and range-wide population of the affected seabird species would be insignificant. Several gull species are recognized as potential predators of snowy plover eggs (Liebezeit and George 2002; Powell et al. 2002; USFWS 2002b, 2007a). All occur at the Leadbetter Point Unit.

Specific local population data for gulls are currently unavailable. An initial step in the predator management plan could include a monitoring program to ensure that any impacts on gull populations can be assessed more precisely. The refuge monitoring program could also reveal more information on the magnitude and extent of threats that gulls pose to plovers and larks at Leadbetter Point. Under the proposed predator management plan, any individual gull could be controlled when they pose a threat to endangered species, as determined by the Refuge Manager, Refuge Biologist, or a qualified predator control contractor (e.g., USDA APHIS Wildlife Services). Actions affecting any seabirds would only be taken after consulting with the Refuge Manager and the Refuge Biologist. Seabirds, including gulls, are not currently suspected to be potential predation risks at Leadbetter Point.

Control of any wildlife species, including gulls, that are known to prey on western snowy plovers or streaked horned larks, and that exhibit hunting behavior in nesting areas, could be authorized. The most effective, selective, and humane tools available to deter, relocate, or in very limited circumstances if necessary, lethally remove that individual would be implemented. As plover and lark numbers increase and their populations stabilize, resident gulls would be allowed a more natural interaction with the local species of concern and active predator management would be de-emphasized. A comprehensive, step-down predator management plan for the Leadbetter Point Unit can be found in Appendix L.

There are 2,894 acres currently available for waterfowl hunting on the Refuge at the Leadbetter Unit and in South Bay. Under this alternative, in the South Bay only, waterfowl hunting (goose included) would be expanded to 6,058 acres through estuarine restoration and opening of currently closed waters. The increase in allowable hunting area and number of days open to hunting would disperse the hunting pressure and reduce the amount of disturbance created. The Presidential Proclamation Boundary area would remain closed to waterfowl hunting. All other existing hunting and fishing opportunities would remain unchanged or expanded to include elk and deer hunting in South Bay and East Hills, and elk hunting only at Leadbetter Point. There should be little if any disturbance or effect to seabirds from expansion of the hunting program, since many of these areas are already hunted (marine waters of Willapa Bay) or are not used by seabirds (upland forests).

The habitat enhancements and potential refuge boundary expansion proposed in Alternative 2 would benefit seabirds that use Willapa Bay. There could be some disturbance resulting from dike removal and estuary restoration activities, but projects having the greatest potential for disturbance would be scheduled before some migrating seabirds arrive in the late fall and winter. Overall there is expected to be a minor positive effect to seabirds resulting from these enhancements.

Alternative 3 would be similar to Alternative 2, but estuarine (intertidal and salt marsh) restoration would occur at a reduced level. The proposed amount of open water and channel habitat within the Refuge would remain unchanged. There would be some increase in the amount of intertidal flat habitat, but it would be less than the 11 acres proposed in Alternative 2. Also, the amount of salt marsh habitat would be increased to 429 acres, instead of the 749 acres called for in Alternative 2. Restoration would result in breaching or removing dikes only in the Lewis and Porter Point units. Any effects from refuge boundary expansion would be positive and the same as Alternative 2. Overall the effects to seabirds would be beneficial, but to a lesser degree than in Alternative 2.

4.11.3.5 Landbirds

Land birds as discussed in this section include all birds other than waterbirds, raptors, shorebirds, and seabirds. Land birds include passerine (perching) birds, woodpeckers, gallinaceous birds, kingfishers, swifts, hummingbirds, etc.

Alternative 1 would result in no change to current refuge management programs. The existing habitats and habitat management practices would be maintained. The current upland forest restoration and Leadbetter Point restoration plans would continue to be implemented. Management would emphasize maintaining all natural habitats in their existing state and continuing existing management practices relating to land birds, including forest-dwelling birds and grassland species. Some disturbance resulting from forest thinning and restoration activities would be expected, but projects having the greatest potential for disturbance would be scheduled outside of the breeding season of most, if not all, land bird species. Likewise any management activities at Leadbetter Point with the potential to disturb nesting land birds, especially streaked horned larks, would be scheduled outside of the breeding season. Additionally the beach and WSPHRA would continue to be closed to all public entry during the snowy plover and streaked horned lark breeding seasons. In the short term, Alternative 1 would be neutral in its effects on land birds since early-seral and open forest obligates would benefit. Alternatively, long-term effects of forest restoration would favor late-seral forest bird species. Alternative 1 would have a neutral effect on land birds.

Alternative 2 would be similar to Alternative 1 with regard to land birds in that existing habitats and habitat management practices would be maintained, with the following exceptions. Converting some existing refuge grasslands to salt marsh would reduce the overall extent of grassland habitat for land birds such as spotted towhee (*Pipilo maculatus*), various sparrow species, and gallinaceous birds that may use those areas for foraging and nesting. Twelve acres of short-grass field would continue to be managed through a mowing program. Construction of a new visitor information center, offices, and maintenance facilities would result in an additional minor reduction in the amount of refuge grasslands. Abandonment and restoration of the old refuge headquarters site would result in more undisturbed habitat being available for forest-dwelling land bird use.

Effects to birds associated with freshwater wetland edges such as the willow flycatcher (*Empidonax trailii*), marsh wren (*Cistothorus palustris*), several swallow species, and red-winged blackbird (*Agelaius phoeniceus*) would be slightly negative due to a reduction of suitable foraging, nesting habitat, and cover habitat. However, 17 acres of seasonally managed wetlands at the Tarlatt Unit and over 600 acres of naturally occurring freshwater wetlands would be maintained on the Refuge, a practice common to all alternatives. There is also additional similar wetland habitat in the vicinity of the Refuge.

There would generally be a positive effect on most birds that inhabit low-elevation coniferous and mixed species forests resulting from this alternative. The estuarine restoration would have some short-term benefit to woodpeckers and other cavity nesting birds if some trees at the coastal edge of forests adjacent to the estuarine restoration at the Lewis, Porter Point, and Riekkola units are killed by salt water tidally inundating their root zone. As these trees are stressed and begin to die they will provide foraging habitat for woodpeckers, red-breasted nuthatches (*Sitta canendensis*), and brown creepers (*Certhia americana*), and nesting structure to primary and secondary cavity nesters like woodpeckers, swallows, and the Vaux’s swift (*Chaetura vauxi*). Forestlands added by any proposed refuge boundary expansion would be protected from harvest or development and thus there would be a positive effect on forest-dwelling birds.

Some species of land birds that use the sparsely vegetated sand beaches, dunes, and lodgepole pine (*Pinus contorta*) forests at Leadbetter Point for resting, foraging, and nesting would likely benefit from predator management. Under this alternative, a plan would be implemented aimed at maximizing adult survival and juvenile recruitment of western snowy plovers and streaked horned larks to achieve population objectives for species recovery. This plan would use predator management to focus on problem animals, which are defined in this context as individuals that belong to species that are known to prey on western snowy plovers or streaked horned larks and that exhibit hunting behavior in nesting areas. The American crow (*Corvus brachyrhynchos*), northwestern crow (*Corvus caurinus*), and common raven (*Corvus corax*) are land birds recognized as potential predators of both juvenile and adult plover and larks (Liebezeit and George 2002; Powell et al. 2002; USFWS 2002b). All three species are currently suspected to be potential predation risks at Leadbetter Point.

Specific local population data for corvids are currently unavailable. An initial step in the predator management plan would be implementation of a monitoring program to ensure that any impacts to corvid populations and their behaviors and use patterns can be assessed more precisely. The refuge monitoring program would also reveal more information on the extent of threats that corvids pose to plovers and larks at Leadbetter Point. Under the proposed predator management plan, any individual corvid could be controlled when they pose a threat to endangered species, as determined by the Refuge Manager, Refuge Biologist, or a qualified predator control contractor (e.g., USDA APHIS Wildlife Services). Any actions affecting corvids would only occur after consulting with the Refuge Manager and the Refuge Biologist. Those species requiring management because of conflicts with endangered species would be impacted by removal. The adverse effects of predator management on the local and range-wide population of the affected predator species would be insignificant. However, other species such as the savanna sparrow (*Passerculus sandwichensis*), snow bunting (*Plectrophenax nivalis*), and song sparrow (*Melospiza melodia*) would also benefit from reduced nest predation pressure.

Control of any wildlife species, including corvids, that prey on streaked horned larks and that exhibits hunting behavior in nesting areas could be authorized. The most effective, selective, and humane tools available to deter, relocate, or in very limited circumstances if necessary, lethally remove that individual would be implemented. As plover and lark numbers increase and their populations stabilize, resident corvids would be allowed a more natural interaction with the local species of concern and active predator management would be de-emphasized. A comprehensive, step-down predator management plan for the Leadbetter Point Unit can be found in Appendix L.

Nearly all species of land birds are protected by state and Federal regulations and would not be targeted by hunters. Local exceptions in areas where they are legal to hunt are grouse, pheasant, quail, pigeons, and doves. The presence of hunters could cause some minor disturbance, but it would be minor and temporary. Nesting would not be affected by the additional areas opened to hunting in this alternative because applicable hunting seasons take place in fall and winter, outside the nesting season.

The effects of Alternative 2 on land birds would vary by species. There is expected to be an overall neutral effect on grassland birds. Effects of changes in grassland habitat would be neutral and minor because of the small acreage involved and the relative abundance of similar habitats in the vicinity of the Refuge. Effects to birds associated with freshwater wetland edges would be slightly negative, but localized and of minor consequence because of the relatively small acreage involved and the relative abundance of similar habitats in the vicinity of the Refuge. Any habitat manipulation results in benefits to some species and disadvantages to others. There would likely be a substantial positive effect to streaked horned larks resulting from predator management. Overall, in this alternative many more species would benefit than would be impacted and the effect of these habitat changes would be minor and positive.

Alternative 3 would be similar to Alternative 2, but estuarine (intertidal and salt marsh) restoration would occur at a reduced level. The proposed amount of open water and channel habitat within the Refuge would remain unchanged. There would be some increase in the amount of intertidal flat habitat, but it would be less than the 11 acres proposed in Alternative 2. Also, the amount of salt marsh habitat would be increased to 429 acres, instead of the 749 acres called for in Alternative 2. Restoration would result in breaching or removing dikes only in the Lewis and Porter Point Units. The freshwater edge habitats currently protected by those dikes would be eliminated. Twenty-five acres of seasonally managed wetlands would continue to be maintained at the Tarlatt Unit. All existing short-grass fields and other grasslands would remain as is. Any effects from refuge boundary expansion would be positive and the same as Alternative 2. Overall the effects to land birds would be beneficial, but to a lesser degree than Alternative 2.

4.11.4 Effects to Mammals

There are features (management actions) common to all alternatives that could affect mammals, including the following: continuation of the current habitat management program and continuation of a public use program that includes waterfowl hunting, big game hunting, fishing, camping, wildlife observation, and photography.

4.11.4.1 Elk

Alternative 1 proposes no changes in current refuge wildlife management, habitat management, public use programs, and other refuge programs. This alternative would continue the current refuge public use programs, which include big game hunting in specific areas of the Refuge. Existing refuge habitats would be protected and maintained and some would be restored. Effects to elk populations would be negligible under this alternative.

Alternative 2 (Preferred Alternative) proposes maximum estuarine restoration, refuge expansion and expanded public use. Alternative 2 proposes establishing additional estuarine habitat, specifically 0.2 acre of open water, 11 acres of intertidal flats, and 749 acres of salt marsh, by removing dikes. This action would decrease some habitat currently used by elk (i.e., freshwater impoundments that have been drawn down). Through this action managed pasture would be also be reduced. Elk occasionally use pastures on the Refuge. Elk also use salt marshes, and this habitat would be greatly increased with estuarine restoration.

Alternative 2 proposes improvements/additions to the public use program. Changes in public uses that would affect elk include expanded opportunities for elk and deer hunting in South Bay and the addition of a regulated permit hunt for elk at Leadbetter Point. Expanded wildlife-dependent public use opportunities to hunt in South Bay may reduce elk populations in that area. The hunt at Leadbetter Point would have the effect of reducing the herd size at that site and result in positive effects for the western snowy plover, which may be currently impacted by the large elk herd in this area.

Alternative 2 also proposes refuge expansion. Securing of additional habitat in the Nemah/Naselle, South Bay, and East Hills areas would provide additional habitat and positive benefits for elk because acquired lands would be protected from future development. Under refuge ownership the land can be managed to enhance and improve value for wildlife and contribute to maintaining the health and integrity of the larger Willapa Bay ecosystem. Divesting property at Cape Shoalwater is expected to have no effect on elk because this unit of the Refuge is currently submerged. Divesting property at Wheaton may or may not have an effect on elk depending on the land uses of the new owner of the property.

Other proposals under Alternative 2 concern restoration of additional coastal dune habitat, establishing habitat for the Oregon silverspot butterfly, and reintroduction of the Oregon silverspot butterfly once enough suitable habitat has been restored. These actions would not affect elk or their habitat.

A predator control program would be initiated and target predators of the federally threatened western snowy plover. This action would not affect elk or their habitat.

Overall effects under this alternative on elk populations locally and regionally would be minor.

Alternative 3 is similar to Alternative 2 but more limited in scope. Elk and deer hunting in South Bay would be more limited than in Alternative 2. The amount of estuarine habitat restored would be reduced. Acres of managed wetland remaining would be greater than under Alternative 2. The area open to waterfowl hunting would be increased in South Bay under Alternative 3, but in a more limited manner than that proposed in Alternative 2. The predator control program would be reduced from that in Alternative 2 to include only avian predators. Refuge expansion would be reduced to 4,895 acres from the 6,804 in Alternative 2. Overall effects under this alternative on elk populations locally and regionally would be minor.

4.11.4.2 Coyote

Alternative 1 would continue the current refuge habitat management program. The existing refuge habitats would be protected and maintained and some would be restored. No effect to coyote populations would be expected.

Alternative 2 (Preferred Alternative) would involve mammalian predator control as necessary under a predator management program for the western snowy plover. The primary means to manage coyotes would be trapping and euthanasia (shooting) and also opportunistic shooting.

There are no known estimates of coyote populations in the counties within which Willapa NWR is located; however, coyotes are abundant and likely number in the thousands in southwest Washington and northwest Oregon. As a conservative estimate, there likely are more than 50,000 coyotes in Washington (WDFW 2008a). In Washington, coyotes may be hunted year-round with no bag limits. Currently coyotes may not be hunted on Willapa NWR.

Under Alternative 2, the coyote population at Leadbetter would be reduced as necessary in the months just prior to the snowy plover nesting season. After control ends, the coyote population would increase rapidly (likely in months) as transients would move into vacant territories (Windberg and Knowlton 1988) and reproductive rates would increase in response to lower densities (Connolly 1978; Knowlton 1972). The coyote population likely would increase in size (possibly pre-control level) consistent with habitat conditions and the small mammal prey base. The small numbers removed from Leadbetter Point would not be expected to negatively affect coyote populations locally, regionally, or nationally.

Under Alternative 2 estuarine habitat would be restored. Restoration of salt marsh would be beneficial to coyotes as additional habitat.

Expansion of public use opportunities and new office/visitor facility would displace coyotes in those areas when the public is present. Expansion of elk and deer hunting in South Bay and regulated elk hunting on the Leadbetter Point Unit may temporarily displace coyotes.

Alternative 2 also proposes refuge expansion. Securing of additional habitat in the Nemah/Naselle, South Bay, and East Hills areas would provide additional habitat and positive benefits for coyotes. Under refuge ownership the land can be managed to enhance and improve value for wildlife and contribute to maintaining the health and integrity of the larger Willapa Bay ecosystem. Divesting property at Cape Shoalwater is expected to have no effect on coyote as this unit of the Refuge is currently submerged. Divesting property at Wheaton may or may not have an effect on coyote depending on the land uses of the new owner of the property.

Other proposals under Alternative 2 concern restoration of additional coastal dune habitat, establishing habitat for the Oregon silverspot butterfly, and reintroduction of the Oregon silverspot butterfly once enough suitable habitat has been restored. These actions would not affect coyotes or their habitat.

Alternative 3 is similar to Alternative 2 but more limited in scope. The amount of estuarine habitat restored would be reduced. Acres of managed wetland remaining would be greater than under Alternative 2. The area open to waterfowl hunting would be increased in South Bay under Alternative 3 but in a more limited manner than that proposed in Alternative 2. The predator control program would be reduced from that in Alternative 2 to include only avian predators. This activity would be of more benefit to coyotes than Alternative 2. Effects of public use would be the same as Alternative 2 except that coyotes may be less displaced by the more limited elk and deer hunting in South Bay.

4.11.4.3 Other Mammals

Alternative 1 proposes no changes in current refuge wildlife management, habitat management, public use programs, and other refuge programs. This alternative would still result in additional positive benefits to most mammal populations because habitat improvements would continue to be made even under the current management scenario, including stream and river restoration activities. Forest restoration activities would also continue, which would result in long-term positive benefits for mammals associated with late-successional forest habitat.

Alternative 2 (Preferred Alternative) proposes maximum estuarine restoration and expanded public use. Alternative 2 proposes improvements/additions to the public use program. Expanded opportunities for elk and deer hunting in South Bay and the addition of a regulated permit hunt for elk at Leadbetter Point may temporarily displace other non-target mammals during the time that hunts are taking place. The presence of hunters could cause minor disturbance to other mammals frequenting these areas. Disturbed mammals would simply move away from hunters. There would be a neutral effect on these non-target mammal populations. Expansion of public use opportunities and a new office/visitor facility would displace small mammals in those areas when the public is present.

Establishing additional estuarine habitat, specifically 0.2 acre of open water, 11 acres of intertidal flats, and 749 acres of salt marsh, by removing dikes would decrease some freshwater habitat currently used by some mammals, including river otter and the non-native nutria. Through this action, managed pasture would also be reduced that is used by small mammals. However, small mammals also use salt marshes, and this habitat would be greatly increased with estuarine restoration, which would benefit small mammal populations.

Alternative 2 also proposes refuge expansion. Securing of additional habitat in the Nemah/Naselle, South Bay, and East Hills areas would provide additional habitat and positive benefits for mammals. Under refuge ownership the land can be managed to enhance and improve value for wildlife and contribute to maintaining the health and integrity of the larger Willapa Bay ecosystem. Divesting property at Cape Shoalwater is expected to have no effect on mammals because this unit of the Refuge is currently submerged. Divesting property at Wheaton may or may not have an effect on mammal populations depending on the land uses of the new owner of the property.

Other proposals under Alternative 2 concern restoration of additional coastal dune habitat, establishing habitat for the Oregon silverspot butterfly, and reintroduction of the Oregon silverspot butterfly once enough suitable habitat has been restored. These actions should provide more diverse habitat for small- and medium-sized mammals.

A predator control program would be initiated and target predators of the federally threatened western snowy plover. If small mammals are identified as predating nests or snowy plovers, populations of these species may be controlled under this alternative.

Alternative 2 includes coyote control. The primary methods of control would be trapping and shooting. Both methods are reasonably selective when properly executed, but trapping may result in a small by-catch of non-target mammals. Non-target mammals would be released.

Alternative 3 is similar to Alternative 2 but more limited in scope. The amount of estuarine habitat restored would be reduced. Acres of managed wetland remaining would be greater than under Alternative 2. The area open to waterfowl hunting would be increased in South Bay under Alternative 3 but in a more limited manner than that proposed in Alternative 2. The predator control program would be reduced from that in Alternative 2 to include only avian predators. This activity would be of more benefit to other mammals than Alternative 2. Effects of public use would be the same as Alternative 1 except that limited expansion of opportunities for elk and deer hunting in South Bay and the addition of a regulated permit hunt for elk at Leadbetter Point may temporarily displace other non-target mammals during the time that hunts are taking place. The presence of hunters could cause minor disturbance to other mammals frequenting these areas. Disturbed mammals would simply move away from hunters. A new office/visitor facility would displace small mammals in those areas when the public is present.

4.11.5 Effects to Reptiles and Amphibians

All three alternatives include stream restoration activities that are occurring under the current management of the Refuge. Stream restoration will continue to improve habitat structure and conditions for amphibians, including enhancing invertebrate populations to serve as a food supply. Improved water quality (e.g., dissolved oxygen) and habitat structure is expected to benefit amphibians, especially the more stream-dependent species such as the tailed frog, Columbia torrent salamander, coastal giant salamander, and Cope's giant salamander as well as other native species. Both long-term and temporary effects may occur under each alternative. Temporary effects to amphibian species include those from construction activities such as large woody debris placement as part of stream and river restoration. Long-term effects to amphibian species may occur due to changes in habitat abundance and diversity and changes in primary production, which affect the food chain. The two species of garter snakes on the Refuge rely partially on amphibians as a food source and also will benefit.

Alternative 1 proposes no changes in current refuge wildlife management, habitat management, public use programs and other refuge programs. This alternative would still result in additional positive benefits to reptiles and amphibians as improvements would continue to be made even under the current management scenario, including stream and river restoration activities. Forest restoration activities would also continue, which would eventually result in long-term positive benefits for amphibians associated with late-successional forest habitat.

Alternative 2 (Preferred Alternative) proposes maximum estuarine restoration and expanded public use. Current stream and river restoration activities would be continued and would be expected to have the same positive effects as in Alternative 1. Establishing additional estuarine habitat, specifically 0.2 acre of open water, 11 acres of intertidal flats, and 749 acres of salt marsh, by removing dikes would decrease the acreage of managed freshwater wetlands and thus reduce breeding and foraging habitat for such amphibian species as the red-legged frog, Pacific treefrog, northwestern salamander, and rough-skinned newt. Populations of native amphibians in these areas would decrease. Populations of non-native bullfrogs would also decrease. Managed wetlands would remain in the Tarlatt Unit of the Refuge and would provide amphibian habitat. Removal of dike structures would reduce dike habitat currently used by common and northwestern garter snakes.

Alternative 2 also proposes refuge expansion. Securing of additional upland and wetland habitat in the Nemah/Naselle, South Bay, and East Hills areas would provide more protection and result in positive benefits for amphibian and reptile species. Under refuge ownership the land can be managed to enhance and improve value for wildlife and contribute to maintaining the health and integrity of the larger Willapa Bay ecosystem.

Divesting property at Cape Shoalwater is expected to have no effect on amphibian and reptile species because this unit of the Refuge is currently submerged. Divesting property at Wheaton may or may not have an effect on amphibian and reptile species depending on the land uses of the new owner of the property.

Other proposals under Alternative 2 concern restoration of additional coastal dune habitat, establishing habitat for the Oregon silverspot butterfly, and reintroduction of the Oregon silverspot butterfly once enough suitable habitat has been restored. These actions would not affect amphibian or reptile species or their habitat.

A predator control program would be initiated and target predators of the federally threatened western snowy plover. This action would not affect amphibian or reptile species or their habitat.

Alternative 2 also proposes improvements/additions to the public use program. Expansion of public use opportunities may displace reptiles and amphibians in areas of the Refuge when the public is present. Any effects to reptiles and amphibians or their habitat by the visiting public is expected to be of a temporary, localized, short-term nature. Constructing a new refuge headquarters facility is estimated to result in less than 5 acres of potential herptile habitat being lost. However, approximately 3 acres of the displaced herptile habitat would be replaced by abandonment and restoration of the old headquarters site.

Alternative 3 is similar to Alternative 2 but more limited in scope. The amount of estuarine habitat restored would be reduced. Acres of managed freshwater wetland remaining would be greater than that in Alternative 2, which would result in increased benefits to amphibians and reptiles (which hunt the edges of wetland areas).

4.11.6 Effects to Invertebrates

All three alternatives include stream restoration which is occurring under the current management of the Refuge. Stream restoration will continue to improve conditions for aquatic invertebrates, including freshwater mussels. Improved water quality (e.g., dissolved oxygen) and habitat structure are expected to benefit a variety of aquatic invertebrates.

Both long-term and temporary effects may occur under each alternative. Temporary effects to invertebrate species include those from construction activities such as large woody debris placement as part of stream and river restoration and construction activities associated with estuarine restoration including dike removal and channel modification. Long-term effects to invertebrate species may occur due to changes in habitat abundance and diversity and changes in primary production, which affect the food chain.

Alternative 1 proposes no changes in current refuge wildlife management, habitat management, public use programs, and other refuge programs. This alternative would still result in additional positive benefits to invertebrate populations as improvements would continue to be made even under the current management scenario; including stream and river restoration activities. Forest restoration activities would also continue, which would result in long term positive benefits for invertebrates associated with late-successional forest habitat.

Alternative 2 (Preferred Alternative) proposes maximum estuarine restoration and expanded public use. Current stream and river restoration would be continued and would be expected to have the same positive effects as in Alternative 1. Establishing additional estuarine habitat, specifically 0.2 acre of open water, 11 acres of intertidal flats, and 749 acres of salt marsh, by removing dikes would increase this valuable habitat which benefits shellfish, benthic invertebrates, and other invertebrates found in the estuarine environment. Through this action managed pasture would be reduced. Managed wetlands, though reduced, would still provide habitat for freshwater invertebrates. The habitat enhancements proposed in Alternative 2 would benefit invertebrate populations more substantially than Alternative 1.

Alternative 2 also proposes refuge expansion. Securing of additional habitat in the Nemah/Naselle, South Bay, and East Hills areas would provide more protection to the Willapa Bay estuary and result in positive benefits for invertebrate species. Under refuge ownership the land can be managed to enhance and improve value for wildlife and contribute to maintaining the health and integrity of the larger Willapa Bay ecosystem.

Divesting of the currently submerged refuge property at Cape Shoalwater is expected to have no effect on invertebrate resources. Divesting property at Wheaton may or may not have an effect on invertebrate species depending on the land uses of the new owner of the property.

Other proposals under Alternative 2 concern restoration of additional coastal dune habitat, establishing habitat for the Oregon silverspot butterfly, and reintroduction of the Oregon silverspot butterfly once enough suitable habitat has been restored. These actions would positively benefit this invertebrate species and its habitat and would likely benefit other invertebrate species with similar life history requirements.

A predator control program would be initiated and target predators of the federally threatened western snowy plover. This action would not affect invertebrate species or their habitat.

Alternative 2 also proposes improvements/additions to the public use program. All changes in public uses would not affect invertebrates with the possible exception of establishment of a boat launch access point (car-top boats only) to access South Bay for waterfowl hunting. Construction of the boat launch may result in temporary effects to invertebrates and habitat at the shoreline site. This action also may result in a slight increase in motorized boat use and resultant water pollution in this area. Pollution could be caused by both routine oil and gas consumption and possible accidental leakage. Any effects to invertebrates or their habitat would be of a temporary, localized, short-term nature.

Alternative 3 is similar to Alternative 2 but more limited in scope. The amount of estuarine habitat restored would be reduced, also reducing maximum possible benefits to estuarine benthic invertebrates. Acres of managed wetland remaining would be greater than under Alternative 2 and would provide habitat for freshwater invertebrates. The area open to waterfowl hunting would be increased in South Bay under Alternative 3, but in a more limited manner than that proposed in Alternative 2. This may result in a slight increase in motorized boat use and resultant water pollution in South Bay.

4.11.7 Effects to Federally Threatened and Endangered Species

It is the policy of the Service to protect and preserve all native species of fish, amphibians, reptiles, birds, mammals, invertebrates, and plants, including their habitats, which are designated, threatened, or endangered with extinction. Endangered, threatened, and candidate species that could occur on or near the Refuge include brown pelican, western snowy plover, marbled murrelet, northern spotted owl, streaked horned lark, and pink sandverbena. There are no endangered and threatened salmonids or bull trout known to occur in the waterways within the Refuge; however, if present they could be temporarily affected by the estuarine restoration project. Any effects would be of short duration and inconsequential.

Alternative 1 proposes no changes in refuge habitat management, public use, and snowy plover management programs. This alternative would be neither more positive nor more negative than the existing situation, including the upland forest restoration program that is common to all alternatives. Management would emphasize maintaining all natural habitats in their existing state and continuing existing management practices relating to endangered, threatened, and candidate species. Some disturbance resulting from forest thinning and restoration activities is expected, but projects having the greatest potential for disturbance would be scheduled outside of the breeding season of all federally listed species.

Likewise any management activities at Leadbetter Point with the potential to disturb western snowy plover and streaked horned larks would be scheduled outside of their breeding seasons. Additionally the beach and WSPHRA would continue to be closed to all public entry during the snowy plover and streaked horned lark breeding seasons. In the short term, Alternative 1 would be neutral in its effects on federally listed species. Long-term effects of forest restoration would benefit late-seral forest bird species such as the marbled murrelet and northern spotted owl. Overall, Alternative 1 would have a neutral effect on threatened and endangered species.

Alternative 2 would be similar to Alternative 1 with regard to federally listed species in that, existing habitats and habitat management practices would be maintained, with the following exceptions. This alternative would re-establish tidal connection and natural functions to 760 acres of estuarine habitats in the South Bay. The increase in estuarine habitats managed by the Refuge would be accomplished by breaching or removing dikes in the Lewis, Porter Point, and Riekkola units and restoration of the natural estuarine functions in south Willapa Bay. There is expected to be a minor-level decline in water quality due to increased suspended sediments during, and for a short time after, deconstruction of existing dikes and the estuarine restoration activities proposed under this alternative. Timing much of the earthwork around low tidal periods, using silt fencing, and implementing other best management practices would reduce the amount of sediment entering the bay. Marbled murrelets may be seen infrequently, and in low numbers, foraging in Willapa Bay. Any potential impacts to marbled murrelets that may be present on the adjacent waters would be minor and temporary, and thus negligible.

Predator management at Leadbetter Point aims to maximize adult survival and juvenile recruitment of western snowy plovers and streaked horned larks to achieve population objectives for species recovery. Those wildlife species requiring management because of conflicts with endangered species would be impacted by removal of a few problem individuals. The adverse effects of predator management on the local and range-wide population of the affected species would be insignificant. There are a number of species recognized as potential predators of snowy plover and streaked horned lark eggs, chicks, and adults. They include crows, ravens, hawks, falcons, owls, coyote, fox, weasel, and mice (Liebezeit and George 2002; Powell et al. 2002; USFWS 2002b, 2007a). Most avian predators and some of the recognized mammalian predators occur at the Leadbetter Point Unit of Willapa NWR.

Specific local population data for predator species are currently unavailable. An initial step in the predator management plan could include a monitoring program to ensure that any impacts on native predator populations can be assessed more precisely. The refuge monitoring program could also reveal more information on the magnitude and extent of threats that predators pose to plovers at Leadbetter Point. Under the proposed predator management plan, any individual predator could be controlled when they pose a threat to endangered species, as determined by the Refuge Manager, Refuge Biologist, or a qualified predator control contractor (e.g., USDA APHIS Wildlife Services). Actions affecting any predators would only be taken after consulting with the Refuge Manager and the Refuge Biologist. American and northwestern crows, common raven, northern harrier, merlin, American kestrel, peregrine falcon, coyote, and mice are currently suspected to be potential predation risks at Leadbetter Point. Elk are also implicated as having an impact on ground-nesting birds.

Control of any wildlife species known to prey on western snowy plovers or streaked horned larks and that exhibit hunting behavior in nesting areas could be authorized. The most effective, selective, and humane tools available to deter, relocate, or in very limited circumstances if necessary, lethally remove that individual would be implemented. Those species requiring management because of conflicts with endangered species would be impacted by removal. The adverse effects of predator management on the local and range-wide population of the affected target predator species would be insignificant. However, other species such as the killdeer would also benefit from reduce nest predation pressure. As plover and lark numbers increase and their populations stabilize, native wildlife would be allowed a more natural interaction with the local species of concern and active predator management would be de-emphasized. A comprehensive, step-down predator management plan for the Leadbetter Point Unit can be found in Appendix L.

There are 2,894 acres currently available for waterfowl hunting on the Refuge at the Leadbetter Unit and in South Bay. Under this alternative, in the South Bay only, waterfowl hunting (goose included) would be expanded to 6,058 acres through estuarine restoration and opening of currently closed waters. The increase in allowable hunting area and number of days open to hunting would disperse the hunting pressure and reduce the amount of potential disturbance created. The Presidential Proclamation Boundary area would remain closed to waterfowl hunting. All other existing hunting and fishing opportunities would remain unchanged, or expanded to include elk and deer hunting in South Bay and East Hills, and elk hunting only at Leadbetter Point. The proposed regulated elk hunt at Leadbetter Point would occur in the fall, and as such would occur after the snowy plover and streaked horned lark nesting seasons. There should be little if any disturbance or effect to the marbled murrelet, snowy plover, or streaked horned lark from expansion of the hunting program, since many of these areas are already hunted (marine waters of Willapa Bay) or are not used by federally listed species during the time of year when hunting would be permitted (Leadbetter Point and upland forests).

The open sand portions of the outer coastal beaches at Leadbetter Point would be unaffected under this alternative, therefore, no significant adverse effects to California brown pelicans that roost and forage in this area are anticipated.

Oregon silverspot butterfly are presumed to have been extirpated from Washington State and do not presently occur on the Refuge. This alternative includes a habitat restoration program as a precursor to Oregon silverspot butterfly reintroduction to the Long Beach Peninsula. Proposed actions under this alternative are expected to have overall significant, long-term, positive effects from the reintroduction of Oregon silverspot butterfly after successful host plants have been established and habitat restoration has been accomplished. The proposed restoration plan would dramatically increase the current average size of restoration sites, the rate that restored habitat becomes functional, availability of native seed and plant material for future restoration efforts, and thus the number of available butterfly reintroduction sites.

Alternative 3 would be similar to Alternative 2, but predator management would only address avian nest predators. Effects from other types of predators would not be addressed. However, impacts from the expanding Leadbetter Point elk herd would be managed through a regulated hunt as in Alternative 2. Although it is expected that avian predator management alone would have a positive effect on western snowy plover and streaked horned lark fecundity and adult survival, a limited predator management program could reduce its effectiveness and extend the time needed to reach recovery objectives for both the western snowy plover and streaked horned lark. As a result, the overall effects on western snowy plover and streaked horned larks from this alternative would be beneficial, but to a lesser degree than Alternative 2.

4.11.8 Effects to Wetland Habitats and Associated Wildlife

Wetland habitats within the Refuge include estuarine open water, intertidal flats, salt marsh, riverine habitats, seasonal, managed freshwater wetlands, and permanent/semi-permanent natural freshwater wetlands.

All of the alternatives propose protection of wetlands. Invasive species would be controlled to preserve the native vegetation and wildlife of the Willapa Bay estuary. Management of tidal wetlands would consist of regulation of public use, invasive species control, wildlife and vegetation monitoring, research, and working with partners to protect the biological integrity and diversity of the estuary.

All three alternatives include stream restoration which is occurring under the current management of the Refuge. Stream restoration would continue to improve habitat structure and conditions for fish, invertebrates, amphibians, and other native wildlife. Improved water quality (e.g., dissolved oxygen) would result, which would also benefit plant and animal life in the Willapa Bay estuary. Both long-term and temporary effects may occur under each alternative. Temporary effects to wetland habitats and associated wildlife include those from construction activities such as large woody debris placement as part of stream and river restoration and construction activities associated with estuarine restoration including dike removal and channel modification. Long-term effects to wildlife species may occur due to changes in habitat abundance and diversity and changes in primary production which affect the food chain.

Alternative 1 proposes no changes in current refuge wildlife management, habitat management, public use programs and other refuge programs. This alternative would still result in additional positive benefits to wetland habitats and associated wildlife as improvements would continue to be made even under the current management scenario, including stream and river restoration activities and maintenance of managed wetlands. Thus its effects on wetland habitat would be expected to be positive, although they would be minor due to the small scope of these projects. Hunters and hikers can potentially damage wetland habitat by trampling vegetation. Any such effects are minor and inconsequential, and they would have a neutral effect overall because hiking generally occurs along roads and trails and hunting is highly dispersed, affecting only small areas.

Alternative 2 (Preferred Alternative) proposes maximum estuarine restoration and expanded public use. Current stream and river restoration activities would be continued and would be expected to have the same positive effects as in Alternative 1. Establishing additional estuarine habitat, specifically 0.2 acre of open water, 11 acres of intertidal flats, and 749 acres of salt marsh, by removing dikes would increase this valuable habitat, which benefits estuarine dependent species. Through this action managed pasture would be reduced. Managed wetlands, though reduced, would still provide habitat for native wildlife species. The habitat restoration proposed in Alternative 2 would benefit estuarine habitat and associated wildlife species positively and much more substantially than Alternative 1. Also this alternative would assist in offsetting historical losses of estuarine habitat in Willapa Bay, which has been estimated as a 64% loss of estuarine wetlands (Coastal Resources Alliance 2007). This action would have an intermediate positive effect.

Alternative 2 also proposes refuge expansion. Securing of additional habitat in the Nemah/Naselle, South Bay, and East Hills areas would provide more protection to the Willapa Bay estuary and result in positive benefits for native species. Under refuge ownership the land can be managed to enhance and improve value for wildlife and contribute to maintaining the health and integrity of the larger Willapa Bay ecosystem.

Divesting property at Cape Shoalwater is expected to have no effect on wetland habitats and associated wildlife because this unit of the Refuge is currently submerged. Divesting property at Wheaton may or may not have an effect on wetland habitats and associated wildlife depending on the land uses of the new owner of the property.

Other proposals under Alternative 2 concern restoration of additional coastal dune habitat, establishing habitat for the Oregon silverspot butterfly, and reintroduction of the Oregon silverspot butterfly once enough suitable habitat has been restored. These actions would not affect wetland habitats and associated wildlife.

A predator control program would be initiated and target predators of the federally threatened western snowy plover. This action would not affect wetland habitats and associated wildlife.

Alternative 2 also proposes improvements/additions to the public use program. The proposed action of developing a new headquarters facility at the Sandridge Road/95th Street may impact site wetland resources. Careful facility planning and site design would avoid impacts to the highest quality wetland resource along Tarlatt Slough, and minimize overall wetland impacts on the site. However, where wetland impacts are unavoidable in order to accommodate the area required for the new facilities, these would be mitigated on site with the in-kind construction of replacement wetlands. Site design would include the enhancement of wetland buffer zones by revegetation with native plant materials, the relocation and mitigation of one site drainage feature, and the restoration of local woodland, shrub, and wetland plant communities on the site. This landscape and entry sequence through a restored natural environment would create a compelling setting for future visitor experiences at the Refuge. Establishment of a boat launch access point (car-top boats only) to access South Bay for waterfowl hunting. Construction of the boat launch may result in temporary effects to habitat at the shoreline site. This action also may result in a slight increase in motorized boat use and resultant water pollution in this area. Pollution could be caused by both routine oil and gas consumption and possible accidental leakage. Any effects to habitat would be of a temporary, localized, short-term nature.

Hunters might trample some wetland vegetation; however, trampling would occur at such small, dispersed areas that overall effects on wetland habitat would be neutral.

Alternative 3 is similar to Alternative 2 but more limited in scope. The amount of estuarine habitat restored would be reduced, also reducing maximum possible benefits to estuarine associated wildlife. Acres of managed wetland remaining would be greater than that in Alternative 2. The area open to waterfowl hunting would be increased in South Bay under Alternative 3 but in a more limited manner than that proposed in Alternative 2. This may result in a slight increase in motorized boat use and resultant water pollution in South Bay. The predator control program would be reduced from that in Alternative 2 to include only avian predators. This activity would have no effect on wetland habitats and associated wildlife species. The site development for the administrative facility would be as described in Alternative 2.

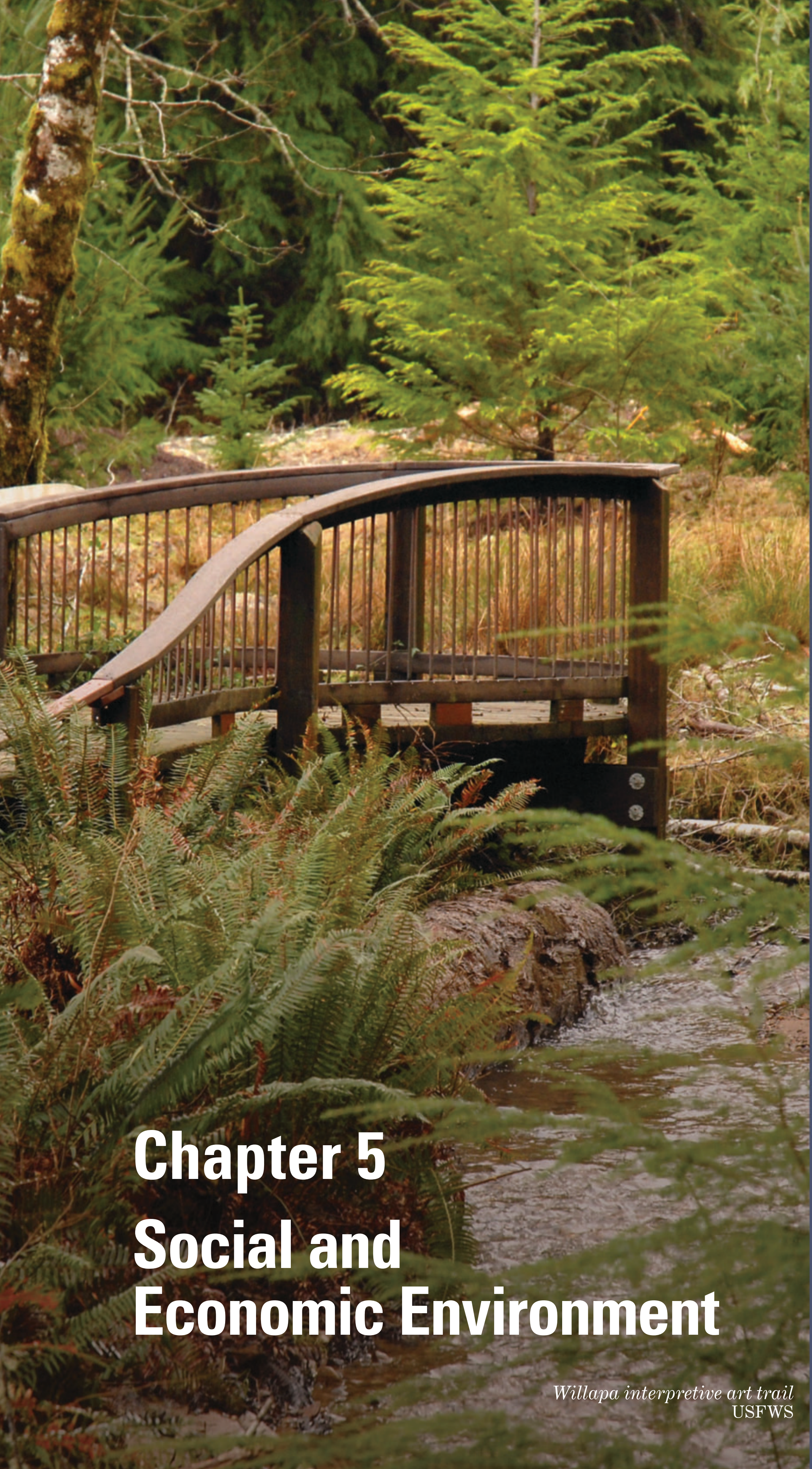
4.11.9 Effects to Riparian and Upland Habitats and Associated Wildlife

Alternative 1 would result in no change in current refuge habitat management practices. Canada geese (dusky, western, and cackling, etc.) use the Refuge and forage exclusively in short-grass fields and marshes. Maintaining grass fields in a short, immature growth form by repeated mowing or livestock grazing during the growing season is an important practice prior to arrival of migrating waterfowl. Once grass matures, it becomes coarse and much less digestible, and it has less protein providing limited food value to migrating geese as compared to short grass.

Alternative 2 and its strategies would likely result in the greatest short and long-term benefits to the wildlife using refuge lands. There would be an increase in the amount of available habitats that meet the life history needs of the most species utilizing refuge managed lands. Moreover, a year-round predator management program, when needed based on defined criteria, would maximize recruitment of juveniles, as well as the survival of adult western snowy plovers and streaked horned larks that is needed to achieve population objectives for species recovery. Because the predator management program under Alternative 2 would likely achieve population objectives in fewer years as compared with Alternative 1, there would be likely be fewer predators removed from the Refuge in the long term.

Alternative 3, like Alternative 1, proposes no change in habitat management practices with regard to short-grass fields and upland forests located on the Refuge. The existing acreages for these habitat types would be maintained under this alternative, except where unnecessary forest roads would be decommissioned and replanted with native trees, a practice common to all alternatives. The overall effect of these habitat changes would be minor because of the relatively small acreage involved, but positive since it would reduce or eliminate stream impacts and fragmentation of forest habitats on the Refuge.

Management of grasslands under this alternative and the total amount of habitat would be the same as for Alternative 2. As a result, the effects of Alternative 3 on riparian and upland habitats would be essentially neutral and similar to Alternative 1. Effects to associated wildlife, particularly western snowy plovers and streaked horned larks, would be positive but to a lesser degree than Alternative 2, due to management of only avian nest predators. Effects from other types of predator and impacts from the expanding Leadbetter Point elk herd would not be addressed. Although it is expected that avian predator management would have a positive effect on western snowy plover and streaked horned lark fecundity and adult survival, a limited predator management program could reduce its effectiveness and extend the amount of time needed to reach recovery objectives for these species.



Chapter 5
Social and Economic Environment

Willapa interpretive art trail
USFWS

Chapter 5. Public Use Programs and Impact on Social and Economic Environment

5.1 Introduction

Willapa National Wildlife Refuge encompasses approximately 16,000 acres of tidelands, temperate rainforest, ocean beaches, and small streams. It also includes several rare remnants of old-growth coastal cedar forest. The Refuge preserves habitat for spawning wild salmon, hundreds of thousands of migrating shorebirds, and threatened and endangered species such as the marbled murrelet. The Refuge is a great place to see what the Pacific Northwest looked like 100 years ago.

The Refuge is located in southwestern Washington on Willapa Bay, one of the most pristine estuaries in the United States. Willapa Bay is the second largest estuary on the Pacific Coast and includes over 260 square miles of water surface. The Refuge was established in 1937 to protect migrating and wintering populations of brant, waterfowl, shorebirds, and other migratory birds. During the time when the Refuge was established, diking, draining, dredging, sedimentation, and pollution were rapidly destroying many estuaries.

Willapa National Wildlife Refuge is located in Pacific County, which is bordered by the Columbia River, the Pacific Ocean, and the pristine Willapa Bay. Traditionally, the county's economy has been natural resource-based (i.e., tourism, logging, lumber, manufacturing, oyster harvesting, seafood canning, crabbing, sports and commercial fishing, dairy farming, and cranberry growing) (Pacific County 2009). With over 25 miles of beach area located along the Pacific Ocean, coastal life provides recreation opportunities such as fishing, hunting, beach combing, clam digging, camping, bird watching, trail hiking, whale watching, kite flying, and various organized community sports. Access to this rural county is an easy drive from Interstate 5 via Highway 12, Highway 6, and Highway 4, connecting to coastal Highway 101.

Visitors to the Refuge can enjoy viewing a wide variety of wildlife, from spawning salmon in the Refuge's numerous streams, Roosevelt elk on Long Island, and the tens of thousands of migrating shorebirds that crowd the beaches at Leadbetter Point and shores of Willapa Bay.

The majority of the public recreation in the local area centers on the Pacific Ocean, Willapa Bay and the many trails. Water-related recreational opportunities including power boating, kayaking, canoeing, waterfowl hunting, fishing, and camping provide the majority of the outdoor pursuits for the local and visiting public. As would be expected, outdoor activities significantly increase during the summer season, although many recreational activities are not restricted to a specific season.

Designated camping facilities are limited in the local area. Although most National Wildlife Refuges do not allow camping, Willapa NWR permits camping in designated spaces on Long Island. Camping sites on Long Island require a boat to access and are primitive. Cape Disappointment, a state park just southwest of the Willapa Refuge provides many multi-use camping opportunities. Newly established yurts help extend the camping season into the fall and winter for individuals without RVs or other type of camp trailers. A few other private parks in the area allow RV or tent camping on a seasonal basis.

Boat launch sites on the Willapa Refuge are available at mile post 24 on Highway 101 adjacent to the Willapa Refuge office headquarters and at the Port of Nachotta, located in the town of Nachotta on the Long Beach Peninsula. To the east of the Refuge is the Naselle river boat launch located in the town of Naselle. Public and commercial oyster and clam beds reside in Willapa Bay along with public and commercial fishing and crabbing.

Willapa National Wildlife Refuge provides opportunities for both big game and waterfowl hunters. Archery hunters interested in a remote hunting experience find Long Island a challenging place to pursue Roosevelt elk, black-tailed deer, black bear, and both ruffed and blue grouse. A refuge hunting permit is required to hunt on Long Island but there is no fee for the permit. Many people who hunt on Long Island prefer to camp overnight since tides can make travel to and from the island challenging. Most of the refuge lands on the mainland between Bear River and Teal Slough are open for those interested in hunting Roosevelt elk or black-tailed deer using modern firearms or archery.

For those interested in hunting waterfowl, portions of the Leadbetter, Stanley Point, Potshot, and North Potshot units are open to walk-in duck and goose hunting seven days a week. The Porter Point Unit is open for duck hunting on Sunday, Monday, and Thursday. The Riekkola Unit is open to goose hunting only from blinds on Sunday and Wednesday. Blind selection is done by lottery early the morning of each hunt. There is a small fee for use of the blinds. Funds from the fee go to help maintain the blinds. Although dogs are normally not permitted on the Refuge, they are allowed when actively engaged in hunting waterfowl.

5.2 Public Use Infrastructure and Administrative Facilities

The infrastructure and facilities discussed in this section include public entrances, roads, trails, and administrative buildings. This section also discusses seasonal closures, easements, and rights-of-way. All existing and proposed public and administrative facilities are depicted within the maps 1-7.

There are currently 13 units on the Willapa National Wildlife Refuge. For brevity and clarity, some units have been combined to form 5 identifiable Refuge areas. These units are located throughout Pacific County, in the southwest portion of Washington State.

5.2.1 East Hills Units

The East Hills Units consist of the property east of Bear River, Refuge Headquarters, Teal Slough, and Pot Shot, North Potshot, and Stanley Point tideland units.

The Bear River Unit extends from South of Greenhead slough, east of Highway 101 to mile post 19. It has refuge housing (Quarters 88) and a barn.

The Teal Slough Unit extends from Teal Slough eastward. The Teal Slough Trail is easily accessible from Highway 101 and is approximately 0.57 mile round trip. Limited parking is available at the Teal Slough Gate. This site, located near the mouth of the Naselle River, supports a remnant coastal old-growth forest represented by ancient cedars and a Sitka spruce, western hemlock/salal community. The forest provides habitat suitable for two state and federally protected species, marbled murrelets and spotted owls, as well as Dunn's and Van Dyke's salamanders and Vaux's swifts and pileated woodpeckers. Deer and elk trails network the area.

The Pot Shot, North Potshot, and Stanley Point tidelands are located adjacent to the Stanley Peninsula located east of Chettlo Harbor. There are no public uses or administrative facilities. They are open to waterfowl hunting according to Washington State regulations.

The Refuge Headquarters unit includes Omeara Point. It is located near mile marker 24 on Washington State Highway 101 and extends north from Greenhead Slough to Teal Slough.

The existing headquarters administrative building, which is the former house for the refuge manager, is over 55 years old. It has been renovated but still does not provide enough space and a design that accommodates the staff. The headquarters area also has a maintenance shop, equipment storage facility, and tool shed. The facilities at the existing site cannot be expanded due to the location in a narrow valley.

The public parking lot at headquarters contains 16 car spots, nine trailer spots, and two accessible spots. Two public vault toilets are available. No running water is available to the public. A public boat launch into Willapa Bay is available directly across from the headquarters, on the west side of Highway 101.

An interpretive kiosk next to the parking lot offers directional, educational, and safety information. A temporary addition to this kiosk is also used for camping and archery permit registration during the early elk archery season. The indoor porch in the main headquarters building serves as an additional informational area with maps, pamphlets, and a collection of avian specimens.

The Willapa Interpretive Art Trail is a quarter-mile-long, curving, ADA-accessible boardwalk that brings visitors close to the tideland marsh and stream. Artwork located along the boardwalk tells the story of the stream and the many species who live there. Students from the University of Washington Public Arts Program designed, constructed, and installed the artwork.

The Cutthroat Climb Trail that spurs off the Willapa Interpretive Art Trail provides a climb into the forest surrounding refuge headquarters. The trail is a moderate three-quarter-mile-long trail with steps cut into the hillside for easier movement up and down the ridge. Additional art pieces weave through the trail, providing a perspective of the natural world and fun for all ages.

5.2.2 Leadbetter Point Unit

The primary public access to Leadbetter Point Unit occurs at the end of a narrow wooded road near the northern tip of the Long Beach Peninsula. The parking lot has two accessible spots, 23 standard parking spots, two bus/RV parking spots, and a turnaround. There are two vault toilets that are maintained by Washington State Parks. There are interpretive kiosks that offer directional, educational, and safety information, as well as a wildlife viewing platform. Pedestrians access the Refuge and adjacent state park lands from a trail that begins at the north end of the parking lot.

Hiking trails at Leadbetter Point unit at the tip of the Long Beach Peninsula allow visitors to walk through coastal woodlands, salt marshes, and beaches. A 1.3-mile Bearberry Trail, 0.5-mile Beach Trail, and a 1.2-mile Bay Loop Trail link the Leadbetter Point Unit with adjacent Washington State Park trails. These trails can be flooded during the rainy season (October through May). The nesting area for the endangered snowy plover is closed to all public entry from March through September and is posted with signs, although the season can vary due to variation in the use by snowy plovers.

There are no administrative facilities on Leadbetter Point Unit.

5.2.3 Long Island Unit

Long Island is unique in being the Pacific Coast's largest estuarine island. Long Island's 5,460 acres contain a rare 274-acre remnant of old-growth lowland coastal forest. The island is entirely owned by the USFWS, except for 1.25 acres located at the southern tip of the mouth of Lewis Slough. Long Island can only be accessed by boat. Most of the campgrounds require a 6-foot or higher tide; however, the boat landing directly across from Refuge Headquarters can be accessed at any tide.

There are five campgrounds on Long Island: Lewis (three campsites), Sawlog (five campsites), Pinnacle Rock (five campsites), Smokey Hollow (four campsites), and Sandspit (three campsites). Each campsite has a fire pit and a picnic table. Each campground also has an evaporator vault toilet.

Hiking trails occur throughout Long Island. A network of old logging roads converted to trails provides well over 10 miles of hiking opportunities. One of the most popular destinations is the Trail of the Ancient Cedars, a three-quarter-mile loop trail near the center of the island, which takes visitors through the northern corner of the old-growth forest. The hike from the old ferry landing, on the southern tip of Long Island, north along the center road to the Grove of the Ancient Cedars is approximately 2.5 miles.

Refuge facilities located on Long Island include a shop building that serves as an equipment/supply storage space. The shop is located on the southern portion of the island situated immediately adjacent to the service road.

5.2.4 Shoalwater and Wheaton Units

The Shoalwater Unit is located in the mouth of the Willapa Bay, immediately south of State Highway 105, and west of the town of Tokeland. There are no public use or administrative facilities on the Shoalwater Unit. The Wheaton Unit is located approximately 5 miles southeast of Raymond, Washington, along the Willapa River. It was received in July 19, 1989, through the Farmers Home Administration. There is a shop on the Wheaton Unit and an RV pad with electrical hook-ups.

5.2.5 South Bay Units

The South Bay Units consist of the Tarlatt, Riekkola, Lewis, and Porter Point units.

The Tarlatt Unit has northern and southern subunits. The northern unit is located in the southwest portion of Willapa Bay west of Tarlatt Slough and east of the peninsula. The northern unit consists of tidal mudflat and native salt marsh. The southern unit is located between Lone Fir Cemetery Road and 95th Street on the Long Beach Peninsula. The southern Tarlatt slough unit has a Wetland Reserve Program (WRP) easement located on the Old Shier property. This WRP easement is administered by the USDA NRCS and offers landowners the opportunity to protect, restore, and enhance wetlands on their property.

There is a photography blind on the southern Tarlatt Unit. The Friends of Willapa National Wildlife Refuge constructed this photography blind on a seasonal freshwater wetland in 2003. The best time of year to use the blind is during the winter and early spring when the wetland is full of water and feeding waterfowl. The blind is available by reservation only. There is a short foot trail to the photo blind. Additionally, the Tarlatt Unit has a temporary hunting blind constructed for the goose hunting season.

The Riekkola Unit is located at the end of 67th Street off of Sandridge Road on the Long Beach Peninsula. There is an equipment storage building, shop office, maintenance shop, and shop yard on the Riekkola Unit. The Riekkola Unit currently has a gravel parking lot. There are seven temporary hunting blinds that are constructed for the goose hunting season. Blind #6 is reserved for hunters with a state disabled permit and their partners.

The Lewis Unit consists of managed freshwater wetland impoundments, intertidal salt marsh, and mudflats. Fish ladders are active within the unit to provide fish passage for anadromous fish between the wetland and bay. The freshwater wetland water is manipulated by using adjustable slide gates to vary the water depth based on current management habitat targets. Entry to the Lewis Unit occurred via a private road, Jeldness Road, off of U.S. Highway 101. Jeldness Road was closed by the property's owners in 2008. Since the closure of Jeldness Road, the Lewis Unit has been closed to public access.

The Porter Point Unit consists of managed freshwater wetland impoundments, intertidal salt marsh, and mudflats. Fish ladders are active within the unit to provide fish passage for anadromous fish between the wetland and Willapa Bay. The Porter Point Unit has parking for car-top boat and foot access. The dike trail is open for hiking. It is accessible by way of 67th Street. During the hunting season, this area is closed on Wednesday and Saturday due to a managed goose hunt in the adjacent Riekkola Unit. During the hunting season, the Porter Point Unit is open on Sunday, Monday, and Thursday for waterfowl hunting, and on Tuesday and Friday for non-consumptive uses such as hiking and wildlife observation.

5.3 Public Use Overview

The Willapa National Wildlife Refuge is a popular destination for local visitors as well as tourists from outside the area. It is difficult to determine exact numbers of visitors to the Refuge but it is estimated the Refuge has 250,000 visitor use-days each year. The Refuge provides funding for one full-time Visitor Services staff member dedicated to public use, education, and volunteer programs. Maintenance of the campgrounds, interpretive signs, trails and other visitor use facilities is completed each summer by the Youth Conservation Corps.

Many refuge visitors discover the Refuge while on their way to and from other destinations, while many other visitors visit the Refuge for specific reasons such as bird-watching, hunting, hiking, and camping. The refuge staff takes advantage of these educational opportunities by providing refuge-specific information, interpretive panels, and printed materials throughout the Refuge.

The majority of the Refuge is open to the public with a few exceptions. During the snowy plover nesting season, portions of the beach on Leadbetter Point are closed. Visitors need to check with the Refuge for dates and look for posted signs. In addition, the Lewis Dike Road has been closed to waterfowl hunting and wildlife observation. Entry to the Lewis Unit occurred via private road, Jeldness Road, off of U.S. Highway 101. Jeldness Road was closed by the property's owners in 2008. An alternative access to the Porter Point Unit through the Riekkola Unit has been developed. While Long Island is open to public access, the Presidential Proclamation Boundary around the island restricts waterfowl hunting in this area.

Accessibility is an important part of planning at Willapa NWR because it is essential to ensuring that facilities are available to all groups, including people who are young or elderly and/or people with disabilities. Several facilities, including the Interpretive Art Trail, headquarters office, restrooms, and one hunting blind for the goose hunt at Willapa NWR are in accordance with the Federal Americans with Disabilities Act of 1990 (ADA).

5.3.1 Area Outdoor Recreational Opportunities and Trends

According to the National Survey on Recreation and the Environment (NSRE 2000), the five most popular individual outdoor recreational activities and percentage of the U.S. population participating were walking (87.1%), family gatherings (76.1%), viewing natural scenery (69.8%), visiting a nature center, nature trail or zoo (62.8%), driving for pleasure through natural scenery (60.0%), and picnicking (59.9%). For the most part, these types of activities are probably popular at least in part because the costs to participate are relatively low, physical exertion is minimal, and special equipment or developed skills are not required.

The Washington State Recreation and Conservation Office (RCO, formerly known as the Interagency Committee for Outdoor Recreation [IAC]) contracted with Clearwater Research, Inc., (Clearwater) to perform questionnaire consultation, data collection, data preparation, data analysis, and reporting activities as part of a population-based research study on outdoor recreation in Washington. The Washington Outdoor Recreation Survey (ORS) was designed to accurately measure the outdoor recreational activity among Washington residents.

The most recently released Washington Outdoor Recreation Survey (RCO 2007) identified the 15 major categories of outdoor recreation. Table 5-1 lists the activities in order from most to least in terms of participation rates. Walking and hiking activities, followed by exercise and sports activities, had the highest levels of participation.

Table 5-1. Ranking of Major Activity Areas

Activity Category	% Population
Walking/hiking	73.8
Team/individual sports, physical activity	69.2
Nature activity	53.9
Picnicking	46.8
Indoor community facility activity	45.1
Water activity	36.0
Sightseeing	35.4
Bicycle riding	30.9
Off-road vehicle riding	17.9
Snow/ice activity	17.5
Camping	17.1
Fishing	15.2
Hunting/shooting	7.3
Equestrian activity	4.3
Air activity	4.0

The ORS survey discusses each activity category in detail, further breaking down the categories into specific activities. Several of these are of note in planning for public use at Willapa National Wildlife Refuge.

- **Walking/hiking:** The most prevalent settings for walking without a pet were sidewalks (at least 57.3%), park or trail settings (at least 47.8%), and roads or streets (at least 42.4%).
- **Nature activity:** The most frequent nature activity (over 35 million times) was observing or photographing wildlife or nature, performed by at least 39.0% of Washingtonians. Visits to nature/interpretive centers were reported by 15.9% of Washington residents. The only significant demographic difference for observing or photographing wildlife or nature for all types and settings combined was age, with the largest prevalence (41.7%) seen for Washingtonians 50 to 64 years old.
- **Water activity:** The water activities with the greatest prevalence in the Washington population were beachcombing (19.9%), motor-boating (11.4%), and canoeing, kayaking, row boating, and other hand-powered boating (7%).
- **Sightseeing:** The most prevalent setting for sightseeing was scenic areas (at least 41.7% of residents).
- **Camping:** Camping with a kayak or canoe was reported by 1.4% of Washingtonians. Those with incomes from $15,000 up to $25,000 showed more interest (33.6%) than those in any other income range to do more camping in general.
- **Fishing:** Roughly equivalent percentages of Washington residents (at least 17%) participated in fishing from a bank, dock, or jetty and fishing from a private boat. However, fishing was performed more frequently from a bank, dock, or jetty (over 2.3 million times) than from a private boat (over 1.4 million times). Fishing for shellfish was reported by 9% of the population.
- **Hunting:** Two categories of hunting or shooting—each one divided into types—were included on the survey questionnaire. The main categories were archery and firearms. The category that the most Washington residents participated in during 2006 was firearms (at least 10.8%). The most prevalent type of activity with firearms was target,

trap, or black powder shooting (at least 7.9%), followed by hunting big game (at least 6.1%), hunting birds or small game (at least 3.4%), and hunting waterfowl (at least 2.5%). At least 2.9 % of Washingtonians engaged in archery, nearly all of it target shooting.

The most recently released 2007 Washington Outdoor Recreation Survey did not offer forecasts of future regional recreation demands. The previous survey, which was released by the Washington Interagency Committee for Outdoor Recreation (IAC 2002b), states that outdoor recreation in most activities continues to increase at high growth rates. Many outdoor activities generally permitted on refuges are expected to show increases of 20% to 40% over the next 20 years. Table 5-2 Shows the percentage change expected for Washington State by activity as reported by IAC in 2002.

Table 5-2. Projected Future Increase in Participation for Selected Outdoor Recreation Activities

Activity	Estimated Change, 10 years (2002-2012)	Estimated Change, 20 years (2002-2022)
Walking	23%	34%
Hiking	10%	20%
Nature activities	23%	37%
Fishing	-5%	-10%
Hunting	-15%	-21%
Sightseeing	10%	20%
Camping	10%	20%
Canoeing/kayaking	21%	30%
Motor boating	10%	No estimate
Equestrian	5%	8%
Non-pool swimming	19%	29%

5.3.2 Overview of Refuge Wildlife-Dependent Public Uses

The National Wildlife Refuge System Improvement Act of 1997 (Public Law 105-57), recognizes that wildlife-dependent recreational uses involving hunting, fishing, wildlife observation and photography, and environmental education and interpretation, when determined to be compatible, are legitimate and appropriate public uses of the Refuge System. These compatible wildlife-dependent recreational uses are the priority general public uses of the Refuge System. Willapa National Wildlife Refuge recognizes and offers these compatible uses.

5.3.2.1 Waterfowl Hunting

Recreational hunting has been identified in the National Wildlife Refuge System Improvement Act of 1997 as a priority public use, provided it is compatible with the purpose for which the refuge was established. Because hunting is one of the six designated wildlife-dependent public uses of the National Wildlife Refuge System, refuges grant hunting special consideration in planning and management.

Willapa National Wildlife Refuge provides opportunities for both big game and waterfowl hunters. Hunting rules and regulations on the Refuge are consistent with the state regulations except as specifically noted herein. Hunting is permitted in some, but not all, of the management units. Specific species/numbers to be taken and hunting periods are set by the WDFW.

For those interested in hunting waterfowl, portions of the Leadbetter Point Unit are open to walk-in duck and goose hunting. Access is by Stackpole Road. Hunting is prohibited in the snowy plover closure area. The Stanley, Potshot, and North Potshot units are also open during the Washington State hunting season for waterfowl.

The Riekkola Unit is open to goose hunting only from blinds. Blind selection is done by lottery early the morning of each hunt. There is a small fee for use of the blinds. Funds from the fee go to help maintain the blinds. Although dogs are normally not permitted on the Refuge, they are allowed when actively engaged in hunting waterfowl and must be kept under control at all times.

Waterfowl hunting previously occurred on the freshwater marsh and salt marsh in the Lewis Unit. Entry to the Lewis Unit occurred via a private road, Jeldness Road, off of U.S. Highway 101. Jeldness Road was closed by the property's owners in 2008. An alternative has been developed for waterfowl hunters to access the adjacent areas of freshwater marsh and salt marsh at the Porter Point Unit in lieu of the Lewis Unit. Access to the Porter Point Unit occurs through the Riekkola Unit, off 67th Street in Long Beach. The Porter Point Unit is suitable for car-top boats and small craft that can be easily moved. No gas-powered engines are allowed in the freshwater wetland. Parking is available across the Riekkola Unit pastures in a delineated graveled parking area with 10 sites for waterfowl hunters. The freshwater wetland can be accessed by the Porter Point Unit levee or boating the wetland. The saltwater marsh of Willapa Bay can be reached from the existing footbridge on the east end of Porter Point Unit or by walking into the bay from the levee on the west end of the unit. Signs are placed on the east and west boundary of the Porter Point Unit, extending into the bay, to delineate the hunt area.

The schedule for the waterfowl hunt has been designed to best accommodate multiple users on adjacent areas throughout the week. A regulated goose hunt occurs on an adjacent pasture on the Riekkola Unit Wednesday and Saturday. To reduce impacts to the goose hunt, waterfowl hunting is open Sunday, Monday and Thursday on the Porter Point Unit. Gates are open from 6 am until 5 pm. The Porter Point Unit is open for other wildlife observation on Tuesday and Friday during the waterfowl hunt season. All users other than waterfowl hunters walk in through the pedestrian gate at the main Riekkola Unit entrance by way of 67th Street.

5.3.2.2 Big Game Hunting

Recreational hunting has been identified in the National Wildlife Refuge System Improvement Act of 1997 as a priority public use, provided it is compatible with the purpose for which the refuge was established. Because hunting is one of the six designated wildlife-dependent public uses of the National Wildlife Refuge System, refuges grant hunting special consideration in planning and management.

Willapa National Wildlife Refuge provides opportunities for both big game and waterfowl hunters. Hunting rules and regulations on the Refuge are consistent with the state regulations except as specifically noted herein. Hunting is permitted in some, but not all, of the management units. Specific species/numbers to be taken and hunting periods are set by the WDFW.

Big game hunting occurs on both the mainland and Long Island. Most of the refuge lands on the mainland between Bear River and Teal Slough with the exception of the quarters (Quarters 88) and headquarters area are open for those interested in hunting Roosevelt elk or black-tailed deer using modern firearms or archery. There are no firearms permitted on Long Island. Archery hunters interested in a remote hunting experience find Long Island a challenging place to pursue Roosevelt elk, black-tailed deer, black bear, and both ruffed and blue grouse. A refuge hunting permit is required to hunt on Long Island but there is no fee for the permit. Many people who hunt on Long Island prefer to camp overnight since tides can make travel to and from the island challenging.

5.3.2.3 Fishing

Although it surrounds much of southern Willapa Bay, the Refuge is not considered a prime fishing location. However, fishing is permitted from the shores of Willapa Bay. Most visitors interested in fishing on the Refuge are in search of sturgeon. Fishing is not permitted on the refuge non-tidal streams or interior sloughs. All fishing on the bay follows WDFW regulations.

5.3.2.4 Shellfish Harvesting

All harvesting on the Refuge follows Washington State shellfish licensing procedures. Shellfish harvesting of Manila clams and Pacific oysters occurs at two locations on Long Island. The public clam and oyster beds were surveyed and posted in 2009.

The first location is at Diamond Point, which is located on the northwest tip of Long Island from the mean high water out to the eastern boundary of the Long Island Oyster Reserve. Harvest is allowed west on reserve tidelands to MLLW between reserve monuments 39, 40, and 41. The second location is at Pinnacle Rock, which is located on the southwest side of Long Island nearest Pinnacle Rock and Smokey Hollow campgrounds.

5.3.2.5 Visitor, Office, and Maintenance Facilities

The existing headquarters administrative building, which is the former house for the refuge manager, is over 55 years old. It has been renovated, but still does not provide enough space and a design that accommodates the staff. The headquarters area also has a shop, equipment storage facility, and tool shed. The facilities at the existing site cannot be expanded due to the location in a narrow valley.

Geological conditions limit effective water and sewage treatment at this site as well. The water supply is heavily contaminated with iron, boron, salts, and coliform bacteria, which an elaborate water treatment system cannot satisfactorily remove. The Refuge is outside all city water districts. In addition, the building is located too close to a salmon-producing stream that drains directly to Willapa Bay, posing a serious contaminant risk. In violation of environmental regulations and the Clean Water Act, the septic tank is 100 feet away from the wetland, the leach line is only 60 feet from the wetland, and an underground waterway goes directly over the leach line. The Washington Department of Water Quality and Washington Department of Health recently designated waters in the Bay as impaired due to E. coli, which adversely impacts wildlife and the oyster industry.

The public parking lot at headquarters contains 16 car spots, nine trailer spots, and two accessible spots. Two public vault toilets are available. No running water is available to the public. A public boat launch into Willapa Bay is available directly across from the headquarters, on the west side of Highway 101.

An interpretive kiosk next to the parking lot offers directional, educational, and safety information. A temporary addition to this kiosk is also used for camping and archery permit registration during the early elk archery season. The indoor porch in the main headquarters building serves as an additional informational area with maps, pamphlets, and a collection of avian specimens.

5.3.2.6 Interpretive Trails

The Willapa Interpretive Art Trail was created to provide visitors with an opportunity to experience nature near the current office site without having to go to another area of the Refuge. Visitors to the stream can now observe wildlife from a curving, ADA-accessible boardwalk. Artwork located along the boardwalk tells the story of the stream and the many species who live there. Students from the University of Washington Public Arts Program designed, constructed, and installed the artwork for the trail under the direction of their professors. The Interpretive Art Trail is about one-quarter-mile long and leads to the Cutthroat Climb loop, which continues another two-thirds of a mile. The loop rises—and then falls—steeply, with wooden steps making the going easier in places. A few huge old-growth hemlocks are interspersed among the smaller trees. Every few dozen yards, there is a nature lesson: for example, the tracks of forest inhabitants such as deer, bear and raccoon are carved into slabs of tree trunk; metal plates can be lifted to uncover the names of the animal. Scavenger hunt worksheets are available in the Refuge office to guide youth through the trail in search of wildlife and art. The Willapa Interpretive Art Trail is open seven days a week from dawn until dusk.

The Teal Slough Trail located near the mouth of the Naselle River, supports a remnant coastal old-growth forest represented by ancient cedars, and a Sitka spruce–western hemlock/salal community. The forest provides homes for two state and federally protected species, marbled murrelets and spotted owls, as well as Dunn’s and Van Dyke’s salamanders and Vaux’s swifts and pileated woodpeckers. Deer and elk trails network the area. The Teal Slough Trail is easily accessible from Highway 101 and is approximately 0.57 mile round trip. Limited parking is available at the Teal Slough Gate.

Hiking trails at Leadbetter Point Unit at the tip of the Long Beach Peninsula allow visitors to walk through coastal woodlands, salt marshes, and beaches. Many miles of pedestrian only trails link the Leadbetter Point Unit with an adjacent Washington State Park. These trails can be flooded during the rainy season (October through May. The threatened western snowy plover nests in the area and signs are used to indicate the closed snowy plover nesting area.

Hiking trails occur throughout Long Island. A network of old logging roads converted to trails provides well over 10 miles of hiking opportunities. One of the most popular destinations is the Trail of the Ancient Cedars, a three-quarter-mile loop trail near the center of the island, which takes visitors through the northern corner of the old-growth forest. There are also five primitive campgrounds on Long Island. The Long Island trails are only accessible by boat; tidal fluctuations, currents, mudflats, and weather can make getting to and from the island difficult.

5.3.2.7Wildlife Viewing and Photography

There are many opportunities for wildlife viewing and photography along the Refuge's many trails. Biologists have recorded over 100 species of birds on Leadbetter Point. Fall and spring migrations bring dizzying concentrations of sandpipers, sanderlings, plovers, dowitchers, and other shorebirds to its shores and tideflats, while dunlin peak in the winter. Peregrine falcons and bald eagles are among the most common raptors at Leadbetter Point. Occasionally a pure white snowy owl can be seen perched on a log during winter.

The South Bay Units are also a prime location for wildlife viewing and photography, although due to the current hunting schedule and gated access, opportunity for the visiting public to view this high concentration of birds is extremely limited.

Long Island offers a multitude of opportunities to observe and photograph wildlife. High Point Meadow is a good place to observe deer and elk. Glimpses of bear are common on hikes along the trails and roads. Birds can be found both on the shores and throughout the forest.

River otters and muskrats glide quietly through the waters of the Lewis and Porter Point units. Visitors can also view wildlife within the wetland units and enjoy a sweeping view of the many waterfowl that congregate in the south end of Willapa Bay.

The Friends of Willapa National Wildlife Refuge constructed a photography blind on a seasonal freshwater wetland in the Tarlatt Unit in 2003. The best time of year to use the blind is during the winter and early spring when the wetland is full of water and feeding waterfowl. The blind is available by reservation only. In addition, the Friends of Willapa National Wildlife Refuge sponsors an annual wildlife photography contest.

5.3.2.8 Environmental Education and Interpretation

Many opportunities are available for environmental education and interpretation at Willapa National Wildlife Refuge. These opportunities range from formal lessons led by volunteers and Refuge Staff to self-led scavenger hunts along the Willapa Interpretive Art Trail.

Refuge staff and volunteers provide talks and lessons to local colleges, scouting groups, community organizations, and local schools both on the Refuge and off-site at schools or community centers. Lessons can be customized and aligned to national and state educational standards.

Over a three-day period in late spring, the Refuge hosts students from regional schools who visit educational science stations to learn more about the environment and how to be stewards of the environment. Friends of Willapa National Wildlife Refuge and the Refuge annually co-sponsor this educational event as part of the fourth-grade environmental education program. The students experience first-hand wildlife viewing, wetlands animal identification, aquatic shellfish and invertebrate identification, the amphibian lifecycle, an introduction to soil science/geology, and an appreciation for animal behavior based on interpretation of bone structure. The field trip is a culmination of a year-long program where fourth-graders learn about the Refuge System, bird basics, habitat, and local amphibian populations as refuge staff visit classrooms in multiple schools over the course of the year. All activities are aligned to Washington State Science

Learning Standards. Each classroom activity takes about one class period, approximately 45 to 55 minutes.

Interpretive information and brochures are located at the refuge office. The refuge office is open to the public Monday through Friday 8 am to 4 pm except Federal holidays. There are several information kiosks throughout the Refuge offering maps, educational materials, and regulations. The parking lots at both the Headquarters area and Leadbetter Point offer restroom facilities. The Leadbetter Point restroom is maintained by the Washington State Parks and Recreation Commission.

5.3.3 Overview of Refuge Non-Wildlife Dependent Public Uses

While several public uses are not recognized as wildlife-dependent by the National Wildlife Refuge System Improvement Act of 1997 (Public Law 105-57), camping a non-wildlife-dependent public use has been found appropriate due to specific site circumstances. Since a large portion of the Refuge consists of navigable waters and island habitat, visitors to the Refuge often use some type of watercraft to access these areas. Due to difficulty accessing Long Island during tidal fluctuations, camping is allowed in designated sites.

5.3.3.1 Boating

Boating, canoeing, and kayaking are popular activities in Willapa Bay. Tidal fluctuations, currents, extensive mud flats, and rapidly changing weather can make boating to, from, and around Long Island difficult and occasionally dangerous. Most of the campgrounds require a 6-foot or higher tide to access them; however, the landing directly across from Refuge Headquarters can be accessed at any tide. Additional launch facilities are located at the Nachotta mooring basin in Nachotta on Long Beach Peninsula.

5.3.3.2 Camping

Although most National Wildlife Refuges do not allow camping, Willapa NWR permits camping in designated spaces on Long Island due to the difficult nature of accessing the island during low tide. To minimize disturbances to wildlife and their habitats, no camping is permitted on the mainland portion of the Refuge. Mainland camping sites are available at the many area state and county parks and commercial campgrounds.

There are five primitive campgrounds on Long Island with a total of 24 campsites. Each campsite includes a picnic table and fire ring. Cutting of live trees or standing dead trees is prohibited because they provide homes for wildlife, but collection of fallen wood is allowed. To maintain the quiet, remote nature of the island, motor vehicles and power equipment are prohibited on Long Island.

Campsites are available on a first-come, first-serve basis only. Campers are required to register for specific campsites one week prior to the start of early elk archery season through the end of the early elk archery season. Registration is not required the remainder of the year. Early elk archery season generally takes place for three weeks in September, but exact dates vary. Leaving items unattended to hold a campsite is prohibited. Due to the high numbers of visitors during this period, no individual or group (maximum five people) may camp for more than 14 days during this period.

5.3.4 Impact of Illegal Uses

The most common law enforcement issues encountered in the field are trespass into closed areas, harvesting of natural resources (mushrooms, berries), hiking with dogs, waterfowl hunting violations (lead shot, hunting in closed areas, taking birds out of season, unplugged shotguns), vandalism (broken gates, defaced signs, vault toilet damage), theft (stolen gas, tools, equipment, signs), and illegal camping. Illegal uses persist partly due to limited law enforcement capability and lack of public awareness of the sensitivity of the wildlife to human disturbance. There is currently one full-time refuge law enforcement officer assigned to cover all three refuges within the Willapa National Wildlife Refuge Complex. The refuge staff coordinates internally with other Federal officers/agents and works with the U.S. Coast Guard as well as state, county, and local law enforcement offices.

5.4 Cultural and Historical Resources

A complete Cultural Resources Overview of Willapa National Wildlife Refuge was completed by Gary Wessen in 2008. Excerpts from this document are provided in the following sections. It is important to consider the cultural and historical setting of the Refuge in planning public use activities and resource management actions. Recognizing the cultural and historical resources of the Refuge would allow educational programs to enhance the public's understanding of this important aspect of the Refuge. This section briefly describes both the Native American and Euro-American occupants of the vicinity.

5.4.1 Native American Cultural History and Landscape

There can be no doubt that the Willapa Bay area once supported a considerable number of Native American people and that they continue to have a presence today. Having said this, we acknowledge that the details of early historic Native American occupation are only poorly documented and many aspects of their presence are not well understood.

Assessing the presence of native people in the Willapa Bay area during the nineteenth century is complicated by the fact that Native Americans from neighboring regions came here to work for Euro-Americans. I n the days before European settlement the shores of Shoalwater Bay were a mix of a bountiful natural environment and many native villages. The north end of bay around the present-day Shoalwater Bay Indian Reservation was populated predominantly by Lower Chehalis–speaking peoples. The southern end of the bay, near present-day Bay Center and southward, was inhabited by Willapa Chinook peoples. It has also been documented that trade and intermarriage between the two groups has been very frequent.

The most detailed information about Native Americans from the Willapa Bay area comes from Ray (1938). They had a traditional economy much like those of most Northwest Coast peoples. They were skilled fishermen, hunters, and plant-material gatherers who possessed great knowledge about the resources available in their environment. Anadromous and marine fish were the most important part of their diet and most fishing occurred in Willapa Bay, the rivers that drained into it, and in the Columbia River mouth. The material culture was also similar to that of most Northwest Coast peoples. They were skilled craftsmen and technicians who produced a wide range of goods from plant, bone, and stone materials. Shoalwater winter villages were marked by the presence of large plank houses. Cedar bark and other plant fibers were used to make a wide variety of basketry, cordage, nets, and clothing. Finally, the social and ceremonial life had much in common with that of other Northwest Coast peoples. Most types of social affiliation appear to have focused upon local lineal (family) groups, which were based in one or more winter villages. Three broad categories of social standing existed within the local groups: nobles or upper class freemen, commoners, and slaves.

An executive order signed by President Andrew Johnson created the small 355-acre Shoalwater Bay Indian Reservation on the northern shore of Willapa Bay in 1866 (Anderson 2000:1-3). While small compared to many reservations, the Shoalwater Bay Indian Reservation community has modern facilities today and is an active part of the cultural landscape of northern Willapa Bay.

5.4.2 Euro-American Exploration and Settlement

Non-Native people were first present in the vicinity of Willapa Bay starting in the late eighteenth century but were not much of a factor until after ca.1850. Since that time, they have dominated the area. This section summarizes the earliest period of exploration, the first Euro-American settlers, and more recent developments in the Willapa Bay area.

The discovery and early exploration of the Willapa Bay area occurs within the context of the search for, and subsequent use of the mouth of the Columbia River. Distracted by this nearby feature, exploration and documentation of details of the bay lagged until the mid-nineteenth century. In 1788, explorer and English trader, John Meares, observed the entrance to a large bay when sailing southward to investigate the report of a large river (Hazeltine 1957:252-254). Meares called the bay "Shoalwater Bay", Leadbetter Point "Low Point", and a prominent headland near it "Cape Shoalwater." While Meares never entered the bay, he comments:

> From the mast head it was observed that this bay extended a considerable way inland, spreading into several arms or branches to the northward and eastward. The back of it was bounded by high and mountainous land which was at a great distance to us. We had concluded this wild and desolate shore was uninhabited; but this opinion proved to be erroneous, for a canoe now came off to us from the point with a man and a boy. On their approach to the ship they held up two sea otter skins. (Hazeltine 1957:252-254).

The Lewis and Clark Expedition, which arrived from the east on the Columbia River in the fall of 1803, was the next well-documented account of the area. While they spent most of their time on the south side of the Columbia River, they briefly explored the area. William Clark and some of the party ventured north on the southern part of the Long Beach Peninsula (Coues 1893:716). Clark noted the presence of a prominent headland further to the north but never specifically mentions a large bay in the area.

The Willapa Bay area was visited briefly again in August of 1841 when representatives of the U.S. Exploring Expedition passed through the area travelling from the Grays Harbor area to

Astoria. The survey party did not map Willapa Bay, but it did canoe across the bay. The first detailed map of Willapa Bay was prepared by Lieutenant James Alden of the U.S. Coast Survey in 1852. While Alden was unable to record some details of the bay's southern end, this was the first map to accurately show its major features.

The first significant movement of settlers into the Willapa Bay area occurred after passage of the Donation Land Act of 1850. A major draw for the earliest arrivals was the oyster business, and several early entrepreneurs made a significant income by hiring Native people to collect oysters for shipment to San Francisco. By 1860, the Euro-American population of Pacific County had reach 406 (Hazeltine 1956:73). The earliest communities to be established in the bay were Bruceport and Oysterville.

Against the backdrop of early settlement, governmental organizations began to form. Pacific County was first established as part of the Oregon territory after the latter was created in 1851. It subsequently became a part of Washington Territory after the latter was created in 1853. The earliest Federal presence near Willapa Bay was at the Columbia River mouth, where fortifications and a lighthouse were present by the mid-1850s. The first lighthouse at Cape Shoalwater, at the entrance to Willapa Bay, was established in 1858.

More settlers arrived after the Civil War, but the rate of growth was relatively slow. The Pacific County population had only reached 1,645 by 1880 (Hazeltine 1956:73). The pace picked up during the 1880s, however, and it had swelled to 4,538 by 1890. While some early settlers came to the area to become farmers, it appears that most were drawn by opportunities in various pursuits that exploited the region's rich natural resources. The first interests were primarily timber and oysters, but other marine animals such as salmon and crabs became increasingly important over time.

The first railroad to reach South Bend was finished in 1892 and it also became increasingly important as a port after this time (Hazeltine 1956:117-122). As the latter trend developed, the name "Shoalwater Bay" was increasingly seen as a problem for shipping interests and the northern half of the bay began to be called "Willapa Harbor" in about 1900. Eventually, the entire bay came to be known as Willapa Bay. While much of the early transportation within the Willapa Bay was by watercraft, increased road building around the bay began to occur during the 1920s (Hazeltine 1956:157).

The principal economic activities in the Willapa Bay area during the twentieth century were much like those of the second half of the nineteenth century. Chief among them were those associated with timber, oysters, and salmon. Agricultural activities also became increasingly important in Pacific County, with the most important cultivation being cranberries. Finally, another industry that began in the late nineteenth century but did not become important until after the Second World War is tourism.

The Refuge was established in 1937 by President Franklin Roosevelt to protect migrating and wintering populations of brant, waterfowl, shorebirds, and other migratory birds and their habitats. Today, these lands preserve a rich heritage of wildlife for environmental conservation and wildlife-dependent recreation.

5.4.3 Archaeological Resources and Historic Properties

According to the Archaeological Resources Protection Act of 1979, the term "archaeological resource" means any material remains of past human life or activities. Archaeological and other cultural resource studies have been relatively limited in the Willapa Bay area, and it is very unlikely that the current inventories reflect the total number of resources that are actually present. It is important to note that one of the earliest written references to archaeological resources in western Washington comes from this region. In commenting about the Native population of the area, James Swan (1857:211-212) states:

> "The relics of old lodges, canoes, heaps of shells, and other remains, give evidence that at some period there must have been a large body of Indians around Shoalwater Bay."

According to the Wessen (2008), there are 55 recorded archaeological sites in the Willapa Bay Area, only 12 of which are located on refuge lands. Most of the sites are shell midden deposits, at least some of which contain human remains. Other types of sites include fish weirs, burial grounds, lithic sites, culturally modified trees, and historic sites. There are currently 149 recorded historic properties in the Willapa Bay area, but none of them are located on refuge lands. Most of the historic properties are existing residential or commercial structures which date to the late nineteenth or early twentieth centuries. Information on the condition of these sites is limited, and they are frequently threatened by shoreline erosion, vandalism, and development (Wessen 2008).

Project-specific archaeological surveys have also been conducted by USFWS archaeologists for refuge construction and restoration activities in compliance with Section 106 of NHPA.

5.5 Special Designation Areas

In addition to refuge status, the "special" status of lands within individual refuges may be recognized by additional designations, either legislatively or administratively. Special designation may also occur through the actions of other legitimate agencies or organizations. There is a wide variety of special land designations. Authority for designation of some special management area types (e.g., Research Natural Areas) on refuges lies solely with the Service. For most special management area types, responsibility is held by or shared with others. Refuges may also be included within much larger special management areas designated by other agencies or organizations, such as National Marine Sanctuaries. Special designation areas provide the visiting public with information on why the area is ecologically important.

5.5.1 Washington State Research Natural Area

The refuge has three state-registered natural areas that are in the RNA category. These RNAs are administered by the Service to 1) preserve examples of all significant natural ecosystems for comparison with those influenced by humans, 2) provide educational and research areas for ecological and environmental studies, and 3) preserve the genetic and behavioral diversity of native and endangered plants and animals. As directed in 8 RM 10.8, RNAs must be reasonably protected from any influence that could alter or disrupt the characteristic phenomena for which the area was established. Management practices, such as prescribed burning and chemical control of plants, may be conducted only where necessary to preserve necessary ecological characteristics.

Diamond Point RNA is an 88-acre forested area at the northern tip of Long Island that was designated an RNA in 1976. Diamond Point RNA is managed to preserve an example of second-growth Sitka spruce/western hemlock forest growing on an island in a coastal estuary for education and scientific purposes. The natural area includes 48 acres of mature red alder and 40 acres of mature Sitka spruce/sword fern forest and Sitka spruce/salal forest (Dyrnesss 1972).

Cedar Grove RNA is 264 acres of old-growth western red cedar/western hemlock/California huckleberry forest located in the southern portion of Long Island. The three-quarter-mile Trail of Ancient Cedars loops through the northern edge of the Cedar Grove RNA (USFWS 1987).

Leadbetter Point RNA, located at the northern tip of the Long Beach Peninsula, was put on the Washington Register of Natural Areas in 1989. The original designation included 1,705 acres of the peninsula tip, Grassy Island, and the marsh between the island and peninsula tip; however, the Leadbetter Point Unit is now approximately 1,742 acres due to sand accretion at the peninsula tip. The unique natural elements protected at Leadbetter Point include salt marsh, native dunegrass, lodgepole pine forest, shrub/lodgepole pine, and open beach habitats. Leadbetter Point contains high quality examples of high salinity Virginia glasswort/inland saltgrass marsh, low salinity marsh, and transition zone wetlands.

Flora associated with the marshes are of primary significance, as are the dune grassland and deflation plain communities. Pockets of native plants within the secondary dune, deflation plains, and dune troughs are also significant ecological features and are of high quality compared to these remaining plant communities elsewhere in Washington. The open beach and dune grassland communities of Leadbetter have been significantly impacted by the invasion and naturalization of two non-native dunegrasses. The salt marsh has been invaded by smooth cordgrass, an eastern salt marsh species. Efforts to control cordgrass in recent years have slowed its spread at Leadbetter Point. Selective removal or control of plant species not native to Leadbetter Point, including *Spartina*, Scotch broom, and common gorse, was an approved management activity at the time the RNA was established. Removal and control of the non-native beachgrass has been recently approved and work has been done as part of the management of habitat for the endangered western snowy plover (Caicco 1989).

5.5.2 American Bird Conservancy Globally Important Bird Areas

American Bird Conservancy's (ABC) IBA Program was launched in 1995 and has concentrated on identifying and documenting the very top sites throughout all 50 states—those of significance on a global level. The goal of the IBA program is not just to recognize the sites as important, but to mobilize the resources needed to protect them. The IBA designation is an important first step in raising awareness among the public, and among land managers, to the importance of each site and its value to bird conservation. Using objective scientific information and relying on the recommendations of experts throughout the United States, ABC has developed a list and set of descriptions of 500 of these internationally significant sites. For a site to be included, it must, during at least some part of the year, contain critical habitat that supports 1) a significant population of an endangered or threatened species, 2) a significant population of a Watch List species, 3) a significant population of a species with a limited range, or 4) a significantly large concentration of breeding, migrating, or wintering birds, including waterfowl, seabirds, wading birds, raptors, or landbirds. Parts of north and south Willapa Bay have been identified as IBAs. This designation attracts visitors to these areas for birdwatching and is an important educational tool.

5.5.3 National System of Marine Protected Areas

The national system of Marine Protected Areas (MPAs) advances the conservation and sustainable use of the nation's vital natural and cultural marine resources. Executive Order 13158 of May 26, 2000, defines an MPA as "any area of the marine environment that has been reserved by Federal, state, territorial, Tribal or local laws or regulations to provide lasting protection for part or all of the natural and cultural resources therein." The National Marine Protection Areas Center website (NOAA and DOI 2010) provides the following summary of the MPA system:

> The national system of MPAs 1) enhances protection of U.S. marine resources by providing new opportunities for regional and national cooperation, 2) supports the national economy by helping to sustain fisheries and maintain healthy marine ecosystems for tourism and recreation businesses, and 3) promotes public participation in MPA decision-making by improving access to scientific and public policy information.
>
> The purpose of the national system is to support the effective stewardship, conservation, restoration, sustainable use, and public understanding and appreciation of the nation's significant natural and cultural marine heritage and sustainable production marine resources, with due consideration of the interests of and implications for all who use, benefit from, and care about our marine environment
>
> The goals of the national system are to conserve and manage natural heritage, cultural heritage, and sustainable production. Natural heritage is the nation's biological communities, habitats, ecosystems, and processes and the ecological services, values and uses they provide. Cultural heritage is the cultural resources that reflect the nation's maritime history and traditional cultural connections to the sea, as well as the uses and values they provide. Sustainable production is the nation's renewable living resources and their habitats (including, but not limited to, spawning, mating, and nursery grounds and areas established to minimize bycatch of species) and the social, cultural and economic values and services they provide.

The Refuge is a 2009 charter member of the national system of MPAs. The site area for the Willapa MPA is 9.8 km^2 (3.8 square miles). The level of protection for the Willapa MPA is the uniform multiple-use category and its primary conservation focus is sustainable production. Uniform multiple-use offers a consistent level of protection for marine habitat and species while providing opportunities for combinations of compatible human activities such as research, education, recreation, and consumptive and non-consumptive uses. There are no site restrictions imposed by the MPA status on fishing regulations in Willapa NWR. The primary conservation focus of the Refuge is sustainable production, which recognizes management wholly or in part with the explicit purpose of supporting the continued extraction of renewable living resources (such as fish, shellfish, plants, birds, or mammals) that live within the MPA, or that are exploited elsewhere but depend upon the protected area's habitat for essential aspects of their ecology or life history (feeding, spawning, mating, or nursery grounds).

5.5.4 Presidential Proclamation Boundary

The Refuge administers the Presidential Proclamation Boundary of 1937 that closes approximately 11,000 acres surrounding and including Long Island in the southern portion of Willapa Bay to hunting, taking, capturing, or killing of migratory waterfowl or other migratory birds, or the attempt to hunt, take capture, or kill such waterfowl of other birds, or the taking of their nests or eggs.

5.6 Social and Economic Conditions

The Refuge is situated entirely within Pacific County, Washington. Pacific County is situated along the Pacific coast of western Washington, including Willapa Bay and south to the mouth of the Columbia River. It is bordered to the north by Grays Harbor County, the south by the Columbia River and State of Oregon, to the east Lewis and Wahkiakum counties, and to the west the Pacific Ocean. With 975 square miles, Pacific County ranks thirtieth in size among Washington counties. The nearest towns are located on the Long Beach Peninsula (Oysterville, Nahcotta, Ocean Park, Oceanside, Long Beach, Seaview, Ilwaco, and Chinook) and inland (South Bend, Raymond, Nemah, and Naselle).

The population of Pacific County is just over 21,000 with a density of 23.37 persons per square mile (Office of Financial Management 2009). Population growth is predicted to be less than state average, with a low estimate of 19,906 and a high estimate of 28,043 for the year 2030. According to Washington State's Office of Financial Management, Pacific County experienced a population increase by 12.6% over the decade, growing from 1990 to 1997, and then decreased at an average annual rate of 0.4% from 1997 to 2000. Between the years 2000 and 2008, Pacific County experienced a slight increase of 0.4%. Pacific County has key competitive assets for future growth: competitive land cost, reasonable property taxes, proximity to urban amenities, education and training resources, dedication to industrial growth, and gateway status for parks and recreation. Because of these assets Pacific County continues to see growth in new housing developments in the North and South County, and anticipates a slight population growth in the future. However, because of the proximity of the Refuge to population centers in the Portland/Vancouver area of northwest Oregon and southwest Washington, the Refuge can expect much greater pressure for recreational and tourism use in the future. Visitation to Pacific County is over 1 million visitor-days per year. In 2008, Cape Disappointment by itself saw 89,286 day-visits and over 92,230 overnight visits. It is likely that an increase in parks and conserved areas for recreation would increase visitations, prolong by days the duration of each visit, and proportionately increase local spending by visitors (Pacific County Economic Development Council 2009).

Table 5-3 summarizes the population and associated social statistics of Pacific County and Washington State.

Table 5-3. Selected Population and Associated Social Statistics

Population Statistics	Pacific County	Washington State
Population, 2008 estimate	21,271	6,549,224
Population, percent change, April 1, 2000 to July 1, 2008	1.4%	11.1%
Population estimates base, 2000	20,984	5,894,143
Persons under 5 years old, percent, 2008	5.1%	6.6%
Persons under 18 years old, percent, 2008	18.8%	23.5%
Persons 65 years old and over, percent, 2008	23.9%	12.0%
White persons, percent, 2008	92.0%	84.3%
African American persons, percent 2008	0.5%	3.7%
American Indian and Alaska Native persons, percent, 2008	2.6%	1.7%
Asian persons, percent, 2008	2.1%	6.7%
Native Hawaiian and Other Pacific Islander persons, percent, 2008	0.1%	0.5%
Persons reporting two or more races, percent 2008	2.7%	3.1%
Persons of Hispanic or Latino origin, percent, 2008	6.9%	9.8%
White persons not Hispanic, percent, 2008	85.7%	75.5%
Living in same house in 1995 and 2000, percent age 5+	57.0%	48.6%
Foreign-born persons, percent, 2000	6.0%	10.4%
Language other than English spoken, percent age 5+, 2000	8.2%	14.0%
High school graduates, percent of persons age 25+, 2000	78.9%	87.1%
Bachelor's degree or higher, percent of persons age 25+, 2000	15.2%	27.7%
Persons with a disability, age 5+, 2000	5,410	981,007
Housing units, 2007	14,598	2,744,069
Homeownership rate, 2000	74.8%	64.6%
Housing units in multi-unit structures, percent, 2000	7.5%	25.6%
Median value of owner-occupied housing units, 2000	$102,700	$168,300
Households, 2000	9,096	2,271,398
Persons per household, 2000	2.27	2.53
Median household income, 2007	$37,501	$55,628
Per capita money income, 1999	$17,322	$22,973
Persons below poverty, percent, 2007	16.0%	11.4%

Source: U.S. Census Bureau 2009.

Pacific County's economy is still identified as natural resource–based. Timber and tourism contribute more total value to Willapa's economy than do other key natural resources (The Willapa Alliance WISC Committee 1995). Beyond those that are natural resource–based. Key industries in Pacific County include food products manufacturing, high-tech/light manufacturing, tourism, and health care/retirement, as summarized in Table 5-4.

Table 5-4. 2009 Pacific County Economic Summary by Industry

Industries	Summary
Natural resources	• There are 12 industrial timber companies that own and harvest timber in Pacific County. These companies together have employed and/or subcontracted jobs to over 500 residents annually since 1993, providing an average annual wage of $46,881. • Fishing (which includes shellfish) is an important subsector of the income base in Pacific County, as well as the seafood supply in Washington. Half of the state's oysters, 25% of the state's crabs, 99% of the sturgeon catch, and over 10% of the salmon catch are landed in this region. The industry generates over $12 million in personal income and provides nearly 600 jobs to the local economy. • At one time, farming made up a large proportion of Pacific County's economic activity, but the last 25 years have shown steady declines in income. While the area has diverse cultivated crops and ranches, the vast majority of activity is in the cranberry industry.

Industries	Summary
Food products manufacturing	• The food processing industry accounted for an average of 45% of the manufacturing activity in Pacific County throughout the 1990s and into the twenty-first century. Pacific County has businesses throughout the county that process shellfish and oysters. • Changes continue to occur in the food processing industry in Pacific County, which is highly dependent upon favorable harvesting seasons and market prices each year for cranberries, fish, and shellfish.
High-tech/light manufacturing	• With the necessary infrastructure in place, Pacific County has begun to see interest from small light industries relocating to port properties. In 2005, the first light manufacturing of aerospace components moved to the Port of Willapa Harbor providing high tech machining and fabrication employment opportunities.
Tourism	• With its strategic location, bordered on the southwest by the Columbia River and the west by the Pacific Ocean, Pacific County offers breathtaking views of the Columbia River and the Pacific Ocean, recreational opportunities, fishing, hunting, birding, clamming and a variety of outdoor experiences. The significance of tourism to Pacific County cannot be understated. • As a gross revenue engine, tourism delivers over $90 million annually to local businesses, by any measure a huge contribution of the county's total output of goods and services. Business earnings from tourism approach $25 million annually. There are over 2,000 jobs related to or dependent on this industry.
Health care/retirement	• Pacific County's two hospitals made significant improvements or expansion of their health care facilities in recent years. With the population in Pacific County has a median age of 45.8 years, and the health care industry is an extremely important part of the social and economic picture. An estimated 650 direct jobs depend on health care while another 271 jobs exist in support of this cluster.

This summary is compiled from the Comprehensive Economic Development Strategy for Pacific County (Pacific County Economic Development Council 2009).

5.7 Environmental Consequences

In this section, we provide an analysis of the environmental consequences of implementing the alternatives described in Chapter 2. Effects addressed under this chapter include public use, hunting, fishing, wildlife viewing, photography, environmental education, interpretation, non-wildlife dependent recreation, and law enforcement. A summary of the cumulative effects from implementing the various alternatives is presented in Chapter 6.

We began this section with an assessment of the change in refuge user groups expected under each of the alternatives. Following this assessment, the effect of management actions under each alternative on each of the wildlife-dependent public uses is evaluated. In addition, opportunities for non-wildlife-dependent public uses are examined, as is the amount of illegal uses.

Adverse effects to opportunities for recreational public uses would be considered significant if a proposed action resulted in:

- Substantial displacement of a wildlife-dependent public use (more than 25% of existing activities or opportunities moved to a different area or terminated at the Refuge); or
- Substantial reduction in the quality of the wildlife-dependent experience (crowding increasing by more than 50% or substantial anticipated losses of wildlife or habitat supporting the experience).

Positive effects to opportunities for recreational public uses would be considered significant if a proposed action resulted in substantial increase to an opportunity for or quality of a wildlife-dependent public.

5.7.1 Projected Future Public Uses

As an overview to assessing the social and economic effects of Alternatives 1, 2, and 3 it is important to understand the broader context of the Refuge within the region and how recreational demand and public use is expected to change over time. A growing visitor presence on the Refuge can be expected in the future. Many of the public use opportunities currently provided at the Refuge are very popular within the state and are forecasted to attract increasing amounts of participants in the coming years.

The 2006 Banking on Nature report (Caudill 2006) focused on the employment, income, and tax revenue effects that recreational visitors to national wildlife refuges have on the economies of local regions. Additionally, it measured the impact of “ecotourism,” which was defined as large numbers of people traveling substantial distances to take part in non-consumptive uses of the natural environment. Ecotourism is on the rise around the world, and it is one method that can be used to derive economic benefits to a community from the conservation of wildlife and habitat. In 2006, 34.8 million people visited a national wildlife refuge in the lower 48 states for recreational purposes. Their spending placed nearly $1.7 billion into regional economies from sales. These sales helped employ approximately 27,000 people.

Regardless of which alternative is selected, population growth and increasing recreational demand, particularly in nature activities, are expected to increase the demand for outdoor recreation on the Refuge.

5.7.2 Opportunities for Quality Waterfowl Hunting

The Refuge’s goal for public use is to foster a connection between visitors and nature (see Section 2.4.8). Visitors will have opportunities to participate in safe, quality wildlife-dependent recreation activities located throughout Willapa NWR including waterfowl hunting. Each of the alternatives presented strive to provide a quality waterfowl hunting program in concert with other wildlife-dependent public uses and habitat programs on the Refuge. Several of these alternatives must occur in conjunction with proposed habitat management actions presented in Chapters 2, 3 and 4. No significant adverse effects to waterfowl hunting opportunities are expected under any of the alternatives presented, because none of the alternatives as presented would displace any hunting activities without offering a comparable alternative. The proposed actions common to all alternatives, which include improved signage, updated maps and hunting brochures, and increased law enforcement, would result in a positive effect on the overall hunting experience. The areas discussed in each alternative would be open in accordance with the state season for waterfowl hunting.

5.7.2.1 Alternative 1

Under this alternative, there would be no changes to the hunt program. The hunt program would continue to follow current management. The regulated goose hunt on the Riekkola Unit would occur two days a week, the waterfowl hunt on the Porter Point Unit would occur three days a week, and the waterfowl hunts on the Leadbetter and Stanley Point units would continue seven days a week. There would be no expansion of waterfowl hunting. Overall, this proposed alternative would have a neutral effect on waterfowl hunting opportunities.

5.7.2.2 Alternative 2

This alternative would change the hunt program by opening up more of the Refuge to hunting. It is important to note that this alternative is only possible when adopted in conjunction with the proposed habitat management plans of tidal restoration in the South Bay Units. The result of this alternative's implementation would be an intermediate, positive, long-term effect to the hunting opportunities on Willapa NWR.

All areas of the Refuge (excluding the Presidential Proclamation Boundary and Tarlatt Slough) would be open in accordance with the state season for waterfowl hunting. While the location of the existing temporary goose blinds would no longer exist due to the proposed tidal restoration of the area in the Riekkola Unit, the Refuge would evaluate locations for construction of several wood blinds and ensure that hunters with disabilities are adequately accommodated.

5.7.2.3 Alternative 3

This alternative would result in a limited expansion of the hunt program. The limited expansion of the hunt program in this alternative is due to the fact that only part of the South Bay Units would be tidally restored under this alternative. The result would be a minor, positive, long-term effect to the hunting opportunities on Willapa NWR.

The waterfowl hunt would have limited expansion in the Porter Point and Lewis units on the South Bay, and the regulated goose hunt would remain on the Riekkola Unit.

5.7.3 Opportunities for Quality Big Game Hunting

The Refuge's goal for public use is to foster a connection between visitors and nature (see Section 2.4.8). Visitors will have opportunities to participate in safe, quality wildlife-dependent recreation activities located throughout Willapa NWR including big game hunting. Each of the alternatives strive to provide a quality hunting program in concert with other wildlife-dependent public uses and habitat programs on the Refuge. Several of these alternatives must occur in conjunction with proposed habitat management actions presented in Chapters 2, 3 and 4. No significant adverse effects to big game hunting opportunities are expected under any of the alternatives presented, because none of the alternatives as presented would displace any hunting activities without offering a comparable alternative.

The proposed actions common to all alternatives, which include improved signage, updated maps and hunting brochures, and increased law enforcement, would result in a positive effect on the overall hunting experience. The areas discussed in each alternative would be open in accordance with the state season for big game hunting, unless otherwise noted. The headquarters area, where trails and visitor information kiosks exist, would remain closed to hunting activity for public safety.

5.7.3.1 Alternative 1

Under this alternative, there would be no changes to the hunt program. The hunt program would continue to follow current management. The big game hunting would continue on Long Island (archery only) and the mainland portion of the Refuge (excluding Headquarters area). The areas currently closed to hunting would remain closed. There would be no expansion of big game hunting. Effects to other public recreational uses are expected to be minimal due to the timing of the activities and limited duration of the hunt. The state elk hunting seasons occur when other public uses are at a minimum because they are outside the main tourist season and occur during the seasonally inclement weather. Overall, this proposed alternative would have a neutral effect on the hunting opportunities.

With no control of elk on the Leadbetter Unit of the Refuge, the herd is expected to grow. As the herd increases and outgrows the available habitat on the Refuge, they may move off the Refuge into the surrounding area in search of food. The largest economic impacts of elk are felt in the agriculture industries. Elk currently cause damage to local crops and residential landscaping. Other incidental negative economic impacts of elk include elk-vehicle collisions and damage to fences. Keeping the hunt at current levels would increase the negative impacts of a large herd to the local community.

5.7.3.2 Alternative 2

This alternative would change the hunt program by opening up more of the Refuge to hunting. The result of this would be an intermediate, positive, long-term effect to the hunting opportunities on Willapa NWR. Big game hunting would remain the same as current management except for the expanded elk and deer hunting in the East Hills and South Bay Units and a regulated elk hunt on Leadbetter Point Unit. The regulated elk hunt (permit only) is proposed for managing the herd size on the Leadbetter Point Unit.

Expansion of big game hunting, under Alternative 2, would cause minor impacts to the social and economic environment. Effects to other public recreational uses are expected to be minimal due to the timing of the activities and limited duration of the hunt. The state elk hunting seasons occur when other public uses are at a minimum because they are outside the main tourist season and occur during the seasonally inclement weather. At the Leadbetter Unit, some noise from muzzleloaders may be experienced from the public on the adjacent Washington State Parks lands, and the public may occasionally observe elk or other wildlife species flushed into the open due to hunter activity. The hiking trails and waterfowl hunting at the Leadbetter Point Unit would be closed to other users during the short muzzleloader season for safety and to reduce user conflicts, but this would be only for a limited time period and would occur when the trails are flooded due to seasonal rains. While hunting activity is not expected to increase (according to surveys described in Chapter 5); expanding hunting opportunities may result in a slight increase in hunting visitation to the area. Having an expanded elk hunt would result in slight increases to spending in the local economy. Again due to the limited scope and timing of the existing and proposed elk hunt program, all effects are expected to be minor and of short duration each year. Implementing this expanded hunt at current levels would reduce the negative impacts of a large herd to the local community.

5.7.3.3 Alternative 3

This alternative would result in a limited expansion of the hunt program. The limited expansion of the hunt program in this alternative is due to the fact that only part of the South Bay Units would be tidally restored. The result would be a minor, positive, long-term effect to the hunting opportunities on Willapa NWR. Big game hunting would remain the same as Alternative 1 but have limited expansion of elk and deer hunting in the South Bay Units and the regulated elk hunt on Leadbetter Point Unit. The regulated elk hunt is proposed for managing the herd size on the Leadbetter Point unit.

Expansion of big game hunting, under Alternative 3, would cause minor impacts to the social and economic environment. Effects to other public recreational uses are expected to be minimal due to the timing of the activities and limited duration of the hunt. The state elk hunting seasons occur when other public uses are at a minimum because they are outside the main tourist season and occur during the seasonal inclement weather. At the Leadbetter Point Unit, some noise from the muzzleloaders may be experienced from the public on the adjacent Washington State Parks lands, and the public may occasionally observe elk or other wildlife species flushed into the open due to hunter activity. The hiking trails and waterfowl hunting at the Leadbetter Point Unit would be closed to other users during the short muzzleloader season for safety and to reduce user conflicts, but this would be only for a limited time period and would occur when the trails are flooded due to seasonal rains. While hunting activity is not expected to increase (according to surveys described in Chapter 5(, expanding hunting opportunities may result in a slight increase in hunting visitation to the area. Having an expanded elk hunt would result in slight increases to spending in the local economy. Again due to the limited scope and timing of the existing and proposed elk hunt program, all effects are expected to be minor and of short duration each year. Implementing this expanded hunt at current levels would slightly reduce the negative impacts of a large herd to the local community.

5.7.4 Opportunities for Quality Fishing

The Refuge's goal for public use is to foster a connection between visitors and nature (see Section 2.4.8). Visitors will have opportunities to participate in safe, quality wildlife-dependent recreation activities located throughout Willapa NWR including fishing. There are no significant changes identified in the fishing program between the alternatives. Each alternative calls for keeping the refuge portion of Willapa Bay and the channel portion of Bear River open for fishing according to Washington State fishing regulations. The small streams on the Refuge will remain closed to fishing in all alternatives. Each alternative results in an overall neutral effect on opportunities for quality fishing experiences.

5.7.5 Opportunities for Quality Shellfish Harvesting

The Refuge's goal for public use is to foster a connection between visitors and nature (see Section 2.4.8). Visitors will have opportunities to participate in safe, quality wildlife-dependent recreation activities located throughout Willapa NWR including shellfish harvesting. There are no significant changes identified in the shellfish harvesting program between the alternatives. Each alternative calls for maintaining the two Willapa Bay Shellfish Areas (Diamond Point and Pinnacle Rock) on Long Island according to Washington State shellfish harvesting regulations.

Each alternative results in an overall neutral effect on opportunities for quality shellfish harvesting.

5.7.6 Opportunities for Visitor, Administrative, and Maintenance Facilities

The Refuge's goal for public use is to foster a connection between visitors and nature (see Section 2.4.8). Visitors will have opportunities to participate in safe, quality wildlife-dependent recreation activities located throughout Willapa NWR including having access to visitor facilities that provide information about the Refuge. No significant adverse effects are expected to the opportunities for visitor, administrative, and maintenance facilities under any of the alternatives, because none of the alternatives would displace any visitor facility access.

5.7.6.1 Alternative 1

The current visitor facilities and maintenance facilities would continue to be available under Alternative 1. Effects on access to visitor facilities would be minor, positive, long-term improvements and maintenance of the current site.

5.7.6.2 Alternative 2

Due to limitations at the current site for visitor, office, and maintenance facilities, this alternative proposes relocating and consolidating these facilities. After consideration of all refuge lands for the relocation, the proposed site for the new headquarters facility is the only area that provides adequate space and public access without compromising ecologically valuable habitat. This area is currently managed as grazed pasture. This relocation would be considered to have an intermediate, positive, long-term effect because facility enhancements in the new location would improve visitor access and opportunities.

Upon relocation, the existing headquarters area would be restored to protect, maintain, and restore habitats historically characteristic of the Willapa Bay region for the benefit of migratory birds, salmonids, amphibians, mussels, lamprey, and a diverse assemblage of other native species. The Willapa Interpretive Art Trail would remain open to the public. In addition to the existing headquarters area being restored, the Riekkola shop area would be restored as a result of the consolidation of facilities at the new headquarters.

The location of the new headquarter facilities has city water and sewage. It is closer to the population center on the Long Beach Peninsula, which would allow greater public access to Refuge visitor services. The facilities would meet LEED energy conservation and sustainability standards. The site plan combines creatively designed visitor facilities with habitat restoration efforts in an attempt to provide the visitor with a natural and educational experience. Other features of the project include picnic tables and a new interpretive trail. The interpretive trail would be along an existing road from the new visitor center to a new observation deck on the South Bay, which would offer unparalleled views of the bay and migratory birds. Overall, the new facilities location would better serve the community, improve staff productivity, conserve crucial wildlife habitat, reduce annual operations and maintenance costs, and serve as an interpretive area for approximately 150,000visitors annually.

5.7.6.3 Alternative 3

Alternative 3 proposes the same relocation and consolidation of visitor, office, and administrative facilities as Alternative 2.

5.7.7 Opportunities for Interpretive Trails

The Refuge's goal for public use is to foster a connection between visitors and nature (see Section 2.4.8). Visitors will have opportunities to participate in safe, quality wildlife-dependent recreation activities located throughout Willapa NWR including having access to interpretive trails. No significant adverse effects are expected under any of the alternatives, because none of the alternatives would displace any access interpretive trails.

5.7.7.1 Alternative 1

Only the current interpretive trails would be maintained under this alternative. This can be considered to have a negligible effect on opportunities for visitors to access interpretive trails.

5.7.7.2 Alternative 2

This alternative would maintain all current trails as well as add a new trail to the South Bay, associated with the construction of the new office/visitor facilities. The new interpretive trail would be along an existing road from the new visitor center to a new observation deck on the South Bay, which would offer unparalleled views of the bay and migratory birds. This additional trail would offer intermediate, positive, long-term effects because greater access to natural resources would be available to the public.

5.7.7.3 Alternative 3

Only the current interpretive trails would be maintained under this alternative. This can be considered to have a negligible effect on opportunities for visitors to access interpretive trails.

5.7.8 Opportunities for Quality Wildlife Observation and Photography

The Refuge's goal for public use is to foster a connection between visitors and nature (see Section 2.4.8). Visitors will have opportunities to participate in safe, quality, wildlife-dependent recreation activities located throughout Willapa NWR including wildlife observation and photography. No significant adverse effects are expected under any of the alternatives, because none of the alternatives would displace any wildlife observation or photography activities. Visitation is expected to increase under all alternatives, mostly due to population increases and the growing popularity of wildlife observation. None of the alternatives are expected to result in increased crowding or in substantial anticipated losses of wildlife or habitat supporting the wildlife viewing or photography experience.

5.7.8.1 Alternative 1

Current visitor facilities and programs would continue under Alternative 1. Effects on opportunities for wildlife observation and photography would be minor, positive, long-term improvements associated with habitat restoration and maintenance. The opportunities for self-guided wildlife observation and photography on the Leadbetter Point, Long Island, and Mainland units would be maintained.

5.7.8.2 Alternative 2

Facilities to improve opportunities for wildlife observation and wildlife photography would be upgraded and enhanced under this alternative, resulting in an intermediate, positive, long-term effect for wildlife observation opportunities and photography. All facilities and programs described in Alternative 1 would remain the same with the expansion of wildlife viewing opportunities and photography at the Tarlatt Unit. A new office, visitor center, trail, and South Bay observation deck would provide unparalleled views of the bay. With concurrent habitat improvements including tidal restoration and improved forest management proposed under Alternative 2, it is reasonable to assume that these improvements would create an increase in wildlife viewing and photography opportunities for some species.

5.7.8.3 Alternative 3

Current visitor facilities and programs would continued under Alternative 3. Effects on opportunities for wildlife observation and photography would be minor, positive, long-term improvements associated with habitat restoration and maintenance. The opportunities for self-guided wildlife observation and photography on the Leadbetter Point, Long Island, and Mainland units would be maintained.

5.7.9 Opportunities for Quality Environmental Education and Interpretation

The Refuge's goal for public use is to foster a connection between visitors and nature (see Section 2.4.8). Visitors will have opportunities to participate in safe, quality wildlife-dependent recreation activities located throughout Willapa NWR including environmental education and interpretation. No significant adverse effects to environmental education and interpretation are expected under any of the alternatives, because none would displace any environmental education or interpretive activities. None of the alternatives would result in substantial anticipated losses of wildlife or habitat supporting the environmental education or interpretive experience.

5.7.9.1 Alternative 1

Alternative 1 maintains the current programs, providing limited on- and off-site environmental education and interpretation programs. No additional programs would be added to the interpretive program under this alternative nor would any additional interpretive facilities (i.e., viewing decks, interpretive panels, and brochures) be added. Continuation of the current environmental education and interpretation program can be seen to have negligible effects on these programs because no changes would be made.

5.7.9.2 Alternative 2

All current programs described in Alternative 1 would be maintained. In addition to the current programs, the addition of the new visitor facilities on the Tarlatt Unit would allow the Refuge to offer expanded on-site environmental education. This can be viewed as having an intermediate, positive effect on educational and interpretive opportunities because the Refuge would be prepared with facilities and environmental education programming to accommodate the current and expected increase in demand for such opportunities.

5.7.9.3 Alternative 3

While a new visitor center would be added to the interpretive program under this alternative, there would be limited expansion in the programming. This can be viewed as having a minor, positive, long-term effect on educational and interpretive opportunities at the Refuge. While the new visitor center would be available to the public, the limited on-site environmental programs would not adequately serve the current and future demand for quality environmental education and interpretation.

5.7.10 Opportunities for Quality Non-Wildlife Dependent Recreation

As stated in Section 5.3.3, several non-wildlife dependent uses are acceptable at Willapa NWR due to specific site circumstances. Since a large portion of the Refuge consists of navigable waters and island habitat, visitors to the Refuge often use some type of watercraft to access these areas. Also, due to the difficulty of accessing Long Island during tidal fluctuations, camping is allowed in designated sites.

All alternatives maintain the five campgrounds with 21 campsites on Long Island. All camping regulations would remain in place. There will be a neutral effect to camping on the Refuge regardless of the alternative selected.

Boat ramp access varies under the different alternatives. Alternative 1 and 3 would keep the car-top boat access at Porter Point and would have neutral or no effect on boating. Alternative 2 would move the car-top boat access to Doman Creek on the Riekkola Unit. Although the location of the boat ramp access would change, the overall effect on boating at Willapa NWR would be neutral.

Recreation alternatives are geared toward the priority wildlife-dependent public uses. These uses include wildlife observation, wildlife photography, environmental education, environmental interpretation, hunting, and fishing. Opportunities for other public and refuge uses not considered priority public uses would be contingent on the completion of a compatibility determination and appropriate use statement for that particular use.

5.7.11 Illegal Uses

All public use alternatives include a strategy for increased law enforcement presence to ensure a safe and quality recreational experience for refuge visitors. Effects from this increased law enforcement presence will be positive, by improving the safety for visitors and protection of habitats and wildlife.

5.7.12 Effects to Cultural and Historic Resources

The Refuge's goal for cultural and historic resources states that the Refuge will protect and preserve the cultural resources of the Refuge for the benefit of present and future generations (see Section 2.4.9). Each alternative states that cultural resource sites will be protected through BMPs. Cultural resources have the potential to be directly affected by ground-disturbing activities such as facility construction or dike repairs as well as indirectly by activities that increase public access to sensitive cultural areas. These potential effects would be considered on a case-by-case basis under any alternative. Cultural resource laws and regulations will be followed, and the management of any cultural resource located will comply with Sections 106 and 110 of the NHPA.

The Cultural Resources Overview for the Willapa National Wildlife Refuge (Wessen 2008) offers management recommendations for the cultural resources of Willapa NWR. The recommendations are not meant to solely direct the management of the cultural resources but offer an initial discussion of issues that are relevant to protecting the cultural resources in Willapa NWR. The issues mentioned include obtaining a more complete inventory of the Refuge's cultural resources, addressing the erosion and vandalism issues at known sites, educating the refuge staff and public on the importance of these resources, and adopting a collaborative approach to develop a final management plan. Overall, the overview recommends improving baseline knowledge, improving the baseline knowledge, and building for the future.

As described in all alternatives, proposed activities such as wildlife observation, interpretation, photography, and environmental education, when confined to non-sensitive cultural areas, can be perceived as having a neutral effect on cultural resources, in that they result in minimal to no effect on cultural resources; moreover, public programs that include interpretation of the cultural history of the Refuge provide an educational benefit. Overall, there is a minor, positive, long-term effect to cultural resources within the refuge boundary.

5.7.13 Social and Economic Effects

Since the CCP implementation is expected to result in generally positive effects on the human environment, all proposed public use actions have little risk of resulting in disproportionate adverse effects on human health, economics, or the social environment.

The Refuge also provides an indirect economic impact to the local economy through the many recreational activities that it supports. These activities currently include wildlife observation, photography, hunting, fishing, environmental education, and interpretation. These activities will continue under any alternative, thus, the visitors that participate in these activities will contribute to the health of the local economy through the purchase of goods and services (e.g., food, lodging, fuel, equipment).

Environmental education and interpretation programs and facilities would vary by alternative with more programs and facilities being developed under Alternative 2. The addition is mostly due to projected increases in interest in interpretation and environmental education programs and the proximity of the new visitor center facilities to the community. Overall, recreational visitation is expected to be slightly higher under Alternative 2 than under Alternative 1 because of the greater emphasis in this alternative for an expanded number of interpretive and environmental education programs. As a result, Alternative 2 would result in the highest number of local jobs and have the highest degree of local economic effect stemming from the recreational expenditures of refuge visitors. Overall, Alternative 2 would result in a positive social and economic effect while Alternatives 1 and 3 would have a negligible effect and a slightly positive effect, respectively.

Future expansion of the Refuge would result in the reduction of future commercial timber harvest opportunities and the conversion of some timber lands into long term conservation status for habitats, but the impact to the overall timber production economies of Pacific County would likely be minor. Forest restoration and management practices of the younger-aged stands on the lands identified for potential acquisition would include some standard timber management practices, such as thinning (see Appendix K). The Refuge's forest management practices would change very little, if at all, from commercial forest management over the life of this plan. The lands proposed for total addition to the refuge comprise 1.6 percent of the 70 percent of Pacific County that is currently managed for long-term commercial forest production. Thus, the impact to the overall timber production economies of Pacific County would be minor.

Chapter 6
Environmental Effects

Pink sand verbena
USFWS

Chapter 6. Summary of Potential Effects and Cumulative Effects Analysis

This chapter presents a summary comparison of the environmental effects of implementing the alternatives described in Chapter 2. The effects are described at the end of each of the chapters 3 through 5, including the physical environment, habitats and wildlife, cultural, and socioeconomic resources. This chapter also presents the cumulative effects of the CCP.

6.1 Effect Ratings Description

The information used in this draft CCP/EIS was obtained from relevant scientific literature, existing databases and inventories, consultations with other professionals, and personal knowledge of resources based on field visits, and experience. The terms identified below were used to describe the scope, scale, and intensity of effects on natural, cultural and recreational resources.

- **Negligible.** Resources would not be affected, or the effects would be at or near the lowest level of detection. Resource conditions would not change or would be so slight there would not be any measurable or perceptible consequence to a population, wildlife or plant community, recreation opportunity, visitor experience, or cultural resource.

- **Minor.** Effects would be detectable but localized, small, and of little consequence to a population, wildlife or plant community, recreation opportunity, visitor experience, or cultural resource. Mitigation, if needed to offset adverse effects, would be easily implemented and successful.

- **Intermediate.** Effects would be readily detectable and localized, with consequences to a population, wildlife, or plant community, recreation opportunity, visitor experience, or cultural resource. Mitigation measures would be needed to offset adverse effects and would be extensive, moderately complicated to implement, and probably successful.

- **Significant (major).** Effects would be obvious and would result in substantial consequences to a population, wildlife or plant community, recreation opportunity, visitor experience, or cultural resource within the local area and region. Extensive mitigating measures may be needed to offset adverse effects and would be large-scale in nature, very complicated to implement, and may not have a guaranteed probability of success. In some instances, major effects would include the irretrievable loss of the resource.

Time and duration of effects have been defined as follows.

- **Short-term or Temporary.** An effect that generally would last less than a year or season.
- **Long-term.** A change in a resource or its condition that would last longer than a single year or season.

6.2 Summary of Potential Effects

Table 6-1. CCP Alternatives Summary of Potential Effects of Alternatives-Willapa NWR

	Alternative 1	Alternative 2	Alternative 3
Effects to Wildlife and Habitats			
Sitka spruce zone forests	Intermediate, positive, long-term effects with continued implementation of Forest Plan strategies for 557 acres existing forest and development of 6,178 acres second- and third-growth stands	Same as Alternative 1	Same as Alternative 1
Open water	Negligible effects from protecting and maintaining 878 acres	Negligible, long-term effects adding (0.2 acre) new open water with dike removal.	Same as Alternative 2, except even less open water would be added
Intertidal flats	Negligible effects from protecting and maintaining 4,178 acres	Minor, positive, long-term effects with 11 acres created with dike removal	Same as Alternative 2
Salt marsh	Negligible effects from protecting and maintaining 1,636 acres	Significant, positive, long-term effects from restoring 749 acres by removing dikes	Same as Alternative 2, except restore only 429 acres by removing dikes
Riverine	Minor, positive effect by improving various sections riverine habitat	Same as Alternative 1	Same as Alternative 1
Freshwater wetlands (seasonally managed)	Minor positive effects with continued water control structure and dike maintenance for 317 acres of freshwater wetlands on Tarlatt, Riekkola, Porter Point, and Lewis units	Intermediate, negative, long-term effect by removing 300 acres of constructed, highly managed freshwater wetland impoundments through restoration of salt marsh habitat (17 acres would remain on Tarlatt Unit)	Same as Alternative 2, except remove only 292 acres, (25 acres would remain on Riekkola and Tarlatt units)
Freshwater wetlands (naturally occurring)	Negligible, long-term effect from protection of 610 acres (permanent and semi-permanent naturally occurring wetlands)	Same as Alternative 1	Same as Alternative 1
Coastal dunes	Intermediate, positive, long-term effects with annual protection and habitat maintenance for 1,581 acres	Significant, positive, long-term effects with restoration 229 acres and maintenance of 121 already restored acres, within total 1,581 acres	Same as Alternative 2
Short-grass fields	Negligible effects with annual habitat maintenance of 250 acres on Riekkola and Tarlatt units	Minor, negative effects to managed plant communities with transition of short-grass fields to saltmarsh habitat on Riekkola and Tarlatt units	Same as Alternative 1.
Grasslands	Negligible effects on 33 acres with habitat maintenance of invasive species	Intermediate, positive effects with removal of non-native plants and establishment of native host plants on 33 acres for the future reintroduction Oregon silverspot butterfly	Same as Alternative 2

	Alternative 1	Alternative 2	Alternative 3
Western snowy plover (predator control)	Intermediate, negative effects due to predation on plovers	Significant, positive effects for fledgling survival with the annual removal of avian and mammalian predators as necessary	Significant, positive, short-term effect for fledgling survival with removal of avian predators; mammalian predator control would not occur
Oregon silverspot butterfly	No current management focus	Significant, positive, long-term effect with reintroduction of Oregon silverspot (after successful host plant reintroduction has been established)	Same as Alternative 2
Marbled murrelet	Significant, positive, long-term effects with continued implementation of Forest Plan strategies for 557 acres of existing forest and future expansion and management of 6,178 acres second- and third-growth stands	Same as Alternative 1	Same as Alternative 1
Effects to the Physical Environment			
Hydrology	Minor, positive effects	Intermediate, positive, long-term effects	Same as Alternative 2
Soil	Minor, positive effects	Intermediate, positive, long-term effects to soils	Same as Alternative 2
Air quality	Negligible effects	Same as Alternative 1	Same as Alternative 1
Water quality	Minor, negative effects due to current office site	Minor, positive effects to water quality	Same as Alternative 2
Surrounding land uses	Negligible effects	Same as Alternative 1	Same as Alternative 1
Effects to Educational and Recreational Opportunities			
Office-maintenance and visitor facility	Negligible effects	Intermediate, positive, long-term effect; new facility and location would improve visitor services, access, and safety	Same as Alternative 2
Wildlife observation and photography	Minor, positive, long-term effects improved with current habitat restoration and maintenance	Intermediate, positive, long-term effects; improved wildlife and habitat management actions and a new trail would increase opportunities	Same as Alternative 1
Interpretive trails	Negligible effects	Intermediate, positive, long-term effects with a new trail to the South Bay, associated with construction of new office/visitor facilities	Same as Alternative 1
Waterfowl hunting	Negligible effects	Negligible, long-term effects with estuarine restoration and expansion of the hunting area for all waterfowl throughout the South Bay salt marsh	Negligible, long-term effects with limited expansion of hunting on South Bay Units and regulated goose hunting on Riekkola Unit

	Alternative 1	Alternative 2	Alternative 3
Big game hunting	Negligible effects	Negligible, long-term effects for wildlife and habitat with an expanded elk/deer hunting program (South Bay and expanded elk hunt on Leadbetter Point Unit)	Negligible, long-term effects for the wildlife and habitat with a limited expanded elk/deer hunting program (South Bay and regulated elk hunt on Leadbetter Point Unit)
Fishing	Negligible effects	Same as Alternative 1	Same as Alternative 1
Environmental education and interpretation	Negligible effects	Intermediate, positive effects with an increase in environmental education programs with new facility and interpretive trail	Minor, positive, long-term effects due to the new visitor facilities, but there would be limited expansion in programming
Camping	Negligible effects	Same as Alternative 1	Same as Alternative 1
Effects of Land Ownership			
Cultural resource protection	Minor, positive, long-term effects for protection of sites within the current acquisition boundary	Same as Alternative 1 and protection of potential sites within expanded acquisition boundary	Same as Alternative 2
Refuge acquisition boundary expansion	Minor, positive, long-term effects if current acquisition boundary lands are completely acquired	Same as Alternative 1 and Intermediate, positive long term effects with a 6,804-acre increased acquisition boundary expansion (from willing sellers) for threatened and endangered species, wildlife, habitat and cultural resource protection.	Same as Alternative 1 and intermediate, positive effects with a 4,895-acre increased acquisition boundary (from willing sellers) for threatened and endingered species, wildlife, habitat and cultural resource protection.
Effects to Socioeconomics			
Regional economy	Negligible effects	Intermediate, positive, short-term effect due to increased operations, facilities enhancements, restoration activities and visitor expenditures	Same as Alternative 2
Recreation economics	Negligible effects	Intermediate, positive, long-term effect due to increases in operations and visitor expenditures (trail enhancements, visitor contacts)	Same as Alternative 2

6.3 Cumulative Effects Analysis

6.3.1 Introduction

Cumulative effects can result from the incremental effects of a project when added to other past, present, and reasonably foreseeable future projects in the area. Cumulative effects can result from individually minor but cumulatively significant actions over a period of time. This analysis is intended to consider the interaction of activities at the Willapa Refuge and with other actions occurring over a larger spatial and temporal frame of reference.

The Council on Environmental Quality (CEQ) regulations, which implement the provisions of NEPA, that define several different types of effects that should be evaluated in an EIS, including direct, indirect, and cumulative effects. Direct and indirect effects are addressed in the resource-specific sections of this draft CCP/EIS (Chapters 3-5). This section addresses cumulative effects.

The CEQ (40 C.F.R. § 1508.7) provides the following definition of cumulative effects: "the impact on the environment which results from the incremental impact of the action when added to other past, present, and reasonably foreseeable future actions regardless of what agency (Federal or non-Federal) or person undertakes such other actions."

It should be noted that the cumulative effects analysis has essentially been completed by virtue of the comprehensive nature by which direct and indirect effects associated with implementing the various alternatives was presented in chapters 3 through 5. The analysis in this section primarily focuses on effects associated with reasonably foreseeable future events and/or actions regardless of what entity undertakes that action.

6.3.2 Cumulative Impacts Wildlife and Habitat

6.3.2.1 Predator Management

The avian species listed as threatened under the ESA and supported by this Refuge were once more widely distributed throughout western Washington, and the sizes of the various populations throughout the region were much larger. The loss of coastal habitat, displacement of nesting areas due to increasing human use of beaches, increases in non-native predators in proximity to natural areas, and the concentration of native predators into smaller, more isolated natural areas have all contributed to significant declines in the populations of western snowy plover and streaked horned lark. The recovery plan prepared for the Federal threatened western snowy plover (USFWS 2007a), as well as the conservation plans prepared to address declines in the populations of streaked horned larks, shorebirds, and waterbirds (Kushlan et al. 2002; Page et al. 2003; Pearson and Altman 2005), all recommend predator control in the list of recovery and conservation actions that must be considered if reversal of these population declines is to be achieved. Predator management at Leadbetter Point aims to maximize adult survival and juvenile recruitment of western snowy plovers and streaked horned larks to achieve population objectives for species recovery.

Implementation of a predator management plan could result in temporary localized reduction in populations of some mammalian and native avian predators around the Refuge. In recent years on plover nesting areas elsewhere in California, Oregon, and the eastern United States., coyote and red fox were the mammalian species most affected by predator management, while crows, ravens, and gulls were the avian species most often removed during predator control actions. The removal of some raptors and lethal control of some native mammalian predators may occur on the Refuge; however, the numbers of individuals lost would be extremely low (less than one annually). Lethal removal would generally be implemented only after other non-lethal methods of behavior modification, removal, and relocation have proven to be unsuccessful. For the most part, avian predators, with the exception of corvids and some gulls, would be trapped and released into suitable habitat elsewhere, and only those avian predators that are foraging within nesting areas would be removed. Only non-native small mammals and some problem coyotes would be lethally removed. Those wildlife species requiring management because of conflicts with endangered species would be impacted by removal of a few problem individuals. The adverse effects of predator management on the local and range-wide population of the affected species would be insignificant.

A similar predator management strategy has been used in Oregon with success. Reproductive rate increases have led to an increasing snowy plover population. It is expected that predator management on the Refuge would have similar results. However, predator control alone cannot achieve the recovery goals established for these species, which is why this predator management plan is just one component of a larger overall management approach for the Refuge. The CCP/EIS for this refuge includes habitat enhancement and restoration as well as additional actions directed at reducing disturbance to sensitive species. Through this combination of efforts, the Refuge's populations of endangered and threatened species are expected, at a minimum to sustain their current sizes, and ideally to increase as these various actions are implemented.

Conclusion

Predator management would be combined with other ongoing programs to restore/improve coastal dune habitats for the benefit of shorebirds, landbirds, and native coastal plant species. The preferred action alternative proposed would represent significant positive cumulative effects for the plants and wildlife that inhabit these habitats.

6.3.2.2 Threatened and Endangered Species

It is the policy of the Service to protect and preserve all native species of fish, amphibians, reptiles, birds, mammals, invertebrates, and plants, including their habitats, which are designated, threatened, or endangered with extinction. Endangered, threatened, and candidate species that could occur on or near the Refuge include marbled murrelet, western snowy plover, and streaked horned lark. There are also endangered and threatened salmonids, bull trout, and eulachon in local marine waters, but they are not known to occur in the waterways within the Refuge; however, if present they could be temporarily affected by the estuarine restoration project. Any effects would be of short duration and inconsequential. Green sturgeon may also be found in local waters and are identified as a species of concern. The northern spotted owl, Oregon silverspot butterfly, and Pacific fisher are not known to occur on the Refuge currently, so they would not be affected by any proposed refuge management actions.

Western Snowy Plover and Coastal Dunes

The Pacific coast population of the western snowy plover is listed as threatened under provisions of the ESA. Their population has shown an overall declining trend during the last century. Reasons for this decline and the severity of threats vary by region and location, but are primarily habitat loss and degradation, and predation at nesting sites. The principal cause of habitat loss in Washington is from previous efforts to stabilize the naturally shifting sand along coastal beaches by planting invasive beachgrass. These grasses out-compete native vegetation, alter the dune ecosystem and form dense stands that reduce the amount and quality of nesting habitat for native wildlife, including the federally threatened western snowy plover and a Federal candidate species, the streaked horned lark. Implementing the restoration and protection plan for the coastal dunes would improve habitat for the western snowy plover and other native species.

Conclusion

The ongoing programs to restore/improve coastal dune habitats for the benefit of shorebirds, landbirds and native coastal plant species, in conjunction with the action alternatives proposed in this CCP/EIS would represent significant beneficial effects for the plants and wildlife that inhabit these habitats. Development of a predator management strategy would maximize adult survival and juvenile recruitment of western snowy plover to achieve population objectives for species recovery by reducing the threat posed by certain problem avian and mammalian predators.

Oregon Silverspot Butterfly

By the early 1980s, most historical populations of the Oregon silverspot butterfly were extirpated (USFWS 2001a). The last Oregon silverspot butterfly found in Washington was in 1990 on the Long Beach Peninsula (WDFW 1993). The primary cause of its decline is due to habitat loss and degradation as a result of urban development, agricultural conversion, invasive non-native vegetation, recreational off-road vehicle use, and natural succession. Direct mortality from collisions with vehicles and pesticide use are also a factors implemented in the reduction of populations. Loss of early successional meadows that support suitable conditions for the larval host plant, the early blue violet, has severely limited the amount of butterfly habitat to a handful of sites on the central Oregon coast and one site in Del Norte County, California. In Washington, most violet habitats are threatened by the presence of heavy grass thatch and invasion by woody vegetation that shade out or restrict violet growth (Pyle 1985).

Conclusion

Significant, long-term, positive effects from the reintroduction of Oregon silverspot butterfly would be achieved after successful host plant reintroduction and habitat restoration has been accomplished. Maintenance of the site will be a component of the CCP, thus affording the long-term habitat protection identified as a goal in the Oregon silverspot butterfly recovery plan.

Marbled Murrelet

According to the Recovery Plan for the Marbled Murrelet (USFWS 1997a), the major factors contributing to the threatened status of marbled murrelets include 1) loss of nesting habitats, and 2) poor reproductive success in the habitat that does remain. Marbled murrelets require suitable canopy structures primarily found in mature and old-growth forest stands for nesting. Elimination of these forests, primarily by timber harvesting and urbanization, is the principal factor contributing to the decline of the marbled murrelet and the most significant impediment to recovery of the species (USFWS 1997a). Habitat fragmentation resulting in increased densities of nest predators, and prey availability also probably limits long-term productivity and survival of the marbled murrelet. Adult mortality caused by predation, impacts from the effects of oil spills, mortality due to entanglement in fishing gear, chronic water pollution, aquaculture, and disturbance at nesting and foraging sites have also been identified as potential limiting factors.

Considering there is currently less than 1% of the original old-growth forests remaining in the overall 700,000-acre Willapa Bay watershed, the goal for the Refuge and its partners is to restore a forested landscape that is representative of past, unmanaged, landscape conditions. The natural ecological process within the low elevation coastal rainforest also supports and maintains healthy freshwater streams and the adjacent estuarine habitat of the bay. Recent scientific research concludes that it is possible to accelerate forest complexity and habitat development through the application of carefully applied silvicultural practices. Techniques such as variable density thinning, underplanting, and the placement of large woody debris (snags and downed logs) have been shown to accelerate the development of complex habitat conditions in young managed stands. Habitat manipulation around isolated legacy trees that remain in young managed forest stands also enhances the forest canopy structure required by murrelets for nesting. Such techniques can be used to promote the development of trees with nesting platforms and canopy characteristics preferred by the murrelet while also benefitting other species of concern. Access to current legacy trees suitable for nesting may also be opened up through these techniques. Techniques such as these, as well as pre-commercial and commercial thinning, would be used in restoration activities.

Conclusion

The proposed refuge acquisition boundary expansion and potential future land additions to the Refuge would contribute to the long-term, positive cumulative impacts on a variety of wildlife habitats and the water quality within the south Willapa Bay watershed. Forest management for older, more complex structured stands on this landscape is considered of critical importance for recovery of the marbled murrelet. The protection and enhancement of wildlife habitats, especially forest restoration efforts, within the proposed expansion areas would represent a cumulative benefit to the long-term conservation of marbled murrelets and other endangered and threatened species, and the overall biological diversity found on these lands.

6.3.2.3 Forest Management of Sitka Spruce Zone Forest

Refuge forests now consist of only a small amount of late-successional forest with presence of large-diameter downed logs and snags within forest habitat matrix of even-aged stands, from lands previously managed for timber production. On the Refuge, there are two primary low elevation coastal rainforest habitats: Sitka spruce forest and western hemlock–western red cedar. Through the implementation of the Forest Landscape Restoration Plan with refuge partners, the forest management strategies within the plan (see Appendix K) would accelerate the forest habitat health and productivity, provide long-term benefits for wildlife, and also help to maintain and improve the water quality of Willapa Bay. Forest management activities would take into consideration all BMPs including the protection of soils and aquatic habitats. Improving forest habitat on the Refuge would also provide for all wildlife habitats.

Conclusion

Forest management for older, more complex structured stands on this landscape is considered of critical importance for recovery of the marbled murrelet. The protection and enhancement of wildlife habitats, especially forest restoration efforts and also within the proposed expansion areas would represent a cumulative benefit to the long-term conservation of marbled murrelets and other endangered and threatened species, and the overall biological diversity found on these lands. The forest management plan strategies contribute and provide positive long-term cumulative impacts for the overall forest ecosystem.

6.3.2.4 Riverine

Riverine habitats including perennial and intermittent streams would continue to be enhanced and restored when feasible, to mimic the historic ecological processes and functions which benefit anadromous fish populations and other ecosystem-wide and riveriene-dependent wildlife. When feasible, improvements initiated would provide migration pathways for adult anadromous fish traveling to spawning grounds and juveniles traveling to the estuary and/or Pacific Ocean.

Conclusion

Riverine restoration activities contribute and provide for the positive long-term health of the riverine habitats and wildlife on the Refuge and contribute to the overall biological diversity found on these lands.

6.3.2.5 Freshwater Wetlands (Naturally Occurring)

Naturally occurring freshwater wetlands on the Refuge include an array of diverse aquatic habitats including swamps, marshes, seeps, springs, and seasonal wetlands. Also included in this category are beaver ponds, which have been constructed through dam building and maintained by these mammals in various refuge streams, creating open ponds and marshes which provide important ecological benefits to a variety of wildlife species.

Conclusion

Protection of the permanent and semi-permanent natural freshwater wetlands on the Refuge contributes to the long-term positive benefits for the wildlife which depend on freshwater aquatic habitats.

6.3.2.6 Estuarine Restoration

Estuaries and their associated mudflats, salt marshes, tidal channels, and open waters are considered one of the most productive habitats on earth. Unfortunately, estuarine habitats world-wide have been severely reduced, and water quality has been negatively affected by pollution. A large portion of historical estuarine habitat in Willapa Bay has been lost to diking, channelization, dredging, and filling. According to ONRC calculations, Willapa Bay originally contained approximately 14,620 acres of saltwater wetlands. Now there are 5,277 acres. This represents a 64% loss of estuarine wetlands (Coastal Resources Alliance 2007). As estuarine habitat has been lost, populations of associated fish and wildlife have also declined. Loss of saltwater wetland habitat is considered one of the most common limiting factors blamed for the decline of nearshore or estuarine salmon habitat.

Prior actions by the Refuge in the late 1940s and early 1950s contributed to loss of estuarine habitat in Willapa Bay. At that time, a large portion of refuge saltmarsh habitat was eliminated by diking to create pasture lands and freshwater wetlands, believed to enhance overall waterfowl use of the Refuge and increase land available for agricultural production. The dikes have substantially reduced the amount of historical shoreline habitat and serve as a barrier, reducing nutrient input to the estuary and interrupting the physical, chemical, and biological processes of the estuarine system. Small streams including Lewis Stream, Porter Point Stream and Dolman Creek do not connect directly with the estuary. Although fish ladders were incorporated into two water control structures in the dike system in 2001, anadromous fish species, including salmon, are restricted in their movements to and from spawning and rearing areas. The conversion of estuarine wetlands to freshwater wetlands and pasture by diking has removed important natural habitat for waterfowl, waterbirds, shorebirds, and salmon as well as many other estuarine-dependent species.

A major objective of the proposed refuge alternative is to restore historic estuarine habitat. According to the Coastal Resources Alliance, restoration of Willapa Bay's estuarine habitat would likely benefit a range of native marine species. Restoration of estuarine habitat would also be of value to local communities who stay here because of the quality and productivity of the marine environment (Coastal Resources Alliance 2007).

Estuarine habitat restoration is also more practical at this time with the imminent eradication of the invasive exotic smooth cordgrass (*Spartina*) from Willapa Bay. *Spartina* formerly covered a large portion (>12,000 acres) of Willapa Bay's intertidal mudflats and would have made this type of estuarine habitat restoration much more difficult. Without control, *Spartina* would have rapidly infested any additional estuarine habitat created.

The most reliable method of estuarine restoration is dike removal or breaching. Once saltwater influence has been restored to diked wetlands, natural processes are initiated that eventually lead to enhanced habitat value (Coastal Resources Alliance 2007).

Key ecosystem processes would be reinitiated when saltwater influence is restored, including tidal hydrology, cycling of organic matter, and sediment movements. New off-channel habitat would be available to fish. Organic nutrients would be added. New plant communities would establish and make organic matter and prey items available (Coastal Resources Alliance 2007). Clams, shrimp, small invertebrates, fish, birds, and mammals would use restored habitat. Breaching or removing the dikes would lead to reclamation of a portion of the historical intertidal mudflats, as well as valuable saltmarsh habitats, maximizing the availability of these habitats for wildlife resources.

Effect on Existing Habitat and Vegetation

Estuarine restoration would reduce the amount of freshwater wetland habitat on the Refuge due to the conversion of managed freshwater impoundments to estuarine habitat. Currently the impoundments contain large percentages of non-native vegetation including reed canarygrass and tussock. Also, conversion of short-grass fields to estuarine habitat would impact the existing vegetation within the fields; however, the majority of these plants are non-native species. For this reason, the negative impact to current vegetative resources from the restoration actions would be considered minor.

Effect on Waterfowl

Waterfowl use of estuarine areas in and around the Refuge has been consistently high from historical times to present. In a 1940 Willapa National Wildlife Refuge Narrative Report, the following statement was made (prior to acquisition of some of this area by the Refuge): "With this writing, this office would like to go on record as recommending that every available means known to the Service be used in holding and protecting the feeding grounds at the south end of the Refuge, at the mouth of the Bear River and known locally at Porter's Point. At the present time the area as named is the most valuable waterfowl habitat in possession of the Refuge. The area in question is not in ownership by the Service and is only protected and reserved at present by state closure. Any and all concentrations of ducks and geese in and on this refuge is at all times at this point." References to high Canada goose use of refuge tidelands were also made in a 1941 Narrative Report.

The 1944 Narrative Report states:

> It was also noted that more birds were consistently feeding around the bays, and especially Long Island's high grass tide-lands, sloughs and beaver dams and less in the fields and lakes of the Peninsula where most of the hunting of this area is done….Pintail have been unusually scarce on the lakes of the peninsula, but always could be observed on the low mud flats when the tide was low….The persistent and very important supply of food however, is from the higher grass tide lands. At every extreme high tide the birds flock on to these areas and feed on the seeds of deschampsia, carex, triglochin, Spartina and so on. Never-the-less, judging from the meat, it is still evident that they feed more on marine animal life and less on cultivated grains than do the birds along the inland flyways….The extensive beds of eel grass around the Smoky Hollow area and northwest shores of Long Island are apparently in good shape and fairly plentiful. The large flocks of brant, geese, and scoters regularly found in these areas would indicate that the eel grass is contributing an important amount of food to the migrants.

Additional references to high Canada goose use of refuge tide flats and tidal marsh areas were also made in the 1949, 1951, 1952, 1953, 1954, 1955, and 1956 Narrative Reports. The 1950 Narrative Report also made reference to high-quality waterfowl food sources in the tidelands.

Recent evidence of high goose use in refuge estuarine areas as compared to refuge pastures was collected and analyzed by Dr. Kim Patten of Washington State University and his staff. The comparative survey of migratory goose use of the two types of habitats (salt marsh at the

Refuge's Porter Point Unit and pasture lands at the Riekkola Unit) for foraging revealed greater use by geese of the salt marsh when compared to that of the adjacent managed pastures protected by dikes. Goose use of the salt marsh occurred regardless of the level of water coverage by the tides. Survey data suggests that migrating geese use salt marsh an average of 8.6 times more than the Riekkola Unit pastures (Patten et al. 2008).

Estuarine restoration of the currently diked areas would enhance waterfowl populations by restoring these important habitats.

Effect on Shorebirds

Willapa Bay hosts some of the largest concentrations of shorebirds on the Pacific Coast during their spring and fall migrations. Shorebirds also use the bay as a wintering area. Research efforts have found that many shorebird species collect in spectacular numbers at certain points along their migratory routes. These staging or stopover areas, like Willapa Bay, provide usually predictable concentrations of food resources which include small worms, crustaceans, flies, insect larvae, and other invertebrates, which help shorebirds build up fat reserves before and during their long journeys, which can reach from the Arctic to the southernmost tip of South America. Willapa Bay is a key stopover site along the Pacific Flyway (National Audubon Society 2004) and hosts hundreds of thousands of shorebirds, with dunlin and western sandpipers being the most numerous. Willapa Bay apparently meets the criteria for status as a site of international significance in the Western Hemisphere Shorebird Reserve Network, although it is not officially a site (Harrington and Perry 1995). Willapa Bay meets these criteria because it supports up to 15.5% of the Pacific Flyway population of wintering dunlin and an average of over 100,000 total shorebirds in the spring (Buchanan and Evenson 1997).

According to the Manomet Center for Conservation Sciences (Brown et al. 2000) shorebird species have declined worldwide due to loss of habitat and human disturbance at staging areas, among other factors. Restoration of additional estuarine habitat, especially tidal mudflats, would be of great value to and maximize shorebird populations in Willapa Bay. This would also increase invertebrate habitat important to shorebird populations dependent on the littoral mudflats of Willapa Bay for prey.

Effect on Fishery Resources

Estuaries provide habitat for anadromous fish to make the transition between life in saltwater and freshwater environments. Adult salmon undergo the physiological transition necessary to survive in fresh water and reach the upstream spawning beds. Juvenile salmon make the physiological transition needed to adjust to salt water. Juveniles also spend time in the estuary foraging and growing. Refuge from predators and protection from currents and high flows are also provided by estuaries. The available literature indicates that different salmon species use estuarine habitat in complex and various ways. Chinook are considered the most dependent on estuarine habitat, chum second-most dependent and coho least dependent (Coastal Resources Alliance 2007).

After more than a decade of focus on uplands and riparian habitat restoration, policy makers have broadened their attention and now seek to encompass the restoration of estuarine and near shore habitat (Coastal Resources Alliance 2007). In 1998, the Western Washington Office of the USFWS prepared a literature review of the available scientific information on salmon utilization of estuaries (Aitkin 1998). The literature review also indicated that few studies have been done to evaluate whether salmon actually use estuarine habitat that has been restored. The studies cited were cautiously encouraging; they showed evidence of extensive use of restored habitat (Coastal Resources Alliance 2007).

Reconnection of tidal channels by removing the dikes and water control structures would provide improved access and rearing habitat for resident and anadromous fish. Estuarine restoration of the currently diked areas would enhance fishery resources overall by restoring these important habitats.

Under Alternative 2, 760 acres currently consisting of managed pasture and impoundments would be restored to estuarine habitat (includes open water, intertidal flats and salt marsh). Under Alternative 3, approximately 440 acres currently consisting of managed pasture and impoundments would be restored to estuarine habitat. With the goal of unrestricted tidal exchange, historic channels currently isolated within diked areas and removed from tidal influence would be reconnected to the Willapa Bay estuary. Such an action would assist in improving and maximizing the current estuarine system and contributing to the health of the bay and associated habitats. The project would be accomplished by removal of dikes and water control structures within the Lewis, Porter Point, and Riekkola units (In Alternative 3 the Riekkola Unit would not be restored). Dikes would be removed completely to grade, and material would be removed or used to fill in the associated borrow ditch. Partial removal or breaching of dikes would not be considered as problems may result, including restricted tidal penetration and circulation, ponding, and erosion (USFWS 2004b).

These efforts would concentrate on restoration of functional processes including tidal influences, sediment delivery, native vegetative communities, and channel networks. These processes would be instrumental to accomplish associated restoration of historical geomorphology and hydrodynamics. This action would also reduce or eliminate the extent of a highly invasive exotic plant, reed canarygrass, which currently infests the Refuge's freshwater impoundments. Tussock infestation would also be reduced. Other exotic species, including nutria and bullfrogs, which currently use the freshwater impoundments, would be eliminated by restoration of estuarine habitat. Juvenile salmon habitat would be restored and other expected benefits include increased waterfowl, waterbird, and shorebird use. Protection and restoration of native estuarine and nearshore habitats is a major ecoregional and recovery goal in the Pacific Northwest Coast Ecoregional Assessment (Vander Schaaf et al. 2006) and the Northern Pacific Coast Regional Shorebird Management Plan (Drut and Buchanan 2000).

Successful estuarine restoration typically depends on recreating a fully functional tidal system, where the tidal prism or volume is sufficient for full tidal inundation in the restored area with each tidal cycle. Natural patterns in tidal flushing and circulation are critical to flush soils, carry nutrients and sediments to all parts of a restored site, and create the intricate system of tidal channels that feed a salt marsh. Conversely, tidal waters must be able to evacuate the site, to avoid ponding and fish entrapment. Excessive ponding would create lagoon-like or subtidal conditions, rather than a salt marsh. Isolated ponding can create artificially high salinities in water or soils due to evaporation and lack of flushing. Successful estuarine restoration also depends on the ability of sediments to reach the restored site, to accumulate soils and build the elevations necessary to grow salt marsh vegetation (USFWS 2004). Saltmarsh plants require a narrow range of elevations in order to be able to successfully colonize an area. This would be taken into consideration when planning restoration activities.

Currently a project is underway to determine engineering needs for the project including the amount of dike material to be removed and the capacity of the borrow ditch as well as bathymetry within the impoundment area. Partners in this project include the Willapa Bay Regional Fisheries Enhancement Group.

Conclusion

Combined with other ongoing programs to restore/improve estuarine habitat in the coastal region for the benefit of salmonids, shorebirds, waterfowl, and other estuarine species, the estuarine restoration actions proposed in Alternatives 2 and 3 would represent significant positive cumulative effects for the fish and wildlife that use these habitats.

6.3.2.7 Refuge Acquisition Boundary Expansion

Low-elevation coastal rainforest habitats, such as those small old-growth stand fragments found in the south Willapa Bay watershed, only occur in a few regions of the world. The Refuge contains portions of the typical habitats found in and around Willapa Bay and includes a rare 274-acre remnant forest stand of old-growth western red cedar located on the Long Island Unit of the Refuge. Nearly all of the Refuge's forested areas can be considered small in size. This limited size reduces the ability of the Refuge to provide landscape-level benefits such as a greater level of watershed and water quality protection and safeguards to sensitive habitats and species which may be considered somewhat compromised by the patchwork effect of the wide range of predominantly young forest stand age classes.

Considering there is currently less than 1% of the original old-growth forests remaining in the overall 700,000-acre Willapa Bay watershed, the goal for the Refuge and its partners is to restore a forested landscape that is representative of past, unmanaged, landscape conditions. The natural ecological process within the low elevation coastal rainforest also supports and maintains healthy freshwater streams and the adjacent estuarine habitats of the bay.

Under Alternative 2, the land acquisition boundary would be adjusted to include 1,909 acres in the Nemah/Naselle areas, 561 acres in the South Bay, and 4,334 acres in the East Hills. This additional expansion is designed to provide maximum protection of the watershed and habitats adjacent to Willapa Bay and the current refuge boundary. This expansion effort, in comparison with Alternative 3 and the current boundary, would maximize the opportunities for forest restoration efforts in a holistic landscape and ecosystem manner. Alternative 3 would expand the boundary to include lands directly adjacent to Willapa Bay (561 acres would be acquired in South Bay and 4,334 acres in the East Hills) and the Refuge. Under both Alternatives 2 and 3, the Shoalwater Bay and Wheaton units would be divested from the Refuge.

The proposal to expand the refuge acquisition boundary would also provide the opportunity for Service staff and their partners to increase studies and monitoring of native wildlife and their habitats. As necessary, Service staff and partners would restore habitats where appropriate while protecting important populations of endangered and threatened species and many other native plants and animals. In addition, the action alternatives would offer greater watershed protection by preventing erosion and contamination associated with potential development or timber harvesting activities. By expanding the refuge acquisition boundary, the action alternatives would complement other regional habitat acquisition and/or protection projects or programs.

Conclusion

The proposed refuge acquisition boundary expansion and potential future land additions (from willing sellers only) to the Refuge would contribute to the long-term, positive cumulative impacts on a variety of wildlife habitats and the water quality within the Willapa Bay watershed. The protection and enhancement of wildlife habitats within the proposed boundary expansion areas would represent a cumulative benefit to the long-term conservation of endangered and threatened species and the overall biological diversity found on these lands.

6.3.2.8 Refuge Programs, Facilities, and Cultural Resources

Wildlife-dependent Recreation

Expanded Elk and Deer Hunting

Hunting affects other wildlife-dependent recreation opportunities in a variety of ways. Many non-hunters plan their vacations or visits to avoid being on a refuge during hunting seasons. In general, refuge visitors tend to seek out areas that offer amenities such as trails, parking areas, and information kiosks, as are available at the Headquarters Unit and the Leadbetter Point Unit. The majority of the wildlife-dependent recreational use on the Refuge occurs during the spring and summer months when elk and deer hunting does not occur. The Headquarters Unit, which receives a greater numbers of visitors, is not open for hunting.

Regional and state-wide hunting opportunities are determined by the Washington State and are based upon a regulatory-setting process that involves state monitoring of big game wildlife populations. Current harvest levels for elk and deer and hunting seasons are set and regulated by WDFW. The refuge staff works with WDFW on an annual basis to identify hunting opportunities that are to be continued in concurrence with the state biologists.

Considering the national trends in overall sport hunting participation (as outlined in Chapter 5), participation in hunting is not likely to increase and may, in fact, decrease.

The Refuge currently has 8,020 acres available for big game hunting. Each of the alternatives proposes to continue the current big game and waterfowl hunting programs. In addition, hunting opportunities would be expanded with the proposed boundary expansion under Alternatives 2 and 3. Complete details regarding the expanded hunt opportunities can be found in Appendices C and M.

There is the potential that hunting could detract from the enjoyment of non-hunters. Overall, the hunting on the South Bay Units or on Leadbetter Point Unit for waterfowl would not be expected to increase. The limited number of hunters in those areas most likely would not create the potential for conflicts between non-hunters and hunters. Hunting for big game and waterfowl already occurs, and would continue to occur, on private lands, state-owned tidelands in the bay, and on the Long Island Unit for big game. Also, hunting occurs during late fall and early winter when other recreational use is at a minimum.

Conclusion

Elk and deer hunting in Washington State is based upon a regulatory-setting process that involves state monitoring of big game wildlife populations. Current harvest levels and seasons are set and regulated by WDFW. Expanding hunting opportunities on the Refuge is not expected to have an effect on either harvest levels or the overall populations of either deer or elk. The Refuge's role in the cumulative impact of elk or deer harvest, even solely on a statewide basis, is insignificant.

The cumulative effects of additional elk and deer hunting on other wildlife-dependent recreation would be minimal. We conclude that the impacts to other public uses would be minimal due to the seasonal timing of this activity and the duration of the hunting periods. Despite elk and deer hunting opportunities throughout the region and locally, there are abundant opportunities for the public to view elk and deer. Hunting on the Refuge could result in some minor disturbance to other wildlife, which would be temporary and localized and result in negligible effects to non-hunted wildlife.

Fishing

The Refuge surrounds much of south Willapa Bay and has coastal beaches yet it is not considered a prime a fishing location. Public and commercial oyster and clam beds reside in Willapa Bay along with public and commercial fishing and crabbing. Fishing is not permitted on the Refuge's non-tidal streams or interior sloughs.

Conclusion

The Refuge provides some fishing opportunities the location is not considered optimal for game fish. The long-term effects to fish and shellfishing on the Refuge are negligible.

Environmental Education and Interpretation

Visitors have opportunity to participate in safe, quality wildlife-dependent recreation activities including environmental education and interpretation. The Refuge hosts students from regional schools who visit educational science stations on the Refuge to learn more about the environment and how to be stewards of the environment. Annually (co-sponsored with the Friends of Willapa Refuge), this educational event is part of the fourth-grade environmental education program. With the proposed expansion of the Visitor/Administrative facility it is expected that the environmental education and interpretation programs would be improved and activities increased by having the expanded building and trail access to the bay.

Conclusion

With the improvements to facilities, there may be an increase in demand for environmental education and interpretation programs on the refuge. Facilities expansion is expected to have a positive long-term effect on the overall environmental education and interpretation on the Refuge.

Camping

Camping has been found an appropriate activity on the refuge for locations on Long Island only, which is due to the difficult nature of accessing the island because of the tidal cycles. There are five primitive campgrounds on Long Island with a total of 21 campsites. A maximum of five campers are permitted at each campsite and limited to a maximum stay of 14 days. To maintain the quiet, remote nature of the island, motor vehicles and power equipment are prohibited on Long Island.

Conclusion

Allowing camping on Long Island with limits on the number of individual campers per site and a limit for the length of stay provides an opportunity for wildlife-dependent public use activities to occur on the island and protection of Refuge resouces. Regulated camping activities would have negligible long-term effects on the habitats.

Waterfowl Hunting

Migratory game birds are those bird species so designated in conventions between the United States and several foreign nations for the protection and management of these birds. Under the Migratory Bird Treaty Act (16 U.S.C. 703-712), the Secretary of the Interior is authorized to determine when “hunting, taking, capture, killing, possession, sale, purchase, shipment, transportation, carriage, or export of any...bird, or any part, nest, or egg” of migratory game birds can take place and to adopt regulations for this purpose. These regulations are 1) written after giving due regard to “the zones of temperature and to the distribution, abundance, economic value, breeding habits, and times and lines of migratory flight of such birds;” and 2) updated annually (16 U.S.C. 704(a)). This responsibility has been delegated to the USFWS as the lead Federal agency for managing and conserving migratory birds in the United States.

Acknowledging regional differences in hunting conditions, the USFWS has administratively divided the nation into four flyways for the primary purpose of managing migratory game birds. Each flyway (Atlantic, Mississippi, Central and Pacific) has a flyway council, a formal organization generally composed of one member from each state and province in that flyway. The Refuge is within the Pacific Flyway and allows hunting for ducks, geese, coots, and snipe.

The USFWS annually prescribes frameworks, or outer limits, for dates and times when hunting of migratory birds may occur and the number of birds that may be taken and possessed. These frameworks are necessary to 1) allow state selections of seasons and limits for recreation and sustenance; 2) aid Federal, state, and Tribal governments in the management of migratory game birds; and 3) permit harvests at levels compatible with population status and habitat conditions. Because the Migratory Bird Treaty Act stipulates that all hunting seasons for migratory game birds are closed unless specifically opened by the Secretary of the Interior, the USFWS annually promulgates regulations (50 C.F.R. Part 20) establishing the frameworks from which states may select season dates, bag limits, shooting hours, and other options for each migratory bird hunting season. The frameworks are essentially permissive in that hunting of migratory birds would not be allowed without them. Thus, in effect, Federal annual regulations both allow and limit the hunting of migratory birds.

The process for adopting migratory game bird hunting regulations, documented in 50 C.F.R. Part 20, is constrained by three primary factors. Legal and administrative considerations dictate how long the rulemaking process would last. Most importantly, however, the biological cycle of migratory game birds controls the timing of data-gathering activities and thus the dates on which these results are available for consideration and deliberation. The process of adopting migratory game bird hunting regulations includes two separate regulations-development schedules, based on "early" and "late" hunting season regulations. Early hunting seasons pertain to all migratory game bird species in Alaska, Hawaii, Puerto Rico, and the Virgin Islands; migratory game birds other than waterfowl (e.g., dove, woodcock); and special early waterfowl seasons, such as teal or resident Canada geese. Early hunting seasons generally begin prior to October 1. Late hunting seasons generally start on or after October 1 and include most waterfowl seasons not already established. There are basically no differences in the processes for establishing either early or late hunting seasons. For each cycle, USFWS biologists and others gather, analyze, and interpret biological survey data and provide this information to all those involved in the process through a series of published status reports and presentations to flyway councils and other interested parties.

Because the USFWS is required to take the abundance of migratory birds and other factors into consideration, it undertakes a number of surveys throughout the year in conjunction with the Canadian Wildlife Service, state and provincial wildlife-management agencies, and others. To determine the appropriate frameworks for each species, the USFWS considers factors such as population size and trend, geographical distribution, annual breeding effort, the condition of breeding and wintering habitat, the number of hunters, and the anticipated harvest. After frameworks are established for season lengths, bag limits, and areas for migratory game bird hunting, migratory game bird management becomes a cooperative effort of Federal and state governments. After USFWS establishment of final frameworks for hunting seasons, the states may select season dates, bag limits, and other regulatory options for the hunting seasons. States may always be more conservative in their selections than the Federal frameworks but never more liberal. Season dates and bag limits for national wildlife refuges open to hunting, including the Refuge, are never longer or larger than the state regulations.

NEPA considerations by the USFWS for hunted migratory game bird species are addressed by the programmatic document, Final Supplemental Environmental Impact Statement: Issuance of Annual Regulations Permitting the Sport Hunting of Migratory Birds (FSES 88-14), filed with the U.S. Environmental Protection Agency on June 9, 1988. A Notice of Availability was published in the Federal Register on June 16, 1988 (53 FR 22582), and a Record of Decision was signed on August 18, 1988 (53 FR 31341). Current-year NEPA considerations for waterfowl hunting frameworks are covered under a separate Environmental Assessment, Duck Hunting Regulations for 2006-07, and an August 24, 2006, Finding of No Significant Impact. Further, in a notice published in the September 8, 2005, Federal Register (70 FR 53376); the USFWS announced its intent to develop a new supplemental environmental impact statement for the migratory bird hunting program. Public scoping meetings were held in the spring of 2006, as announced in a March 9, 2006, Federal Register notice (71 FR 12216).

With regard to the effects of the Refuge's current harvest of migratory birds, the impacts of continuing the recreational hunting program (Alternative 1) would be negligible. There are an estimated 75 visitor days devoted to migratory bird hunting. As hunting conditions for ducks are less than ideal on the Refuge, with many hunts having no harvest, the estimated daily harvest is approximately 1.75 ducks per hunt. There are on average 118 hunting visits devoted to geese each year, with a success ratio of 1 goose per visit due to the poor success rate of pass-shooting more than one-quarter-mile removed from the river. Snipe hunting is virtually non-existent on the Refuge. Considering the national trends in hunting participation, these numbers are not likely to increase and may, in fact, decrease.

The State of Washington's five-year average (2001-2005) harvest of ducks, geese, and doves was 394,821, 48,140 and 73,108 birds, respectively (516,069 total). This includes harvest on other national wildlife refuges, other public lands and waters, and private lands. Annual snipe harvest rates vary considerably throughout the state and have ranged from 879 to 164,595 birds taken statewide within the past 10 years. In comparison with statewide harvests, the harvest of migratory birds on the Refuge is minimal and represents <1% of the statewide harvest.

Conclusion

The Refuge's role in the cumulative impact of migratory bird harvest, even solely on a statewide basis, is negligible.

Likewise, the indirect effects of harvesting migratory birds on the Refuge are negligible, as there are no known significant correlations between the population sizes of these species and other refuge resources. Some birds are taken by coyotes, bald eagles, and other raptors; however, the slight fluctuations in population sizes from hunting would have no effect on predatory species. Further, the areas frequented by eagles such as the Presidential Proclamation Boundary, are closed to hunting. Eagles foraging for waterfowl in these areas would not be impacted by hunting due to the spatial separation from hunting areas. This, added to the hunting regulations described earlier (e.g., non-toxic shot requirement), would protect eagles.

Discontinuing recreational hunting program would, likewise, have no significant cumulative physical effects, although the social impacts could be significant.

Visitor/Administrative Office and Maintenance Facility (with additional trail and boat launch)

The proposed Refuge Office/Maintenance and Visitor Information Center on the Tarlatt Unit is intended to serve as the primary office headquarters and information center for visitors seeking information, education, and interpretation opportunities related to the Refuge. The Refuge is expected to attract 150,000 visitors per year, and this new facility would be open during office hours and depending on staffing and volunteers possibly open on weekends. The proposed site of the office complex would improve visitor access to the office staff. The site would utilize approximately 10 acres of grassland, short-grass fields, and wetlands on the Tarlatt Unit. We are not aware of any additional county or local expanded public use initiatives in the area. Measures would be implemented to mitigate all wetland impacts to any site selected.

If the new facility is established, the decommissioning of the former office and maintenance facilities/sites habitats would be restored to historic values for wildlife. Priority wildlife-dependent public use opportunities would increase with the establishment of new public facilities (trail, car-top boat launch, interpretive exhibits) improving access to view the South Bay and its wildlife resources. By maintaining one location for the Refuge facilities and restoring all other sites, there would be long-term positive beneifits for soils in these areas. Protection measures would be incorporated into all site plans to reduce or eliminate loss of site soils and or impacts to wetland habitats.

Conclusion

Cumulative impacts involving the public use program would offer an overall long-term positive improvement in the amount of on-site environmental education and wildlife-dependent recreation opportunities available to the public in south Willapa Bay. Priority public use opportunities could increase and would improve with the establishment of new public information facilities and access. These improvements would also help address the adverse effects that may result as the human population continues to increase in the region and visitation grows over time (see Chapter 5)

During construction of the proposed new headquarters facility, soils would be disturbed to form graded surfaces and adequate foundations for proposed buildings and paved areas. BMPs during construction would be implemented to reduce erosion and soil compaction to areas outside the facilities construction zone, trail, and boat launch.

6.3.2.9 Air Quality

The restoration activities proposed may result in a slight temporary increase in vehicle emissions due to the proposed estuarine restoration, forest restoration, and construction activities identified in the plan. Once completed there would be no need for further active management with equipment on these lands. A slight increase in vehicular emissions could be expected due to an increase in visitation with the proposed construction of a visitor/administrative facility. Indirect benefits could occur with efforts to strengthen environmental education programs.

Conclusion

Negligible effects are expected for the long term for air quality and may be offset by environmental education programs on the Refuge.

6.3.2.10 Water Quality

With the proposed actions, the overall water quality, water chemistry, temperature, and risk of contaminant release would remain unchanged. Some localized, short-term effects might occur associated with various construction activities, although they would be offset by implementing BMPs and would be temporary and localized. Long-term changes in the amount of freshwater impoundments would change.

Conclusion

Some minor negative impacts are expected to freshwater wetland impoundments transitioning with minor long-term positive effects transitioning to estuarine aquatic habitats. Long-term water quality would remain the same.

6.3.2.11 Surrounding Land Uses

Land uses would change with the refuge boundary expansion (upon acquisition from willing sellers) on 6,804 acres, resulting in a change away from commercial forest production to managed forest harvest activities needed for long-term ecological forest restoration.

With the proposed Visitor/Administrative and Maintenance Facility, the change would consolidate and provide a more centralized location for refuge facilities. Allowing for roadway/sidewalk improvements that could include a southbound left-turn land and a northbound right-turn lane at required driveway access points onto Sandridge Road.

Conclusion

Surrounding land use changes with the proposed boundary expansion and refuge vicinity would provide negligible cumulative affects overall to the region.

6.3.3 Other Wildlife Management Actions within the Willapa Bay Watershed

In addition to the Service, other conservation agencies and groups that manage and protect habitat in the area include TNC, The Friends of Willapa NWR, Washignton State Parks, WDNR, and WDFW. Impacts to area habitats resulting from the enhancement of rivers, streams, wetlands, forests, and managed upland/grassland habitats would result in an overall long-term benefit to a wide variety of native birds and animals.

TNC and the Refuge have developed a landscape level forest restoration plan for the south Willapa Bay lands they manage (See Appendix K).

Locally the economic benefit to the overall health of Willapa Bay would be enhanced by the habitat enhancement/protection efforts and potential growth of the Refuge. The mariculture industry has been an economic mainstay of the area for over 100 years; the south Willapa Bay economy would potentially benefit from an expanded Refuge by enhancing protection of the watershed and restoring the forests.

Increased visibility of the new refuge headquarters, enhanced interpretation and educational materials, and the associated new trail expansion would potentially increase visitation/tourism to the community and enhance economic benefits as well.

6.3.4 Potential Beneficial Cumulative Effects

All alternatives could result in beneficial cumulative effects on the local economy. An increase in visitation to the Refuge would have a slight beneficial effect on the local economy. This beneficial effect would also affect the economy in an additive manner, when combined with other economic impacts in the region, such as increased tourism not associated with the Refuge.

6.3.5 Potential Irretrievable and Irreversible Effects

The restoration of historic estuarine habitat necessitates the removal of all or portions of dikes and the conversion of some human-made artificial freshwater wetlands under all action alternatives. Although it would be possible to reconstruct the dike system and re-establish freshwater wetlands, this would be unlikely to occur once estuarine habitat is restored.

Establishing new concentrated areas of public use, including the construction of additional parking lots and office/visitor/maintenance facilities, may result in irreversible and irretrievable effects on resources, such as a reduction in biological resources in the vicinity of the public use areas. Implementing BMPs would limit the likelihood of potential irretrievable and irreversible effects on biological and potential cultural resources.

Alternatives 2 and 3 focus on concentrating public use areas and facilities in a common area, localizing any potential irretrievable and irreversible effects; these effects would be mitigated by focusing development of public use facilities in areas with no or few natural or cultural resources. Specifically, implementation of the following reasonable foreseeable actions may result in the irretrievable and irreversible commitments described below.

- The office/visitor/maintenance facility complex would require approximately 10 acres and would be offset by restoring habitats on the previous office and maintenance facilities which are scattered around the Refuge.
- Approximately a quarter-acre would be needed for the car-top carrier boat launch and small parking area on Doman Creek.
- A 1-mile-long trail to the South Bay overlook would have a minimal footprint, yet the visitation on this trail would create localized temporary disturbance to wildlife in the vicinity.

6.3.5.1 Implementing Elk and Deer Hunting

An expanded elk and deer hunting program could be implemented or halted fairly quickly, and the limited impacts of any direct effects of hunting (e.g., wildlife or habitat disturbance, public use conflicts) could be reversed either through halting the individual hunt program, and/or limiting the hunting permits issued. There are no irreversible commitments of resources.

6.3.5.2 Implementing Predator Management (Leadbetter Point Unit)

The predator management program would be conducted under close biological scrutiny and monitored routinely. Predators would only be managed on an as needed basis. Western snowy plover nesting areas are already off limits to the public, and direct effects to public use are not expected. There are no irreversible commitments of resources.

6.4 Short-term Uses and Long-term Productivity

The No Action Alternative (Current Management) would not effectively maintain or improve long-term productivity of refuge resources discussed in the CCP.

All of the action alternatives are focused on the long-term enhancement and expansion of habitat for native species. The preferred Alternative 2 would be most effective at enhancing the long-term productivity of the Refuge and local ecosystem, south Willapa Bay watershed and contribute toward the maintenance and recovery of native fish and wildlife populations.

There would be loss of freshwater wetlands from the conversion of this artificial habitat to estuarine habitat, if additional freshwater wetlands cannot be acquired at the same time and rate. In the longer term, with refuge boundary expansion under the action alternatives this could result in acquiring and then establishing more naturally functioning habitats that provide long-term benefits to the fish and wildlife species. There is potential for additional stream and freshwater wetlands within the proposed boundary expansion area.

Short-term management activities that enhance long-term productivity within the Refuge are primarily related to ongoing forest habitat restoration, ongoing dune restoration management, and artificial freshwater wetland restoration with dike removal.

The following habitat restoration activities would be undertaken under all alternatives.

- Forest Plan implementation: thinning techniques, road decommissioning, forest plantings.
- Vegetation removal—usually invasive species—through chemical or physical means (e.g., mowing, discing, chopping) for dune maintenance, grassland maintenance, and necessary invasive species removal.

The short-term effects of these activities would include temporary effects on aesthetics, connectivity, and localized wildlife use of the project sites. Over time, impacts from the various alternatives are expected to have a positive effect on the refuge resources and wildlife.

The effects for proposed hunting elk at the Leadbetter Point Unit would be temporary and short in duration. Construction and restoration activities would also be temporary. However, new or improved opportunities would be provided as part of the preferred Alternative 2, providing overall improvements in the programs.

6.5 Unavoidable Adverse Effects

The preferred Alternative 2 would result in refuge restoration activities that would change the current artificial freshwater impoundments to a natural estuarine environment.

Relatively common wildlife species depend solely or largely on these freshwater wetland habitat and would be most affected by these reductions in this habitat type. The proposed restoration of estuarine habitat would provide very positive overall environmental effects and would benefit other affected species and many more species like salmonids, that are higher priority to recover or maintain. Freshwater wetland acreage would be depleted within the diked area; however, improved natural saltmarsh habitat would provide other wildlife benefits, and the potential refuge acquisition expansion may provide additional opportunities to increase the overall amount and quality of freshwater wetlands in the Willapa Bay watershed. Changes proposed in the public use program may have some site-specific adverse effects such as construction projects (trail, boat launch, building facilities, and hunting programs) which may increase visitation and temporarily displace wildlife. Improved habitat and species monitoring would be undertaken as part of the preferred alternative and would assist refuge staff in adapting management approaches to maximize resource benefits under all actions.

Appendix

Headquarters stream
USFWS

Appendix A. Draft Land Protection Plan

U.S. Department of the Interior
Fish and Wildlife Service

Land Protection Plan

Willapa National Wildlife Refuge

Pacific County, Washington

Prepared by:

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APPENDIX A

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A.1 Introduction

The U.S. Fish and Wildlife Service (Service) has prepared this Land Protection Plan (LPP) in conjunction with the Draft Comprehensive Conservation Plan and Environmental Impact Statement (CCP/EIS) for the Willapa NWR.

Alternative 2 has been identified in the Draft CCP/EIS as the preferred alternative for the long-term (15-year) management plan for the refuge. This LPP is one component of the 15-year plan, which identifies LPP project details. Information regarding habitats and wildlife, as well as public and economic uses and the effects of the LPP are further described within Chapters 1 through 5 of the CCP/EIS.

Identified in this LPP is a description of the proposed LPP, land and habitat protection methods, and a priority listing of lands to be considered for acquisition within the proposed boundary and/or current approved boundary.

Reference maps which identify the alternatives can be found within the CCP. Tract maps are provided within the LPP.

A.2 Project Description

Situated in the South Willapa Bay Watershed of Pacific County, Washington, the proposed South Willapa Bay Addition encompasses three distinct areas: Nemah/Naselle, East Hills, and South Bay (see Map 1). Combined, these areas total 6,804 acres. The nearest cities to these areas are Ilwaco, Long Beach, and South Bend.

A.2.1 Nemah/Naselle Area

The Nemah/ Naselle area encompasses 1,909 acres (three land ownerships). The areas are located slightly north and east of the Long Island Unit on the mainland and most of these properties are found directly adjacent to the bay. Highway 101 is east of this area. In general this area is upland forest habitat which can be described as a very young, less than 20-year-old monotypic Sitka spruce forest. This forested unit contains many small seasonal streams and drainages that flow directly into Willapa Bay and many gravel logging roads bisect this area. The current preferred alternative in the draft CCP/EIS includes restoration of forest habitat within the Nemah/Naselle area and would include road decommissioning and forest restoration management practices that would improve and protect the water quality of the bay important for many species such as juvenile salmon and shorebirds.

A.2.2 East Hills Area

The East Hills area encompasses 4,334 acres (six land ownerships) located west of the Bear River Ridge and east of highway 101. This is the largest area being proposed in the CCP/EIS acquisition boundary expansion. The area follows the Bear River watershed boundary from the crest of the Bear River ridgeline leading toward the west and connecting with current Refuge Bear River Unit. This East Hills area strategically connects The Nature Conservancy property, which lies on the eastside of the Bear River ridgeline. Connection of the two forests would provide the landscape-scale habitat restoration and protection opportunities (see Map 1). The current patchwork of upland forest age classes is evident in this area: newly harvested timber units (clear cuts) to well-established second- and third-growth forest stands. The area has a large number of gravel roads, which bisect small streams and drainages. Restoration opportunities would also include decommissioning old gravel roads and restoring fish passage as appropriate.

A.2.3 South Bay Area

The South Bay area encompasses 561 acres (five land ownerships). The ten surrounding upland units that make up the 561 acres are considered upland forest habitat, and over half of these acres have been utilized for timber purposes within the last five years. The area is bordered by refuge wetlands to the north; historically this area was diked and developed into the intensively managed wetlands and grasslands. The CCP proposes to remove the Refuge's artificial dikes adjacent to the upland forested area and promote tidal function of the historic estuarine habitat. Future acquisition of the upland area adjacent to the current refuge lands would provide an easily managed/recognized refuge boundary. Forest habitat restoration within the area would include road decommissioning and forest restoration management practices, which would improve and protect the water quality of the bay important for juvenile salmon, shorebirds and the mariculture industry. Acquisition would also protect the current remaining forested lands from future timber harvest activities and/or development.

A.3 Status of the Resource

Land use activities have impacted fish and wildlife habitat values in the Willapa Bay area. There is increasing pressure for development of bay front property for residential use, as well as future timber harvest of these lands. Pacific County land use restrictions in the area are classified as timber land, which precludes development. However, landowners can ask for re-zoning to allow for development. Currently there is a 5-acre minimum restriction in place per house outside of designated zones/towns. Several property owners (private and commercial) within the proposed project study area presently have lands for sale. If sold, the lands may become new housing developments. It is well documented that with development of communities, nonpoint source pollution increases within a local watershed. Nonpoint source pollution in the bay may increase and degrade the water quality within the watershed as lands are cleared and developed with newly constructed roads and homes. Potential nutrient loads, sedimentation, concentrations of pollutants will run-off, and possibly in the future, further degrade this important ecosystem and its fishery resources. Present impacts to the overall water quality within the south Willapa Bay are not known.

Continued habitat fragmentation due to timber harvesting and development may limit the ability of the Refuge and its partners to develop habitat planning and restoration activities on a viable landscape level that would provide habitat benefits to wildlife and threatened and endangered species.

Climate change poses a considerable threat to the temperate northwest rainforests. The forests are quite sensitive to climate variation because warm dry summers stress them directly, by limiting seedling establishment and summer photosynthesis, as well as indirectly, by creating conditions favorable to pests and fire. The extent, species mix, and productivity of northwest forests are likely to change under projected twenty-first-century climate change, but the specifics of these changes are not known with confidence at present. Refuge Sitka swamp forested lands found adjacent to the bay and rivers may be impacted by sea level rise. In time, these forest loses could be mitigated by increasing the protected forested area within the proposed boundary expansion area. Any sea level rise will not affect upland forest lands identified in our proposal.

A.4 Purpose of the Proposed Expansion

The boundary expansion proposal would set the stage for the Refuge and its partners to work together on a landscape scale to achieve the historic late-successional old-growth forest condition, protect forest habitat, protect habitat for endangered species and provide long-term protection of the South Willapa Bay watershed.

The expansion of the Refuge would 1) contribute to the protection and overall health and function of the watershed that supports a healthy Willapa Bay and the aquatic species of the bay, 2) create an opportunity to enhance and restore western red cedar forests to eventually re-establish late-successional old-growth function, 3) protect and restore important migratory bird habitat, especially threatened and endangered species such as the marbled murrelet (*Brachyramphus marmoratus*) and spotted owl (*Strix occidentalis caurina*), 4) contribute to the enhancement of riverine/stream habitat where necessary for the benefit of endangered salmon and other species, and 5) provide high-quality wildlife-dependent public use where appropriate.

The LPP boundary is located within the North Pacific Coast Ecoregion. The Service's goal for the North Pacific Coast Ecoregion is to protect, restore, and enhance the function, structure, and species composition of ecosystems for fish and wildlife conservation for the continuing benefit of people by implementing an ecosystem approach to management. This goal will be attained to the degree that the Service, working through partnerships, would 1) minimize species extinction, 2) reverse population declines, 3) maintain and enhance healthy populations of native fish and wildlife, 4) provide people with healthy ecosystems, and 5) work with our partners and the public at all levels.

The objectives of the North Pacific Coast Ecoregion are to 1) maintain high biological productivity, reverse population declines, and recover federally listed species, 2) combine and coordinate federal, state, local, tribal, and private forest management practices and watershed restoration efforts on a holistic ecosystem approach across ownership boundaries, 3) increase awareness and knowledge of fish and wildlife issues and ecosystem management, and 4) provide state-of-the-art biological data to resource managers and partners to restore functioning watersheds and improve forest management practices.

The Refuge expansion would help achieve North Pacific Coast Ecoregion goals and objectives by 1) actively managing and restoring forest habitat to achieve late-successional old-growth quality which would benefit a variety wildlife species, 2) protecting and restoring habitat for populations of federally listed birds (marbled murrelet and northern spotted owl), 3) enhancing and contributing to existing habitat protection efforts in southwest Washington by The Nature Conservancy, Cascade Land Trust, Washington Department of Fish and Wildlife, Washington Department of Natural Resources, 4) providing native habitats that will maintain and enhance healthy populations of fish, wildlife, and plant species, 5) protecting the long-term water quality of the bay, and 6) providing quality wildlife-dependent public use opportunities where appropriate.

The purpose of the boundary expansion is identified in Goal 10 of the draft CCP/EIS: "To contribute to the protection of the long-term environmental health of the Willapa Bay ecosystem." The objective of the goal is "to implement the new Land Protection Plan, recognizing the prioritized lands which provide habitat for endangered and threatened wildlife and the overall protection of the Willapa Bay ecosystem." Also identified in the draft CCP/EIS are wildlife-dependent recreational opportunities, which would be considered for new refuge lands acquired in the future. These recreational opportunities would be implemented only if found to be appropriate and compatible.

Also within the Refuge's long-term management plan, the draft CCP/EIS identifies the late-successional forest under Goal 1: "Protect, maintain and restore ecologically functional late-successional forest habitats (mature and old-growth forest) characteristic of the low-elevation temperate forests in the southwest Washington coastal region for the benefit of endangered and threatened species, migratory and resident birds, and a diverse assemblage of other native species."

This project would provide the necessary protected habitat linkage to The Nature Conservancy and Cascade Land Conservancy lands outside the expanded boundary. By combining the conservation efforts with a shared focus on restoring late-successional old-growth forest habitat, success of this shared vision will result in landscape-level conservation measures that will help maintain wildlife populations, help protect water quality of the bay, and help with the recovery of threatened and endangered species.

The authorities for the proposed expansion include the Fish and Wildlife Act of 1956, as amended (16 U.S.C. 742(a)-754) and the Migratory Bird Conservation Act of 1929 (16 U.S.C. 715-715d). The Fish and Wildlife Act of 1956 authorizes the Service to use funds made available under the Land and Water Conservation Fund Act of 1965 (16 U.S.C. 4601-4601-11) to acquire lands, waters, or interests therein for fish and wildlife conservation purposes. Federal monies used to acquire private lands through the Land and Water Conservation Fund are derived primarily from oil and gas leases on the outer continental shelf, excess motorboat fuel tax revenues, and the sale of surplus Federal property.

A.4.1 Wildlife and Habitat

Low elevation coastal rainforest habitats, such as those small old-growth stand fragments found in the South Willapa Bay Watershed, only occur in a few regions of the world. The Refuge contains portions of the typical habitats found in and around Willapa Bay and includes a rare 274-acre remnant forest stand of old-growth western red cedar located on the Long Island Unit of the Refuge. Nearly all of the Refuge's forested areas can be considered small in size, which reduces the ability of the Refuge to provide landscape-level benefits such as a greater level of watershed and water quality protection, as well as safeguards to sensitive habitats and species, which may be considered somewhat compromised by the patchwork effect of the wide range of predominantly young forest stand age classes. Considering there is currently less than 1% of the original old-growth forests remaining in the overall 700,000-acre Willapa Bay watershed, the goal for the Refuge and its partners is to restore a forested landscape that is representative of past, unmanaged landscape conditions. The natural ecological process within the low elevation coastal rainforest also supports and maintains healthy freshwater streams and the adjacent estuarine habitat of the bay.

Historically, forests within this area have been managed for timber production over most of the last century. Extensive forest management over the years has profoundly changed ecological conditions within the landscape. Altered streams create scouring and carry high sediment loads, and extensive forest road systems fragment habitat and modify hydrological processes. The dominant, simplified, young-managed forests of today do not support several species that are dependent on complex low elevation coastal old-growth rainforest including the federally listed marbled murrelet and northern spotted owl, which is currently extirpated from the Refuge. Lack of late-successional forest habitat is one reason for the disappearance of the spotted owl from the Refuge. Spotted owls use regenerated forest but depend greatly on old- growth forest for nesting and prey species. (Late-successional forests are forests in the mature and old-growth age classes.)

Recovery efforts regarding the marbled murrelet and spotted owl would best be accomplished by large contiguous areas of late-successional forest in the Willapa Bay area. Currently, suitable late-successional forest habitat in the Willapa Bay area is isolated and highly fragmented. As stated previously, less than 1% of the original old-growth forests remain in the Willapa Bay watershed. It should be noted that second- and third-growth forests currently dominate the watershed. According to recommendations in the recovery plan for the threatened marbled murrelet, in order to maintain a well-distributed marbled murrelet population, recovery efforts should be directed toward increasing the size and distribution of marbled murrelet populations between the Long Beach Peninsula and the small populations in southwestern Washington. Non-Federal lands in this area currently provide a limited amount of marbled murrelet nesting habitat and have the potential to be managed to increase the amount of suitable nesting habitat in the future (USFWS 1997a).

The forests of the Willapa Bay area provide habitat for diverse assemblages of species, from familiar vertebrate species (black bear, Roosevelt elk, black tail deer, river otter, etc.) and abundant salmon to the less known, like fungi, lichens, bryophytes, and many groups of invertebrates such as mollusks and millipedes. These species, and others, all play key roles in functional pathways within the forest, such as decomposition and nutrient cycling. Amphibians are another important group of species within these forests. Surveys by The Nature Conservancy have shown the area to have some of the highest species richness found in the Pacific Northwest.

Willapa Bay is often described as one of the most pristine water bodies along the western coast of the United States. Mariculture is a large fishing industry here, which relies completely on the outstanding water quality of the bay. In addition to commercial shellfish operations and commercial fishing, recreational clamming, crabbing and fishing are also supported by the excellent water quality and healthy tidelands of Willapa Bay. All are recognized as important economic industries and activities in Pacific County. By protecting and restoring the current forest lands surrounding the south bay, the Refuge and its partners will protect and improve the water quality which is important to the area’s economy.

Efforts toward additional protection of the Willapa Bay watershed have been initiated between a number of entities including the Refuge and The Nature Conservancy, as well as state and county agencies and private landowners. Because of the rarity and biological significance of old-growth forest ecosystem in the Willapa Bay region, the Refuge and The Nature Conservancy have been working together since 2003 to restore a forested landscape within their respective boundaries, that is representative of past, unmanaged, landscape conditions.

A.5 Land Protection Methods

A.5.1 Willing Seller Policy

It is the policy of the Service to acquire lands from willing landowners. Landowners within the approved refuge boundary who do not wish to sell their property or any other interest in their property are under no obligation to negotiate with or sell to the Service. In all acquisitions, the Service is required by law to offer 100% of fair market value, as determined by an appraisal completed by a professional, certified appraiser, in accordance with the Uniform Appraisal Standards for Federal Land Acquisitions.

The Service, like other Federal agencies, has the power of eminent domain. Eminent domain allows the use of condemnation to acquire lands and other interest in lands, such as easements, for the public good. The Service rarely uses this power. The Service typically is not compelled to buy specific land within a certain time frame.

Under the Uniform Relocation Assistance and Real Property Acquisition Policies Act, landowners who sell their property to the Service may be eligible for certain payments. Determinations are made on a case-by-case basis.

A.5.2 Habitat Protection Methods

A variety of habitat protection methods can be used to preserve fish and wildlife habitat. The actual method selected for any individual parcel will depend upon both the needs and desires of the landowner and the Refuge. If a mutual agreement cannot be reached, the landowner retains full use, control, and responsibility for the property. Cooperative efforts could involve key partners, including the Shoalwater Bay Indian Tribe and The Nature Conservancy.

A.5.2.1 Cooperative Agreements. The Service can enter into cooperative agreements with landowners to improve wildlife habitat management. Cooperative agreements may specify shared responsibilities or a transfer of funds from the Service to another entity or vice-versa for management purposes. Cooperative agreements can be used for lands under any type of ownership.

A.5.2.2 Conservation Easements. Conservation easements transfer some, but not all, property rights to the Service as specified by mutual agreement. Easements are managed in partnership with landowners and enable traditional low impact land uses (such as forestry and agriculture) to continue on the landscape, while protecting wetlands and wildlife habitat. Under a conservation easement, a landowner could agree not to engage in activities damaging to wildlife habitat resources, and/or the Service could manage the land for wildlife. The Service can acquire easements through purchase, donation, or exchange. The property owner retains all responsibility for paying property taxes. The Service could negotiate conservation easements on land under any type of ownership.

A.5.2.3 Fee Title Acquisition. A fee title interest is normally acquired when 1) the fish and wildlife resources on a piece of property require permanent protection that is not otherwise available, 2) the property is needed for development associated with public use, 3) a pending land use could otherwise harm wildlife habitats, or 4) purchase is the most practical and economical way to assemble small tracts into a manageable unit. Fee title acquisition transfers all property rights held by the landowner to the federal government. A fee title interest may be acquired by purchase, donation, or exchange.

A.6 Land Protection Priorities

The tract table lists the lands within the preferred alternative's expansion boundary by parcel and tract number, land ownership, total acres, and priority (ownership information is from the Pacific County Assessor's Office and is subject to change). Priorities 1, 2, or 3 are assigned to each tract, 1 means high, 2 means moderate, and 3 means low.

Tracts are being considered for acquisition because of their biological significance, existing or potential threats to wildlife habitat, significance of the area to refuge management and administration, and/or existing commitments to purchase or protect the land. Landowners within the proposed refuge boundary and approved refuge boundary may or may not wish to participate in the Service's habitat protection objectives, or may not wish to divest themselves from their land management responsibilities. Based on this, the final configuration of the acquired lands is impossible to predict. But because the parcels have been identified and the potential effects of converting those lands to Refuge status have been assessed in the DCCP/EIS, the delineated proposed expansion boundary will provide the Service with future habitat protection options if willing sellers and participants and available funds present themselves in the future.

A.7 Ownership and Types of Acquisitions

The proposed acquisition boundary expansion area is 6,804 acres. The largest percentage (approximately 50%) is held by six corporations for investment and timber production purposes. Two non-governmental organizations hold approximately 36% of the land. The City of Long Beach and the State of Washington hold approximately 10%, and four private individuals own approximately 4% of these lands (See tract table and maps).

Acquisition efforts would be prioritized by funding availability and necessary wildlife and habitat protection priorities. Fee title and conservation easements would all be considered as options to acquire lands in this area.

A.8 Coordination

The Service worked with a variety of interested parties to identify issues and concerns associated with the proposed Refuge expansion. These interested parties included members of the public, interested private groups, landowners, elected officials, and state, Federal, tribal, and local government agencies. The Service's public involvement activities included hosting public scoping meetings, developing and mailing planning updates, requesting information, undertaking consultations, and responding to inquiries. The Service provided information about the proposal to the media and other interested or affected parties throughout the public scoping period (DCCP/EIS Appendix E).

A.9 Refuge Revenue Sharing

Under the Uniform Relocation Assistance and Real Property Acquisition Policies Act, as amended, landowners who sell their property to the Service are eligible for certain benefits and payments including: reimbursement of reasonable moving and related expenses or certain substitute payments; replacement housing payments under certain conditions; relocation assistance services to help locate replacement housing, farmland, or business property; and reimbursement of certain necessary and reasonable expenses incurred in selling real property to the Federal government.

Under provisions of the Refuge Revenue Sharing Act (Public Law 95-469), the Service would annually reimburse Pacific County for tax revenue which is lost as a result of the Services acquisition of private property. This law states that the Secretary of the Interior (Secretary) shall pay to each county in which any area acquired in fee title is situated, the greater of the following amounts:

- An amount equal to the product of 75 cents multiplied by the total acreage of that portion of the fee area that is located within such county.
- An amount equal to three-fourths of one percent of the fair market value, as determined by the Secretary, for that portion of the fee area that is located within such county.
- An amount equal to 25 percent of the net receipts collected by the Secretary in connection with the operation and management of such fee area during such fiscal year. If a fee area is located in two or more counties, however, the amount for each county shall be apportioned in relationship to the acreage in that county.

Some payments to the counties have been less than the legislated amounts because of governmental funding deficits. Congress may appropriate, through the budget process, supplemental funds to compensate local governments for any shortfall in revenue sharing payments. The Refuge Revenue Sharing Act requires Service lands be reappraised every five years to ensure that payments to local governments remain equitable. Payments under this Act would be made only on lands that the Service acquires in fee title. On lands where the Service acquires only partial interest through easement, all taxes would remain the responsibility of the individual landowner.

The most recent Refuge Revenue Sharing Act payment to Pacific County of $ 46,765 was based on the 2005 Refuge Revenue Share Appraisal and may also be representative of federal budgetary constraints determined annually by congress. Appraisals of Refuge lands are conducted every five years and the 2005 appraisal evaluated approximately 11,000 fee title acres.

The formula of three-fourths of one percent of fair market value (estimated appraised value) is what is commonly used to determine the revenue sharing payments because this formula usually results in the highest revenue sharing calculation.

The most recent appraisal (2010 Appraisal Review and Approval of the Willapa Bay NWR Appraisal, Pacific County, Washington) identified 4,121 acres as second growth forest lands, timberland with reproduction, at an appraised/estimated value of $2,800 per acre. These Refuge lands are appraised and evaluated as if they are privately owned parcels; the Refuge timberlands are in some cases generally larger continuous tracts of forested land specifically set aside for conservation purposes. The appraisal estimate value is based on the current local land and timber values at the time of the appraisal.

The future Revenue Sharing Act payments under the proposed land acquisition alternatives (see Goal 2.4.10), for Pacific County timberlands, would generally be higher than the timberland taxes that would have been collected for these same private properties. The County property tax revenue is based only on the land value; a future tax is obtained once the timber is harvested.

Under Service ownership, these timberlands would be conserved for the long-term as part of the Refuge for wildlife and habitat purposes. If the proposed lands are acquired for Refuge purposes, the State and County would not receive tax revenue for timber cut (five percent of timber value) on the lands identified in the alternatives.

A.10 Social and Cultural Impacts

The current quality of life for communities and individuals around the proposed additions to the Refuge is expected to be the same or better as a result of the refuge addition. Intensified forest management would increase habitat quality and improve wildlife use which would result in positive effects for wildlife observation, interpretation, and photography opportunities at the Refuge. Improvements would also enhance environmental education opportunities, particularly the opportunity to observe active habitat restoration/management activities.

In addition, enhanced forest and stream habitats would likely improve big game hunting and fishing opportunities (DCCP/EIS Chapter 5). Approximately 6,804 acres could be considered for expansion to open up to a big game hunting program. If sufficient lands are acquired that allow for adequate wildlife sanctuary, minimal conflicts with other priority public uses are expected. The hunting regulations on the acquired lands would match adjacent refuge lands and be in accordance with Washington Department Fish and Wildlife guidelines.

Bank fishing opportunities would be investigated along the shores of Willapa Bay and the rivers that enter it if appropriate sites were acquired. Overall, the fishing opportunity at Willapa Refuge is not expected to decrease (DCCP/EIS, Chapter 5).

The Refuge's environmental education program could be expanded to include formal and informal events highlighting the habitat restoration activities. A new trail could be established, and trails could be expanded within the preferred acquisition boundary and would offer greater diversified wildlife viewing opportunities if appropriate lands were acquired.

Through refuge expansion, an economic expansion is expected, which would be proportionate to increased recreation and public access. Increased revenue for the Refuge and the surrounding region would depend on what lands were acquired. The effects of potential new facilities, new trails, improved habitat, and more visits would be expected to contribute to an increasing trend in visitation, producing increased economic benefits (CCP/EIS Chapter 5).

Expansion of the Refuge would result in the reduction of future commercial timber harvest opportunities and the conversion of some timberlands into long term conservation status for habitats, but the impact to the overall timber production economies of Pacific County would likely be minor. Forest restoration and management practices of the younger-aged stands on the lands identified for potential acquisition would include some standard timber management practices, such as thinning (see Appendix K). Forest management practices would change very little, if at all, from commercial forest management over the life of this plan. The proposed total acquisition is less than 2 percent of the 70 percent of Pacific County that is currently managed for long-term commercial forest production.

Implementation of Alternative 2, the preferred alternative, would have a minor but positive impact on property tax revenue. The preferred boundary expansion of 6,804 acres is 1.1 percent of the total 975 mi^2 area of Pacific County, of which more than 95 percent is private land (Pacific County 2010). The long-term benefits of expanding the preferred alternative boundary, would add protection and enhancements of the forests within the watershed, would help to provide for healthy water quality and benefit the mariculture industry and salmon streams. The future Refuges lands which may be acquired from willing sellers, would be opened to wildlife-dependent public use opportunities such as wildlife observation, hunting and environmental education. These opportunities would provide expanded tax revenue from a potential increase in tourism and recreation.

Tract Table and Maps

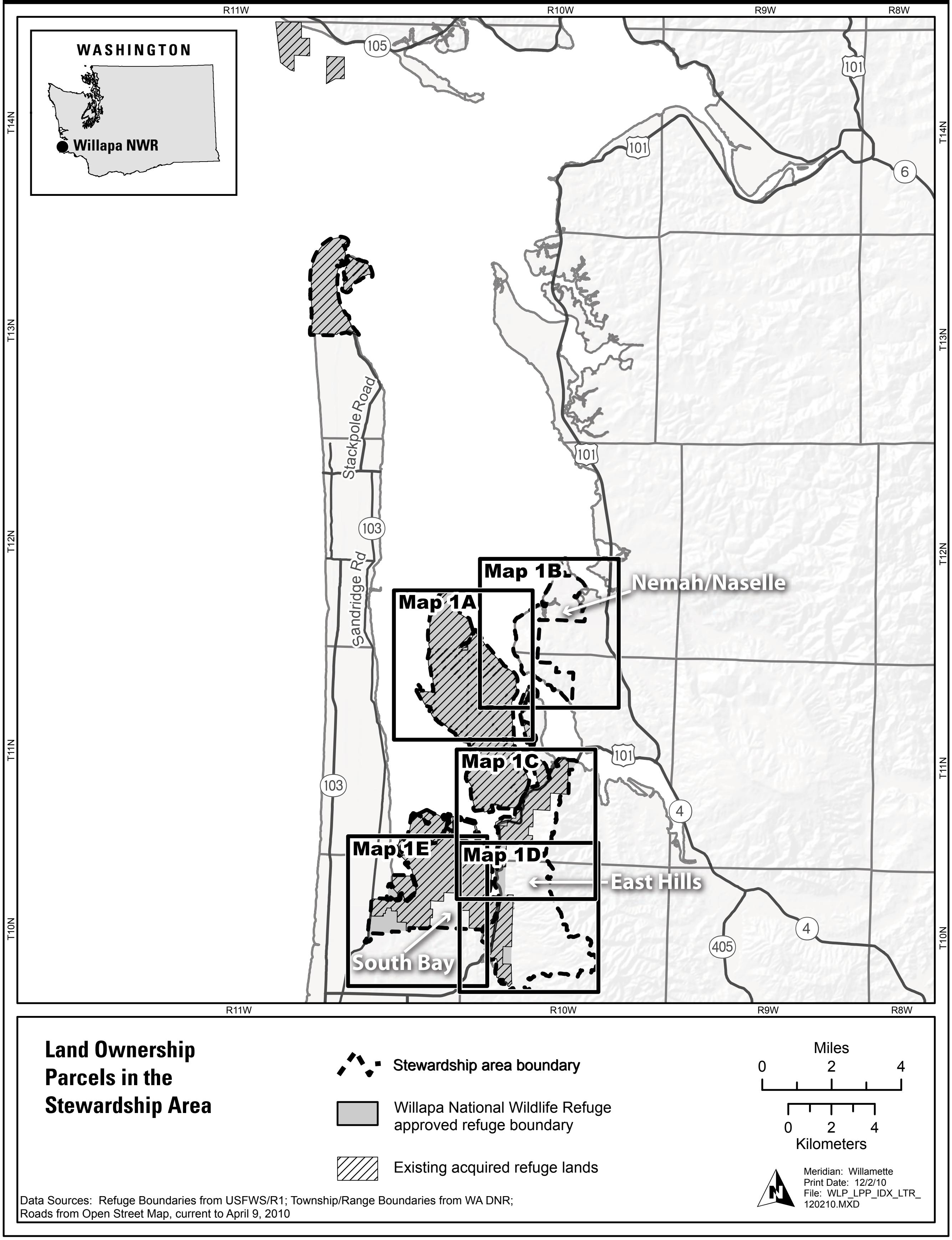
The following tract table and maps identify the lands within the preferred alternative's proposed expansion boundary by parcel number, landowner, tract number, parcel acres, County Assessor number, and priority; the maps also identify lands within the current approved Refuge boundary. Land ownership information was obtained from the Pacific County Assessor's Office and is subject to change. Priorities 1, 2, or 3 are assigned to each tract (1 means high, 2 means moderate, and 3 means low). An explanation of the tract table columns and the numbers on the maps follows.

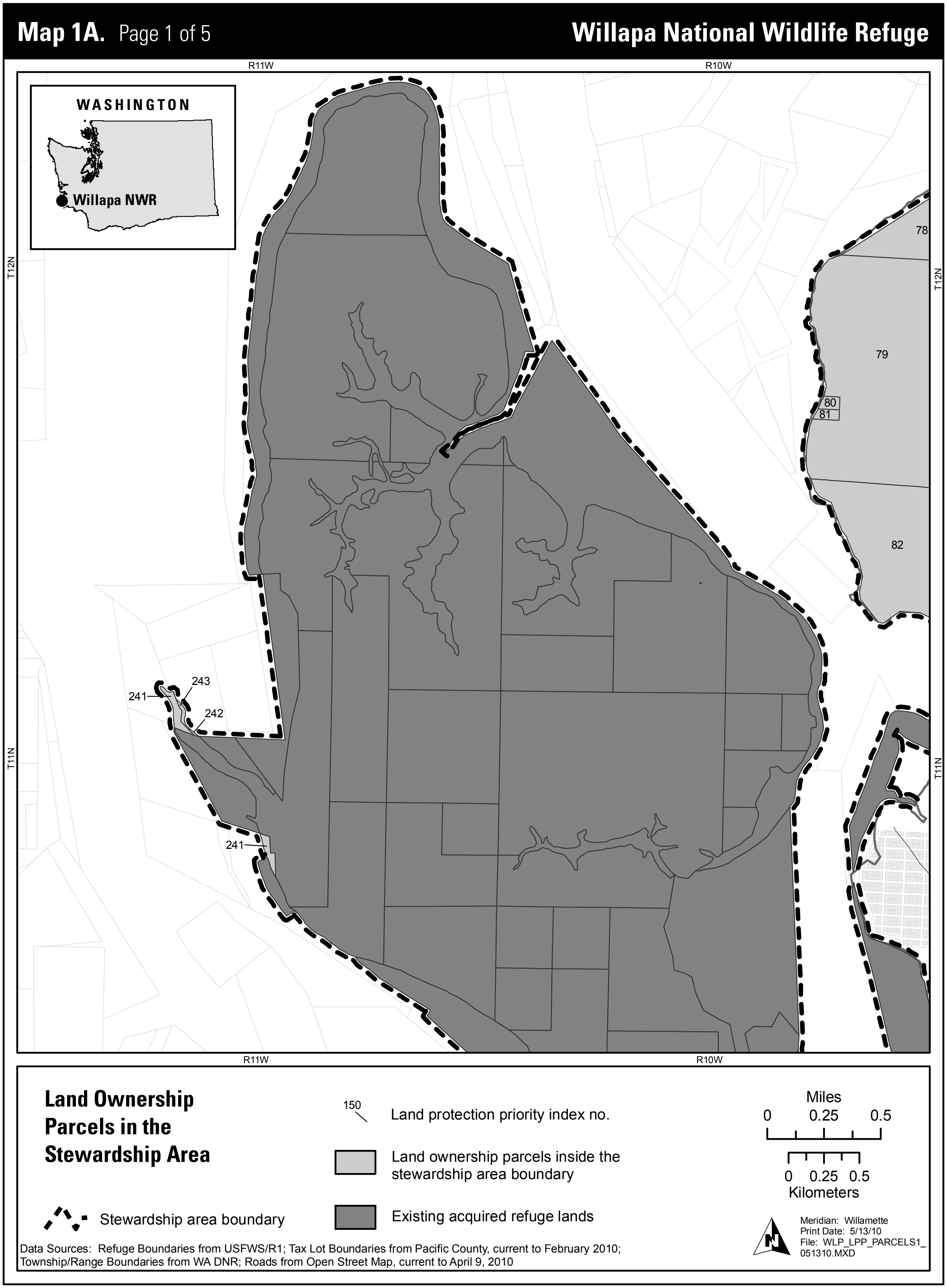
- In Column 1 we listed parcel numbers; the corresponding parcel locations are identified in Maps 1A, 1B, 1C, 1D, and 1E.
- In Column 2 the names of the current landowners are listed.
- In Column 3 the tract numbers assigned by the Service to each landowner's parcel(s) of land are listed, and the corresponding tract locations are identified in Maps 2A and 2B.
- In Column 4 the number of acres in each parcel of land is identified.
- In Column 5 the County Tax Assessor's number for each parcel of land is listed.
- In Column 6 the priority the Service assigned to each tract of land is identified.

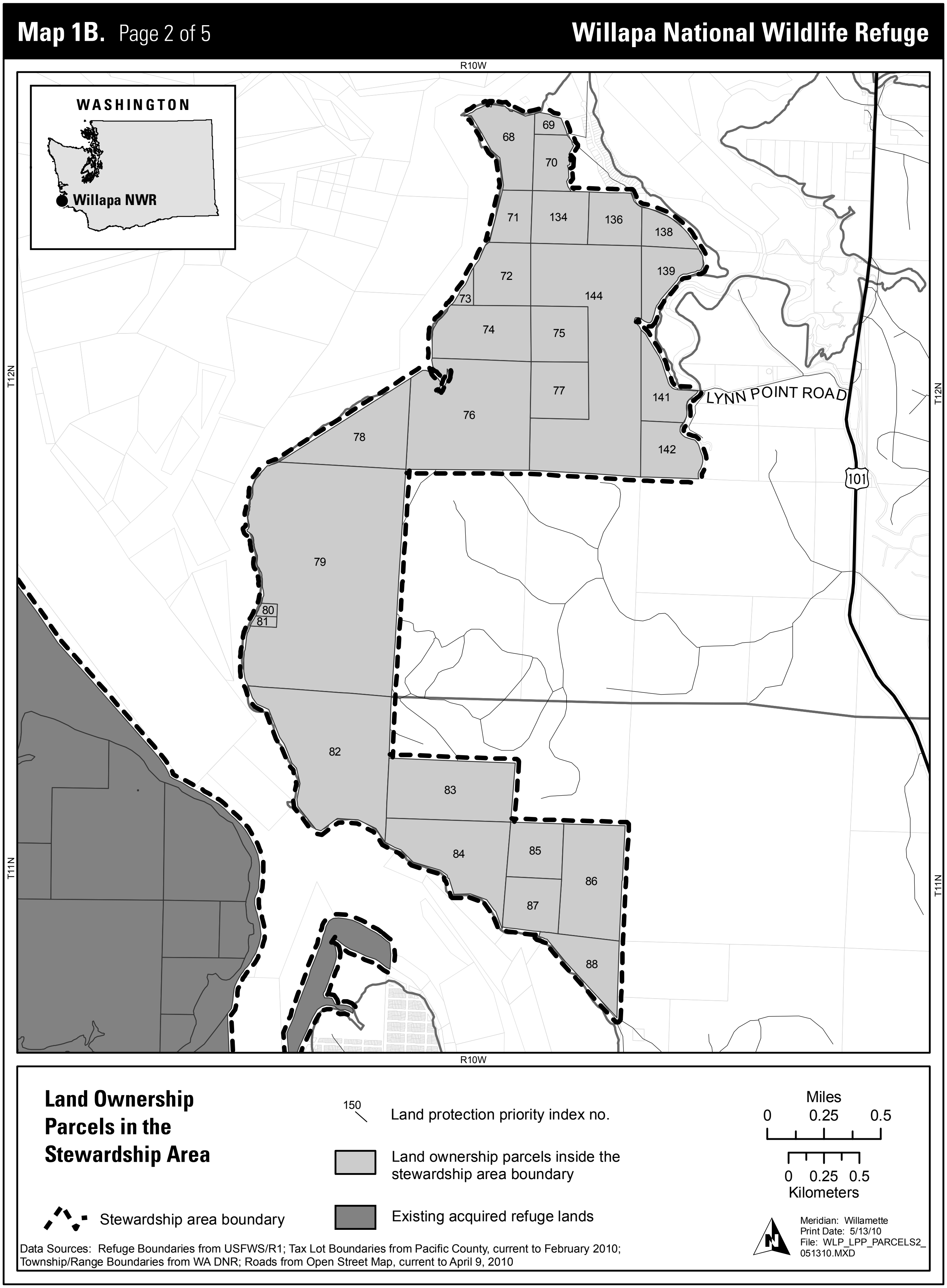
t!w/9[#	[!NDOWNER b!a9	¢RAC¢ I	!CRES	ASSESSOR #	PRIORITY	
1	730 TEXAS TIMBERLANDS II LTD	38,a	304	10111210000	1	
2	NEIKES, JAMES J	30,b	20	10111223800	1	
3	NEIKES, JAMES J	30,b	6	10111250002	1	
4	NEIKES, JAMES J	30	37	10111241000	1	
5	730 TEXAS TIMBERLANDS II LTD	38	84	10100732000	1	
6	NEIKES, JAMES J	30,b	4	10111250003	1	
7	CITY OF LONG BEACH	7	7	10111231002	1	
8	CITY OF LONG BEACH	7	6	10111233004	1	
9	NEIKES, JAMES J	30	80	10111247000	1	
10	NEIKES, JAMES J	30,a	13	10111250002	1	
14	RAYONIER TRS WEST TIMBER LLC	36,a	319	10100810000	2	
15	NATURE CONSERVANCY	79,h	81	10100922000	2	
17	NATURE CONSERVANCY	79,h	159	10100930000	2	
18	RAYONIER TRS WEST TIMBER LLC	36,a	318	10101780000	2	
19	STATE OF WASHINGTON	2,d	658	10101600000	2	
21	RAYONIER TRS WEST TIMBER LLC	36,a	152	10102016000	2	
28	WEYERHAEUSER COMPANY	9,h	21	11103211800	2	
29	WEYERHAEUSER COMPANY	9,h	28	11103322000	2	
30	NATURE CONSERVANCY	79,h	41	11103300000	2	
31	WEYERHAEUSER COMPANY	9,h	8	11103322001	2	
35	NATURE CONSERVANCY	79,h	46	11103234000	2	
36	NATURE CONSERVANCY	79,h	43	11103243000	2	
37	NATURE CONSERVANCY	79,h	120	10100516000	2	
39	NATURE CONSERVANCY	79,h	71	10100517000	2	
40	NATURE CONSERVANCY	79,h	77	10100423000	2	
41	NATURE CONSERVANCY	79,h	12	10100542001	2	
42	NATURE CONSERVANCY	79,h	1	10100542001	2	
43	NATURE CONSERVANCY	79,h	135	10100548000	2	
44	NATURE CONSERVANCY	79,h	3	10100542001	2	
47	NATURE CONSERVANCY	79,h	457	11102810000	2	
48	NATURE CONSERVANCY	79,h	317	11103300000	2	
51	NATURE CONSERVANCY	79,h	229	11103300000	2	
53	NATURE CONSERVANCY	79,h	419	10100980000	2	
54	NATURE CONSERVANCY	79,h	273	10100410000	2	
56	NATURE CONSERVANCY	79,h	259	10100437000	2	
59	RAYONIER TRS WEST TIMBER LLC	36	309	10101580000	2	
62	TC&I-CHINOOK LLC	37	313	10101590000	2	
64	RAYONIER TRS WEST TIMBER LLC	36,a	159	10102126000	2	
65	RAYONIER TRS WEST TIMBER LLC	36,a	397	10102110000	2	
67	TC&I-CHINOOK LLC	37	556	10102260000	2	
145	NATURE CONSERVANCY	79,h	263	11103246000	2	
147	UNITED STATES OF AMERICA	1	85	11103210000	2	
152	RAYONIER TRS WEST TIMBER LLC	36,a	91	10102017000	2	

154	BEAR RIVER TREE FARMS LLC	82,c	51	10100524000	2	
156	BEAR RIVER TREE FARMS LLC	82,b	140	10100524000	2	
157	NATURE CONSERVANCY	79,h	319	10100810000	2	
158	NATURE CONSERVANCY	79,h	3	10100548000	2	
68	CASCADE LAND CONSERVANCY	23	44	12102150002	3	
69	CASCADE LAND CONSERVANCY	23	7	12102150001	3	
70	CASCADE LAND CONSERVANCY	23	25	12102142000	3	
71	CASCADE LAND CONSERVANCY	23	23	12102150004	3	
72	MID-VALLEY RESOURCES INC	85,c	42	12102814160	3	
73	MID-VALLEY RESOURCES INC	85,c	5	12102850001	3	
74	WEYERHAEUSER NR COMPANY	9,f	64	12102827000	3	
75	WEYERHAEUSER NR COMPANY	9,f	39	12102813000	3	
76	WEYERHAEUSER NR COMPANY	9,f	161	12102830000	3	
77	WEYERHAEUSER NR COMPANY	9,f	41	12102842000	3	
78	WEYERHAEUSER NR COMPANY	9,f	72	12102950001	3	
79	WEYERHAEUSER NR COMPANY	9,f	403	12103200000	3	
80	COCHRAN, GREGORY J & SHERRY L	33	3	12103231003	3	
81	COCHRAN, GREGORY J	32	3	12103231002	3	
82	WEYERHAEUSER NR COMPANY	9,f	171	11100550001	3	
83	WEYERHAEUSER NR COMPANY	9,f	93	11100423000	3	
84	WILSON, CHARLES GARY TRUSTEE	34	90	11100431000	3	
85	WEYERHAEUSER NR COMPANY	9,g	37	11100442000	3	
86	WEYERHAEUSER NR COMPANY	9,g	85	11100441000	3	
87	WILSON, CHARLES GARY TRUSTEE	34	36	11100431000	3	
88	WEYERHAEUSER NR COMPANY	9,g	39	11100950001	3	
134	CASCADE LAND CONSERVANCY	23	37	12102143000	3	
136	CASCADE LAND CONSERVANCY	23	34	12102150005	3	
138	CASCADE LAND CONSERVANCY	23	19	12102250007	3	
139	CASCADE LAND CONSERVANCY	23	33	12102750003	3	
141	CASCADE LAND CONSERVANCY	23,a	32	12102750003	3	
142	CASCADE LAND CONSERVANCY	23,a	37	12102750009	3	
144	MID-VALLEY RESOURCES INC	85,c	233	12102814160	3	

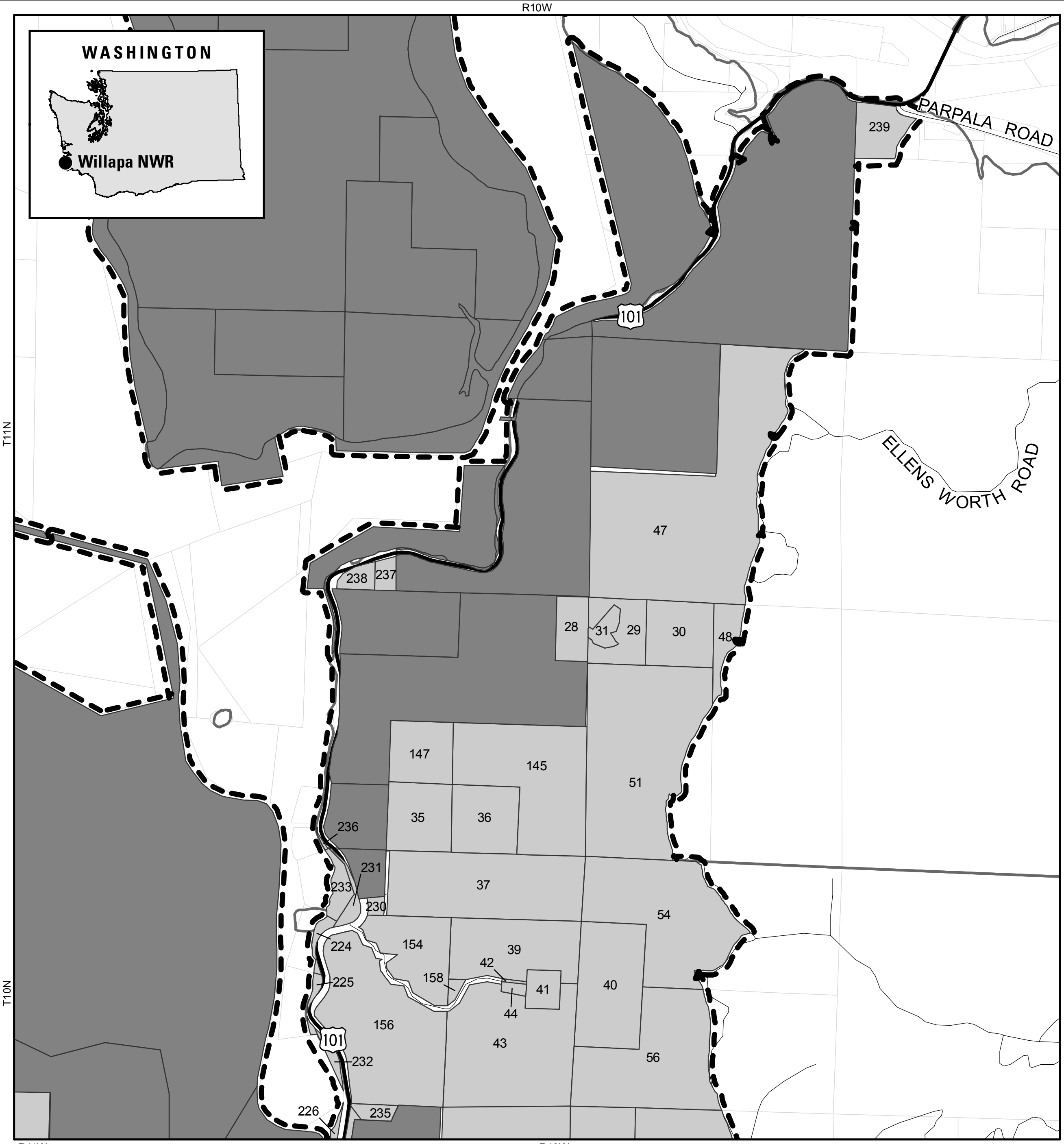
Map 1. Index Page **Willapa National Wildlife Refuge**




Map 1A. Page 1 of 5
Willapa National Wildlife Refuge
R11W
R10W
T12N
T11N
WASHINGTON
Willapa NWR
78
79
80
81
82
241
242
243
Land Ownership Parcels in the Stewardship Area
150
Land protection priority index no.
Land ownership parcels inside the stewardship area boundary
Existing acquired refuge lands
Stewardship area boundary
Miles
0 0.25 0.5
0 0.25 0.5
Kilometers
Meridian: Willamette
Print Date: 5/13/10
File: WLP_LPP_PARCELS1_051310.MXD
Data Sources: Refuge Boundaries from USFWS/R1; Tax Lot Boundaries from Pacific County, current to February 2010; Township/Range Boundaries from WA DNR; Roads from Open Street Map, current to April 9, 2010


Map 1B. Page 2 of 5
Willapa National Wildlife Refuge
R10W
WASHINGTON
Willapa NWR
T12N
T11N
LYNN POINT ROAD
101
68
69
70
71
134
136
138
139
72
73
144
74
75
77
76
78
141
142
79
80
81
82
83
84
85
86
87
88
R10W
Land Ownership Parcels in the Stewardship Area
150
Land protection priority index no.
Land ownership parcels inside the stewardship area boundary
Existing acquired refuge lands
Stewardship area boundary
Miles
0 0.25 0.5
0 0.25 0.5
Kilometers
Meridian: Willamette
Print Date: 5/13/10
File: WLP_LPP_PARCELS2_051310.MXD
Data Sources: Refuge Boundaries from USFWS/R1; Tax Lot Boundaries from Pacific County, current to February 2010; Township/Range Boundaries from WA DNR; Roads from Open Street Map, current to April 9, 2010

Map 1C. Page 3 of 5 **Willapa National Wildlife Refuge**



Land Ownership Parcels in the Stewardship Area

150 Land protection priority index no.

Land ownership parcels inside the stewardship area boundary

Stewardship area boundary

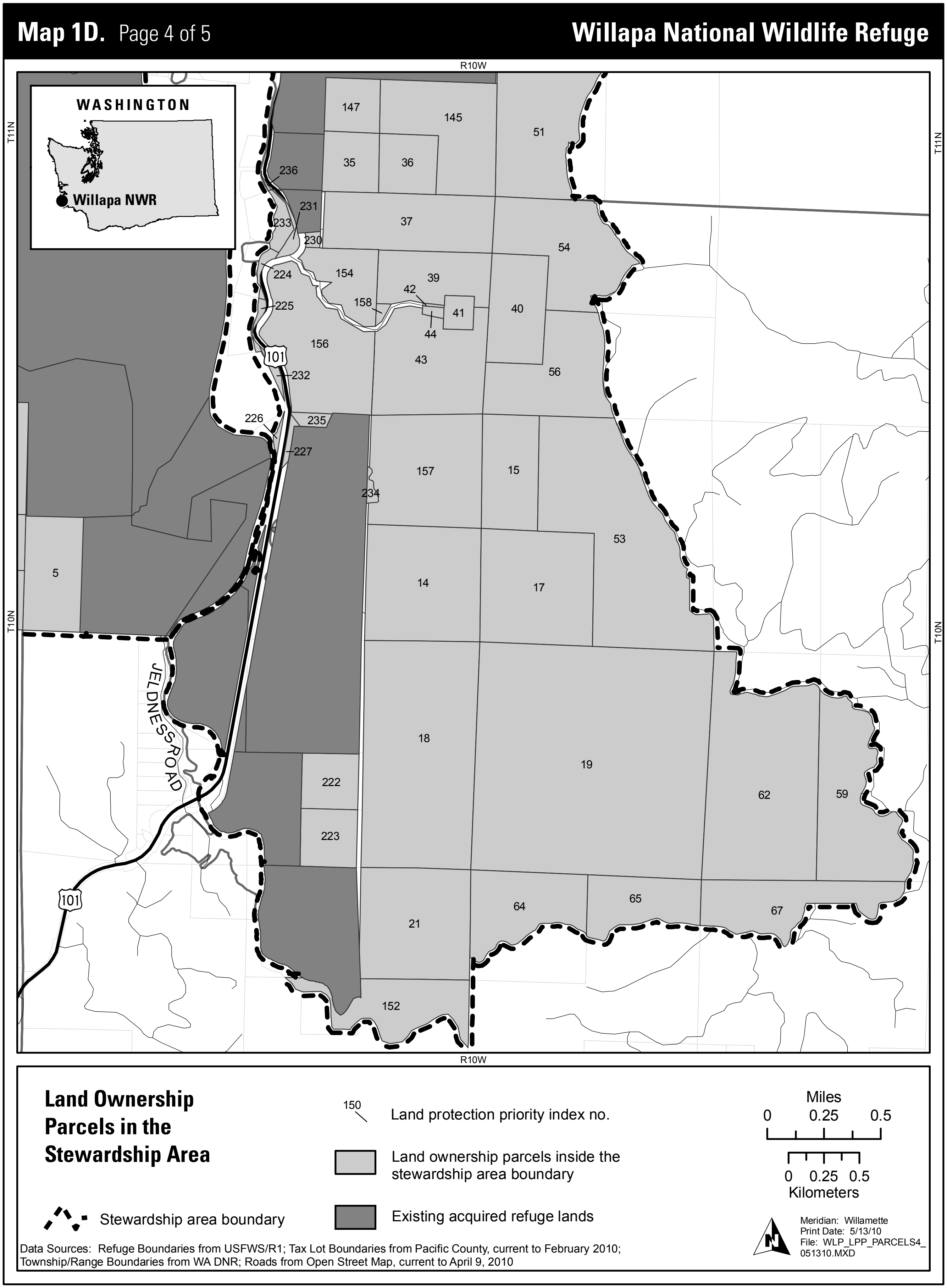
Existing acquired refuge lands

Miles
0 0.25 0.5

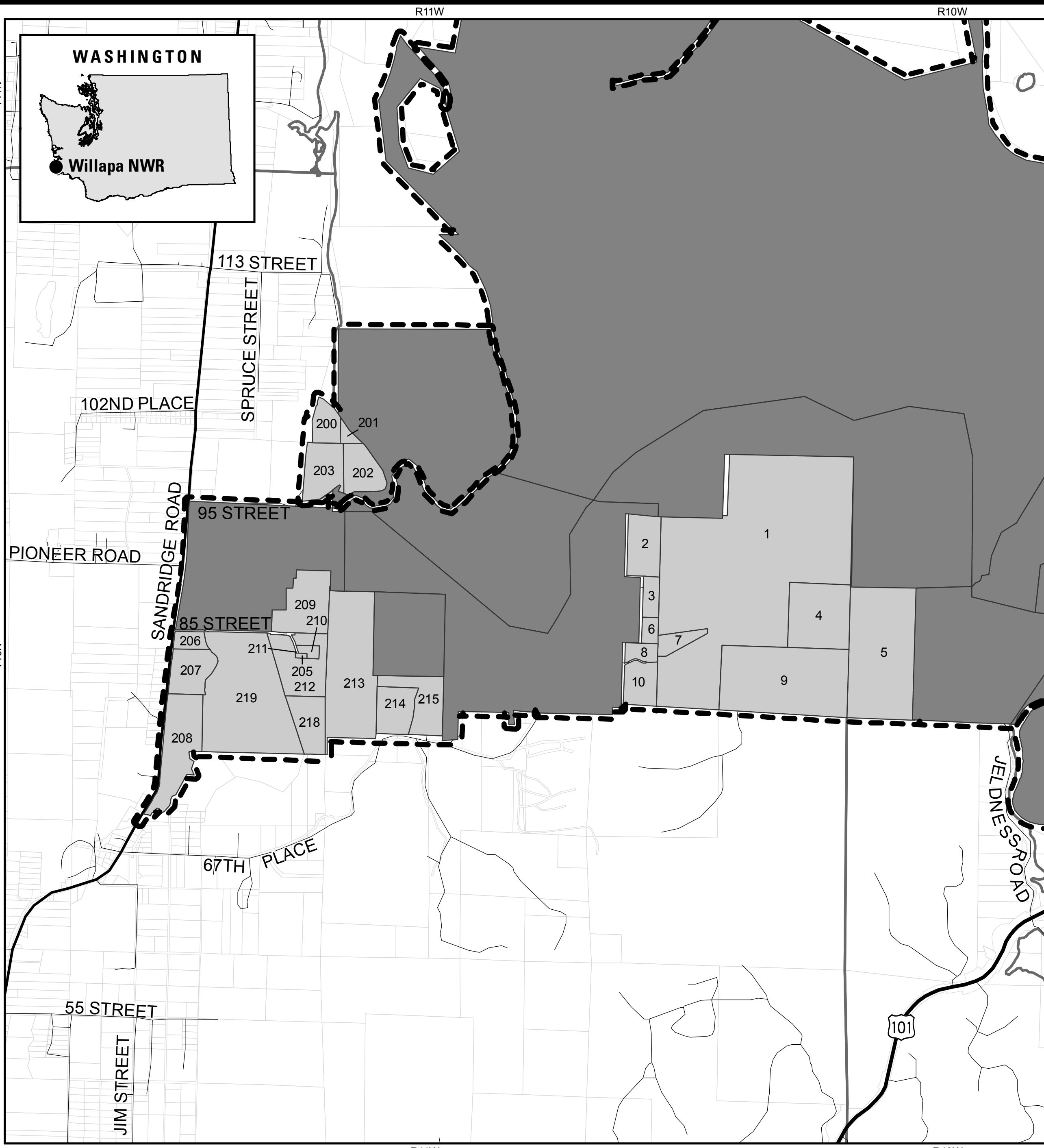
0 0.25 0.5
Kilometers

Meridian: Willamette
Print Date: 5/13/10
File: WLP_LPP_PARCELS3_051310.MXD

Data Sources: Refuge Boundaries from USFWS/R1; Tax Lot Boundaries from Pacific County, current to February 2010; Township/Range Boundaries from WA DNR; Roads from Open Street Map, current to April 9, 2010


Map 1D. Page 4 of 5
Willapa National Wildlife Refuge
R10W
T11N
T10N
WASHINGTON
Willapa NWR
JELDNESS ROAD
101
147
145
51
35
36
236
231
233
230
37
54
224
154
39
42
158
41
40
225
44
156
43
56
232
226
235
227
157
15
234
53
5
14
17
18
19
222
62
59
223
65
64
67
21
152
Land Ownership Parcels in the Stewardship Area
150
Land protection priority index no.
Land ownership parcels inside the stewardship area boundary
Existing acquired refuge lands
Stewardship area boundary
Miles
0 0.25 0.5
0 0.25 0.5
Kilometers
Meridian: Willamette
Print Date: 5/13/10
File: WLP_LPP_PARCELS4_051310.MXD
Data Sources: Refuge Boundaries from USFWS/R1; Tax Lot Boundaries from Pacific County, current to February 2010; Township/Range Boundaries from WA DNR; Roads from Open Street Map, current to April 9, 2010

Map 1E. Page 5 of 5 **Willapa National Wildlife Refuge**



Land Ownership Parcels in the Stewardship Area

150 Land protection priority index no.

Land ownership parcels inside the stewardship area boundary

Existing acquired refuge lands

Stewardship area boundary

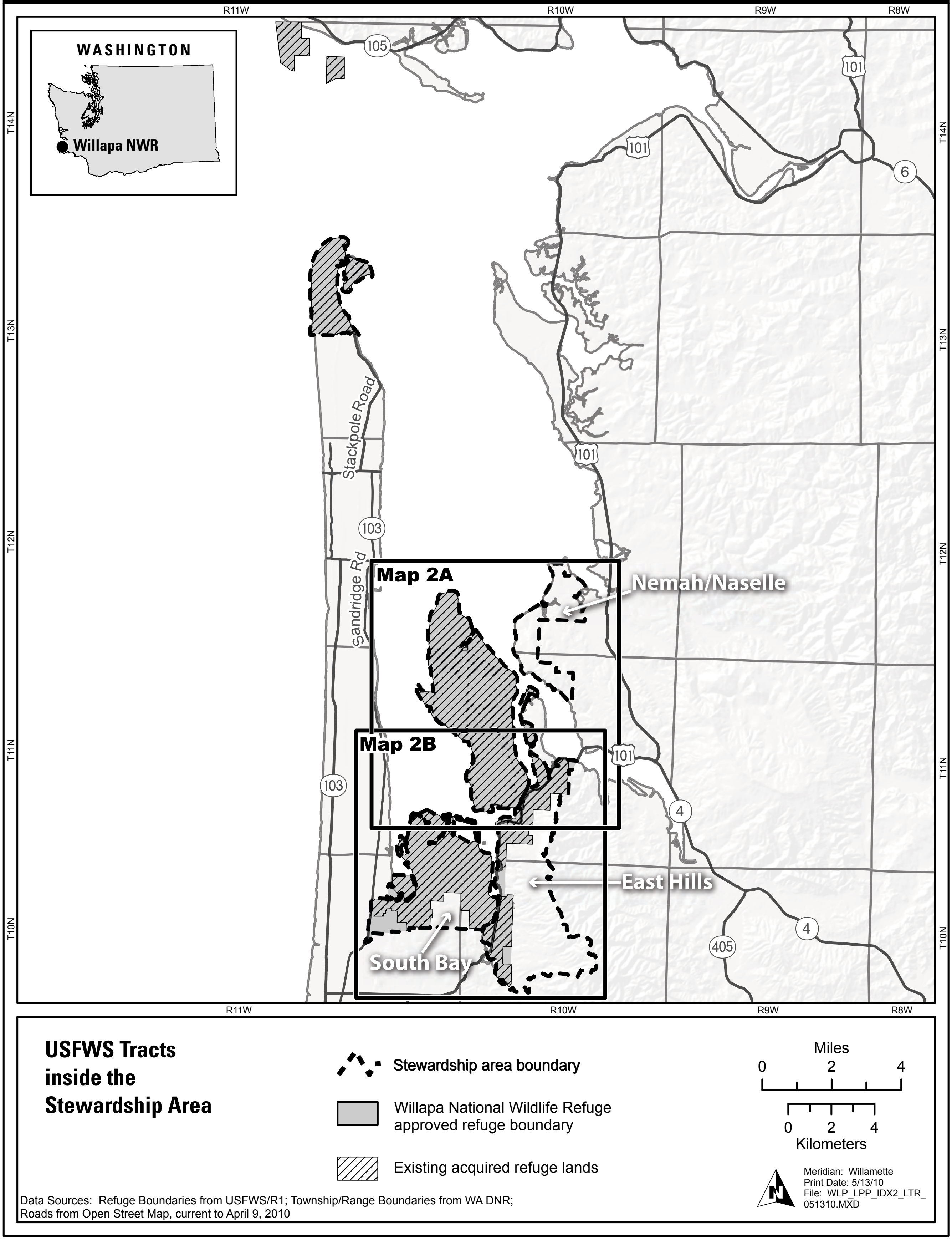
Miles: 0, 0.25, 0.5

Kilometers: 0, 0.25, 0.5

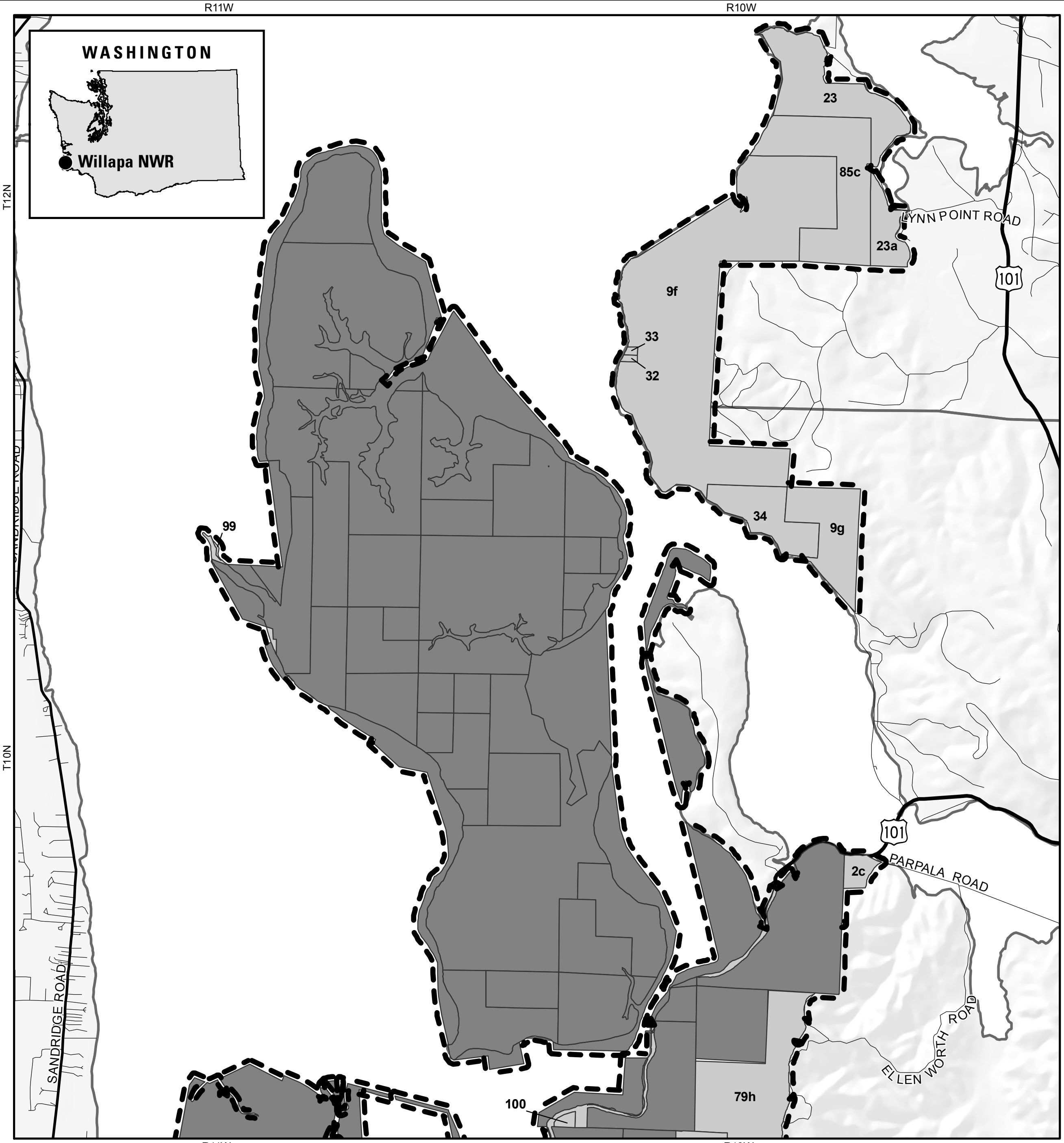
Meridian: Willamette
Print Date: 5/13/10
File: WLP_LPP_PARCELS5_051310.MXD

Data Sources: Refuge Boundaries from USFWS/R1; Tax Lot Boundaries from Pacific County, current to February 2010; Township/Range Boundaries from WA DNR; Roads from Open Street Map, current to April 9, 2010

Map 2. Index Page **Willapa National Wildlife Refuge**



Map 2A. Page 1 of 2 **Willapa National Wildlife Refuge**



USFWS Tracts inside the Stewardship Area

Stewardship area boundary

150a Tract number

FWS designated ownership tracts

Existing acquired refuge lands

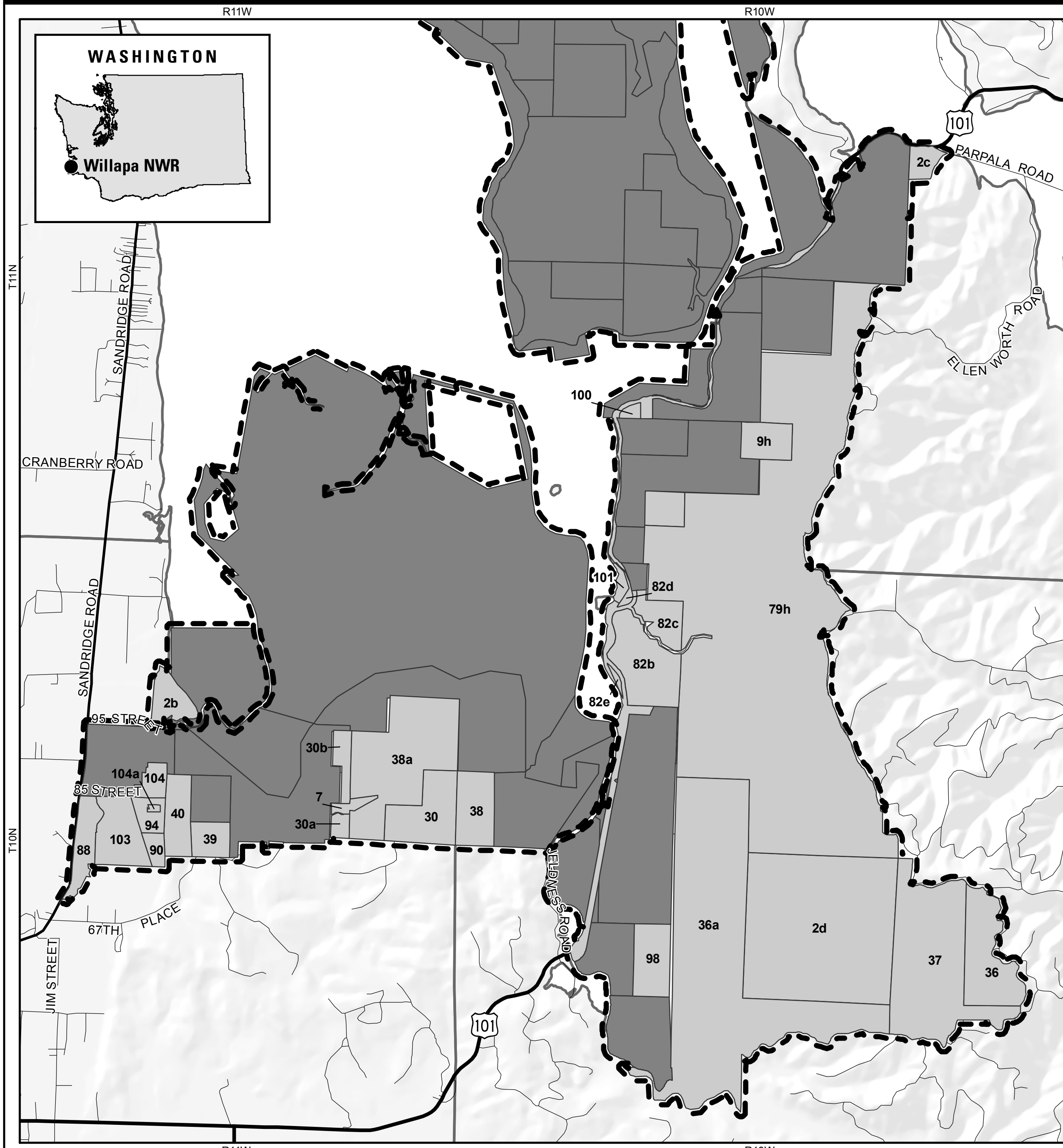
Miles 0 0.5 1

0 0.5 1 Kilometers

Meridian: Willamette
Print Date: 10/28/10
File: WLP_LPP_TRACTS1_102810.MXD

Data Sources: Refuge Boundaries from USFWS/R1; Tax Lot Boundaries from Pacific County, current to February 2010; Township/Range Boundaries from WA DNR; Roads from Open Street Map, current to April 9, 2010

Map 2B. Page 2 of 2 **Willapa National Wildlife Refuge**



USFWS Tracts inside the Stewardship Area

150a Tract number

FWS designated ownership tracts

Stewardship area boundary

Existing acquired refuge lands

Miles 0 0.5 1

0 0.5 1 Kilometers

Meridian: Willamette
Print Date: 10/28/10
File: WLP_LPP_TRACTS2_102810.MXD

Data Sources: Refuge Boundaries from USFWS/R1; Tax Lot Boundaries from Pacific County, current to February 2010; Township/Range Boundaries from WA DNR; Roads from Open Street Map, current to April 9, 2010

Appendix B. Appropriate Use Determinations

Introduction

The Appropriate Refuge Uses Policy (603 FW 1 [2006]) outlines the process that the Service uses to determine when general public uses on refuges may be considered. Priority public uses previously defined as wildlife-dependent uses (hunting, fishing, wildlife observation and photography and environmental education and interpretation) under the National Wildlife Refuge System Improvement Act of 1997 are generally exempt from appropriate use review. Other exempt uses include situations in which the Service does not have adequate jurisdiction to control the activity, as well as refuge management activities.

In essence, the appropriate use policy provides refuge managers with a consistent procedure to first screen and then document decisions concerning a public use. When a use is determined to be appropriate, refuge managers must then decide if the use is compatible before allowing it on a refuge. The policy also requires review of existing public uses.

During the CCP process, the Refuge Manager evaluated all existing and proposed refuge uses at Willapa National Wildlife Refuge using the following guidelines and criteria as outlined in the appropriate use policy:

- Do we have jurisdiction over the use?
- Does the use comply with applicable laws and regulations (Federal, State, tribal, and local)?
- Is the use consistent with applicable Executive orders and Department and Service policies?
- Is the use consistent with public safety?
- Is the use consistent with goals and objectives in an approved management plan or other document?
- Has an earlier documented analysis not denied the use or is this the first the use has been proposed?
- Is the use manageable within available budget and staff?
- Will this be manageable in the future within existing resources?
- Does the use contribute to the public's understanding and appreciation of the refuge's natural or cultural resources, or is the use beneficial to the refuge's natural or cultural resources?
- Can the use be accommodated without impairing existing wildlife-dependent recreational uses or reducing the potential to provide quality (see section 1.6D of the appropriate use policy for recreational uses description), compatible, wildlife-dependent recreation into the future?

The Refuge Manager also determined the following refuge use(s) were appropriate and directed that compatibility determinations be completed for each use: Camping, Haying and Grazing

Finding of Appropriateness of a Refuge Use

Refuge Name: Willapa NWR

Use: Camping

This exhibit is not required for wildlife-dependent recreational uses, forms of take regulated by the State, or uses already described in a refuge CCP or step-down management plan approved after October 9, 1997.

Decision criteria:	YES	NO
(a) Do we have jurisdiction over the use?	X	
(b) Does the use comply with applicable laws and regulations (Federal, state, tribal, and local)?	X	
(c) Is the use consistent with applicable Executive Orders and Department and Service policies?	X	
(d) Is the use consistent with public safety?	X	
(e) Is the use consistent with goals and objectives in an approved management plan or other document?	X	
(f) Has an earlier documented analysis not denied the use or is this the first time the use has been proposed?	X	
(g) Is the use manageable within available budget and staff?	X	
(h) Will this be manageable in the future within existing resources?	X	
(i) Does the use contribute to the public's understanding and appreciation of the refuge's natural or cultural resources, or is the use beneficial to the refuge's natural or cultural resources?	X	
(j) Can the use be accommodated without impairing existing wildlife-dependent recreational uses or reducing the potential to provide quality (see section 1.6D. for description), compatible, wildlife-dependent recreation into the future?	X	

Where we do not have jurisdiction over the use ("no" to (a)), there is no need to evaluate it further as we cannot control the use. Uses that are illegal, inconsistent with existing policy, or unsafe ("no" to (b), (c), or (d)) may not be found appropriate. If the answer is "no" to any of the other questions above, we will generally not allow the use.

If indicated, the refuge manager has consulted with State fish and wildlife agencies. Yes ____ No __X__

When the refuge manager finds the use **appropriate** based on sound professional judgment, the refuge manager must justify the use in writing on an attached sheet and obtain the refuge supervisor's concurrence.

Based on an overall assessment of these factors, my summary conclusion is that the proposed use is:

Not Appropriate ______ Appropriate __X__

Refuge Manager:____ Date:______________________

If found to be **Not Appropriate**, the refuge supervisor does not need to sign concurrence if the use is a new use.
If an existing use is found **Not Appropriate** outside the CCP process, the refuge supervisor must sign concurrence.
If found to be **Appropriate**, the refuge supervisor must sign concurrence.

Refuge Supervisor:______________________________________ Date:_______________________

A compatibility determination is required before the use may be allowed.

FWS Form 3-2319 02/06

Finding of Appropriateness of a Refuge Use
Supplement to FWS Form 3-2319
Camping

Further Explanation of Answers Provided for the Decision Criteria:

(a) The use takes place within the boundaries of the Refuge.

(b) 50 C.F.R. 26.31 states that "Public recreation will be permitted on national wildlife refuges as an appropriate incidental or secondary use only after it has been determined that such recreational use is practicable and not inconsistent with the primary objectives for which each particular area was established or with other authorized Federal operations." Willapa National Wildlife Refuge allows camping because it is difficult and sometimes dangerous to access the island due to tidal influences. Camping allows visitors to safely participate in the big six activities on the island.

(c) The use is consistent with Service Policy. Specifically, 8 RM 9.5 (b) states that "Camping and picnicking may be permitted only when required to implement or sustain an approved wildlife/wildlands oriented activity only when no other alternative is practical." At Willapa National Wildlife Refuge, camping is sometimes required in order for the public to engage in wildlife-dependent public uses.

(d) The use is consistent with public safety.

(e) The use is consistent with goals or objectives in an approved refuge management plan and other refuge documents.

(f) This use has previously been requested and allowed on the Refuge.

(g) This use is currently manageable with available budget and staff. Based on current staffing, budget etc., this use would be manageable in future within existing resources.

(i) The use does contribute to public understanding of the Refuge's natural or cultural resources.

(j) This use would not impair existing wildlife-dependent uses.

Finding of Appropriateness of a Refuge Use

Refuge Name: Willapa NWR

Use: Haying and Grazing

This exhibit is not required for wildlife-dependent recreational uses, forms of take regulated by the State, or uses already described in a refuge CCP or step-down management plan approved after October 9, 1997.

Decision criteria:	YES	NO
(a) Do we have jurisdiction over the use?	**X**	
(b) Does the use comply with applicable laws and regulations (Federal, State, tribal, and local)?	**X**	
(c) Is the use consistent with applicable Executive orders and Department and Service policies?	**X**	
(d) Is the use consistent with public safety?	**X**	
(e) Is the use consistent with goals and objectives in an approved management plan or other document?	**X**	
(f) Has an earlier documented analysis not denied the use or is this the first time the use has been proposed?	**X**	
(g) Is the use manageable within available budget and staff?	**X**	
(h) Will this be manageable in the future within existing resources?	**X**	
(i) Does the use contribute to the public's understanding and appreciation of the refuge's natural or cultural resources, or is the use beneficial to the refuge's natural or cultural resources?	**X**	
(j) Can the use be accommodated without impairing existing wildlife-dependent recreational uses or reducing the potential to provide quality (see section 1.6D. for description), compatible, wildlife-dependent recreation into the future?	**X**	

Where we do not have jurisdiction over the use ("no" to (a)), there is no need to evaluate it further as we cannot control the use. Uses that are illegal, inconsistent with existing policy, or unsafe ("no" to (b), (c), or (d)) may not be found appropriate. If the answer is "no" to any of the other questions above, we will generally not allow the use.

If indicated, the refuge manager has consulted with State fish and wildlife agencies. Yes ___ No _X__

When the refuge manager finds the use **appropriate** based on sound professional judgment, the refuge manager must justify the use in writing on an attached sheet and obtain the refuge supervisor's concurrence.

Based on an overall assessment of these factors, my summary conclusion is that the proposed use is:

Not Appropriate_____ Appropriate_X

Refuge Manager:____ Date:______________________

If found to be **Not Appropriate**, the refuge supervisor does not need to sign concurrence if the use is a new use.
If an existing use is found **Not Appropriate** outside the CCP process, the refuge supervisor must sign concurrence.
If found to be **Appropriate**, the refuge supervisor must sign concurrence.

Refuge Supervisor:______________________________________ Date:______________________

A compatibility determination is required before the use may be allowed.

FWS Form 3-2319 02/06

Finding of Appropriateness of a Refuge Use
Supplement to FWS Form 3-2319
Haying/Grazing

Further Explanation of Answers Provided for the Decision Criteria:

(a) The use takes place within the boundaries of the Refuge.

(b) The use does not violate applicable laws and statues.
There are specific regulations which address economic uses of refuges. At 50 C.F.R. 29.1, it states, in part, that, "…We may only authorize public or private economic use of the natural resources of any national wildlife refuge, in accordance with 16 U.S.C. 715s, where we determine that the use contributes to the achievement of the national wildlife refuge purposes or the National Wildlife Refuge System mission." Grazing livestock and harvesting hay are listed in the regulation as example uses to which this provision applies.

(c) The use is consistent with Service Policy (6 RM 5 "Grassland Management"), which states that, "Grazing programs may be implemented only when they benefit or are not harmful to wildlife and wildlife habitat" and "Frequency of grazing will vary according to productivity and condition of the site and should be held to the minimum necessary to achieve the desired results" (6 RM 5.6 A.) The policy also states that, "annual haying of grasslands leads to reduced plant vigor, removal of organic material, and a reduction of wildlife values. However, under some circumstances annual haying may be necessary in order to provide emergent growth on seasonally flooded sites or otherwise support refuge objectives. In some situations, occasional haying can be used to remove excessive mulch accumulation that is inhibiting growth of desired plant species. Haying should be timed to achieve the desired results while minimizing the adverse effects" (6 RM 5.6 C.)

(d) The use is generally consistent with public safety.

(e) The use is consistent with goals and objectives in an approved refuge management.

(f) This activity is consistent with refuge goals and objectives, specifically the objective to maintain short grass pastures for the benefit of Canada geese.

(g) This use has not been previously denied on the Refuge.

(h) The use requires the issuance of permits and oversight by refuge personnel. The Refuge currently has the available budget and staff that would be required to administer this use.

(i) This use is more economical than using refuge personnel and equipment to manage the entire refuge pasture system. It is anticipated that this cost savings would continue into the future.

(j) Although the use by itself does not necessarily contribute to public understanding of the Refuge's natural or cultural resources, the use is definitely beneficial to the Refuge's natural resources providing management of the Refuge's grasslands for the benefit of Canada geese.

(k) It is anticipated that this use would not impair existing wildlife-dependent uses or impact other refuge recreational users.

Finding of Appropriateness of a Refuge Use

Refuge Name: Willapa NWR

Use: Research, Scientific Collecting, and Surveys

This exhibit is not required for wildlife-dependent recreational uses, forms of take regulated by the State, or uses already described in a refuge CCP or step-down management plan approved after October 9, 1997.

Decision criteria:	YES	NO
(a) Do we have jurisdiction over the use?	**X**	
(b) Does the use comply with applicable laws and regulations (Federal, state, tribal, and local)?	**X**	
(c) Is the use consistent with applicable Executive Orders and Department and Service policies?	**X**	
(d) Is the use consistent with public safety?	**X**	
(e) Is the use consistent with goals and objectives in an approved management plan or other document?	**X**	
(f) Has an earlier documented analysis not denied the use or is this the first time the use has been proposed?	**X**	
(g) Is the use manageable within available budget and staff?	**X**	
(h) Will this be manageable in the future within existing resources?	**X**	
(i) Does the use contribute to the public's understanding and appreciation of the refuge's natural or cultural resources, or is the use beneficial to the refuge's natural or cultural resources?	**X**	
(j) Can the use be accommodated without impairing existing wildlife-dependent recreational uses or reducing the potential to provide quality (see section 1.6D. for description), compatible, wildlife-dependent recreation into the future?	**X**	

Where we do not have jurisdiction over the use ("no" to (a)), there is no need to evaluate it further as we cannot control the use. Uses that are illegal, inconsistent with existing policy, or unsafe ("no" to (b), (c), or (d)) may not be found appropriate. If the answer is "no" to any of the other questions above, we will generally not allow the use.

If indicated, the refuge manager has consulted with State fish and wildlife agencies. Yes ___ No __X__

When the refuge manager finds the use **appropriate** based on sound professional judgment, the refuge manager must justify the use in writing on an attached sheet and obtain the refuge supervisor's concurrence.

Based on an overall assessment of these factors, my summary conclusion is that the proposed use is:

Not Appropriate ______ Appropriate __X__

Refuge Manager:____ Date:_______________________

If found to be **Not Appropriate**, the refuge supervisor does not need to sign concurrence if the use is a new use.
If an existing use is found **Not Appropriate** outside the CCP process, the refuge supervisor must sign concurrence.
If found to be **Appropriate**, the refuge supervisor must sign concurrence.

Refuge Supervisor:____ Date:________________________

A compatibility determination is required before the use may be allowed.

FWS Form 3-2319 02/06

Finding of Appropriateness of a Refuge Use
Supplement to FWS Form 3-2319
Research

Further Explanation of Answers Provided for the Decision Criteria:

Project: Conducting research on refuge lands and waters

Summary: The Refuge receives requests to conduct scientific research on refuge lands and waters. Research applicants must submit a proposal that would outline: 1) objectives of the study; 2) justification for the study; 3) detailed methodology and schedule; 4) potential impacts on Refuge wildlife and/or habitat, including disturbance (short and long term), injury, or mortality; 5) personnel required; 6) costs to Refuge, if any; and 7) end products (i.e. reports, publications). Research proposals would be reviewed by Refuge staff, Regional Office Branch of Refuge Biology, and others as appropriate prior to the refuge issuing a special use permit (SUP). Projects will not be open-ended, and at a minimum, will be reviewed annually.

For each of the findings listed on FWS Form 3-2319, a justification has been provided below:

(a) Do we have jurisdiction over the use?

Some or all of the proposed activities would take place within refuge boundaries. The refuge has jurisdiction over those research projects that are sited within refuge boundaries.

(b) Does the use comply with applicable laws and regulations (Federal, State, tribal, and local)?

Any proposed research activities would comply with all applicable laws and regulations and any restrictions or qualifications that are required to comply with law and regulations would be specified in the SUP.

(c) Is the use consistent with applicable Executive orders and Department and Service policies?

Through the review of individual projects, the refuge would ensure that they are consistent with applicable policies, especially Research on Service Lands Policy (803 FW 1).

(d) Is the use consistent with public safety?

Through individual project review, the refuge will ensure that each project is consistent with public safety. If necessary, stipulations to ensure public safety will be included in the project's SUP.

(e) Is the use consistent with goals and objectives in an approved management plan or other document?

Research activities are approved in instances where they can provide meaningful data that may contribute to refuge management and public appreciation of natural resources.

(f) Is the use manageable within available budget and staff?

The refuge receives fewer than 6 requests per year for this activity and it is manageable with available budget and staff.

(g) Will this be manageable in the future within existing resources?

The proposed activity at current levels would be manageable in the future with the existing resources (see above).

(h) Does the uses contribute to the public's understanding and appreciation of the refuge's natural or cultural resources, or is the use beneficial to the refuge's natural or cultural resources?

The proposed use is beneficial to the refuge's natural and cultural resources because the types of research projects approved are those which have the distinct likelihood to help achieve refuge purposes by providing information useful for the management of trust resources and may contribute to the public's understanding and appreciation of natural and/or cultural resources.

(i) Can the use be accommodated without impairing existing wildlife-dependent recreational uses or reducing the potential to provide quality (see section 1.6D, 603 FW 1, for description), compatible, wildlife-dependent recreation into the future?

The refuge will ensure that the research activities will not impair existing or future wildlife-dependent recreational use of the refuge during individual project review, prior to issuing a SUP for the project.

Appendix C. Compatibility Determinations

Introduction

The compatibility determinations (CDs) developed during the CCP planning process evaluates uses projected to occur under Alternative 2, the Preferred Alternative in the Draft CCP/EIS for the Willapa National Wildlife Refuge CCP.

The evaluation of funds needed for management and implementation of each use also assumes implementation as described under Alternative 2. Chapter 6 of the Draft CCP/EIS also contains a cumulative effects analysis of the impacts related to public use, wildlife, and habitats.

A. Uses Evaluated at This Time

The following section includes CDs for all refuge uses that are required to be evaluated at this time. According to Service policy, compatibility determinations will be completed for all uses proposed under a CCP. Existing wildlife-dependent recreational uses must also be re-evaluated and new CDs prepared during development of a CCP or every 15 years, whichever comes first. Uses other than wildlife-dependent recreational uses are not explicitly required to be re-evaluated in concert with preparation of a CCP, unless conditions of the use have changed or unless significant new information relative to the use and its effects have become available or the existing CDs are more than 10 years old. However, the Service planning policy recommends preparing CDs for all individual uses, specific use programs, or groups of related uses associated with the proposed action. Accordingly, the following CDs are included in this document for public review.

Refuge Use	Compatible	Next Year Due for Re-evaluation
Waterfowl Hunting: Lewis, Porter Point, Riekkola, Leadbetter, Potshot, North Potshot, Stanley Peninsula	yes	2025
Big Game and Upland Game Bird Hunting (Elk, Deer, Bear, and Grouse)	yes	2025
Sport Fishing	yes	2025
Environmental Education, Interpretation, Wildlife Observation, and Photography	yes	2025
Camping: Long Island	yes	2020
Haying, Silage Harvest, and Cattle Grazing	yes	2020
Research, Scientific Collecting, and Surveys,	yes	2020

B. Compatibility—Legal and Historical Context

Compatibility is a tool refuge managers use to ensure that recreational and other uses do not interfere with wildlife conservation, the primary focus of refuges. Compatibility is not new to the Refuge System; the concept dates back to 1918. As policy, it has been used since 1962. The Refuge Recreation Act of 1962 directed the Secretary of the Interior to allow only those public uses of refuge lands that were "compatible with the primary purposes for which the area was established." If a general public use is determined to be appropriate, the use must then undergo a compatibility review. A compatibility review is required for all appropriate public uses, including wildlife-dependent recreational uses.

The term "compatible use" is defined as a wildlife dependent recreational use or any other use of a refuge that, in the sound professional judgment of the Refuge Manager, will not materially interfere with or detract from the fulfillment of the mission of the Refuge System or the purposes of the refuge.

The Administration Act defines sound professional judgment as a finding, determination, or decision that is consistent with principles of sound fish and wildlife management and administration, available science and resources, and adherence to other applicable laws. Included in this finding, determination, or decision is a Refuge Manager's field experience and knowledge of the particular refuge's resources.

Part 603 FW 2 of the Fish and Wildlife Service Manual sets forth the policy and guidelines for determining compatibility of proposed uses and provides procedures for documentation and periodic review of existing uses. In addition, the policy requires an opportunity for public review and comment on all compatibility determinations. When prepared in conjunction with a CCP, compatibility determinations are distributed for public review along with the draft CCP and environmental impact statement (EIS).

Under compatibility policy, uses are defined as recreational, economic/commercial, or management use of a Refuge by the public or a non-Refuge System entity. Uses generally providing an economic return (even if conducted for the purposes of habitat management) are also subject to compatibility determinations. The Service does not prepare compatibility determinations for uses when the Service does not have jurisdiction. For example, the Service may have limited jurisdiction over refuge areas where property rights are vested by others; where legally binding agreements exist; or where there are treaty rights held by tribes. In addition, aircraft over-flights, emergency actions, some activities on navigable waters, and activities by other Federal agencies on "overlay Refuges" are exempt from the compatibility review process.

New compatibility policy, developed in response to the 1997 amendments to the National Wildlife Refuge System Administration Act (Administration Act), was adopted by the Service in October 2000 (http://refuges.fws.gov/policymakers/nwrpolicies.html). The policy requires that a use must be compatible with both the mission of the System and the purposes of the individual refuge. This standard helps to ensure consistency in application across the Refuge System.

The Service recognizes that compatibility determinations are complex. For this reason, refuge managers are required to consider "principles of sound fish and wildlife management" and "best available science" in making these determinations (House of Representatives Report 105-106). Evaluations of the existing uses on Willapa Refuge are based on the professional judgment of Refuge personnel including observations of Refuge uses and reviews of appropriate scientific literature.

The Refuge Manager has the authority to determine, by exercising sound professional judgment, what is a compatible use. In addition to determining if a use would materially interfere with or detract from the fulfillment of the System mission or the purposes of the refuge, the Refuge Manager must also evaluate the direct and indirect impacts of a use on refuge resources. Further, the cumulative impacts of the use when conducted in conjunction with other existing or planned uses of the refuge must also be considered. After evaluating the anticipated impacts of a proposed use and determining if any stipulations (terms or conditions) are needed to avoid or minimize potential adverse impacts, the Refuge Manager will determine whether or not the use is compatible. This determination is documented in writing and is available for review by the public.

A proposed use can be denied without determining compatibly under certain circumstances, such as instances in which:

1. a proposed use would conflict with other applicable laws or regulations;
2. the use would result in conflicts with the goals or objectives of an approved CCP; or
3. a use is determined to be inconsistent with public safety.

Refuges are closed to all public uses until officially opened. Regulations require that adequate funds be available for administration and protection of refuges before opening them to any public uses. However, wildlife-dependent recreational uses (hunting, fishing, wildlife observation and photography, and environmental education and interpretation) are to receive enhanced consideration and cannot be rejected simply for lack of funding resources unless the Refuge has made a concerted effort to seek out funds from all potential partners. Once found compatible, wildlife-dependent recreational uses are deemed the priority public uses at a refuge. If a proposed use is found not compatible, the use must be modified to be compatible or if the use cannot be modified to be compatible, then the use may not be allowed. Economic uses that are conducted by or authorized by the refuge also require compatibility determinations.

References

House of Representatives Report 105-106 (on NWRSIA):
http://refuges.fws.gov/policyMakers/mandates/HR1420/part1.html

Compatibility regulations, adopted by the Service in October 2000:
http://refuges.fws.gov/policymakers/nwrpolicies.html

C.1 Draft Compatibility Determination for Waterfowl Hunting on Willapa National Wildlife Refuge

Use: Hunting (Waterfowl)

Refuge Name: Willapa National Wildlife Refuge

Location: Pacific County, Washington

Date Established: 1936

Establishing and Acquisition Authorities

- Migratory Bird Conservation Act of 1929, as amended (16 U.S.C. 715-715s)
- Executive Order 7541, Willapa Harbor Migratory Bird Refuge, Washington, signed: January 22, 1937
- Fish and Wildlife Act of 1956, as amended (16 U.S.C. § 742a-754c)
- Land and Water Conservation Fund Act of 1965, as amended (16 U.S.C. § 4601-4601.11)
- Endangered Species Act of 1973, as amended (16 U.S.C .1532-1544, 87 Stat 884)
- Refuge Recreation Act of 1962, as amended (16 U.S.C. 460k-460k-4)

Refuge Purpose(s)

The purposes for the Willapa NWR have been identified in historic legal documentation establishing and adding refuge lands. The Refuge was originally established to preserve an important wintering and foraging habitat for migratory waterfowl in the Pacific Flyway with Refuges Purposes specified as follows:

... as a refuge and breeding ground for migratory birds and other wildlife: ... Executive Order 7541, dated Jan. 22, 1937

"... for use as an inviolate sanctuary, or for any other management purpose, for migratory birds." 16 U.S.C. § 715d (Migratory Bird Conservation Act)

"... suitable for— (1) incidental fish and wildlife-oriented recreational development, (2) the protection of natural resources, (3) the conservation of endangered species or threatened species ..." 16 U.S.C. § 460k-1

"... the Secretary ... may accept and use ... real ... property. Such acceptance may be accomplished under the terms and conditions of restrictive covenants imposed by donors ...” 16 U.S.C. § 460k-2 (Refuge Recreation Act (16 U.S.C. § 460k-460k-4), as amended).

"... for the development, advancement, management, conservation, and protection of fish and wildlife resources ..." 16 U.S.C. § 742f(a)(4)

"... for the benefit of the United States Fish and Wildlife Service, in performing its activities and services. Such acceptance may be subject to the terms of any restrictive or affirmative covenant, or condition of servitude ..." 16 U.S.C. § 742f(b)(1) (Fish and Wildlife Act of 1956)

In accordance with 601 FW1, all lands acquired since the original establishment of the Refuge retain this purpose.

Management priorities are further stated in subsequent land acquisition documents to preserve, protect, and restore newly acquired habitats and provide habitat for other migratory birds, plants and wildlife with special emphasis for marbled murrelets, bald eagles, Aleutian Canada geese, shorebirds, marsh birds, wading birds, and water howellia (plant). Documentation for additional lands also identified the following habitats, wildlife, public opportunities, and management priorities to support a diverse assemblage of native fish, wildlife, and plants which includes: eelgrass beds, gravel bars, old-growth/mature forests, riverine habitats, intertidal mudflats, sand dune habitat, fish species (coho, Chinook, chum salmon, steelhead, sea-run cutthroat trout), amphibian diversity, compatible wildlife-dependent recreation, educational/research opportunities, and cultural resource sites.

Management priorities are further derived from various legal and land acquisition documents:

"…one of the most important concentration points for migratory waterfowl on the Washington Coast. It has a fine supply of natural aquatic foods, especially eel-grass, and there by has been for years one of the few suitable wintering grounds available for Black Brant…it is essential for the preservation of the Pacific flyway that the Restoration program provide adequate sanctuary facilities for migratory birds in that state." (Migratory Bird Conservation Commission Memorandum, Memo 16, May 7, 1936)

…as a refuge and breeding ground for migratory birds and other wildlife… (Executive Order 7541, dated Jan. 22 1937)

…in order to effectuate further the purposes of the Migratory Bird Conservation Act (45 Stat. 1222)" and states that "Provided, that any private lands within the area described shall become a part of the refuge upon the acquisition of title thereto or lease thereof by the United States. (Executive Order 7721, October 8, 1937)

… for use as an inviolate sanctuary. Or for any other management purpose, for migratory birds." 16 U.S.C. § 715d (Migratory Bird Conservation Act)

…To preserve and protect unique ecosystems associated with Willapa Bay…To provide for maximum use and production by migratory birds other than wintering waterfowl, with special emphasis on bald eagles and marsh and wading birds. (Long Island Land Exchange; September 1983)

…protect habitat for old growth dependent species including the threatened marbled murrelet and threatened northern spotted owl… protect and restore upland forest and associated stream habitat in order to protect and enhance declining fish populations, including coastal cutthroat trout, and Chinook, coho, and chum salmon runs… protect and restore coastal wetlands to provide a diversity of habitats for migratory waterfowl, shorebirds, wading birds, and

songbirds…protect the intertidal mudflats along Willapa Bay by consolidating spartina infested lands for better management of control and eradication efforts on existing Refuge lands and on adjacent tidelands.…provide large scale habitat management through linking existing Refuge lands in a contiguous Refuge boundary, and provide wildlife-dependent public use opportunities compatible with Refuge purposes. (Willapa Addition Environmental Assessment/ Land Protection Plan, and Conceptual Management Plan 1999)

National Wildlife Refuge System Mission:

The mission of the System is to administer a national network of lands and waters for the conservation, management, and where appropriate, restoration of the fish, wildlife, and plant resources and their habitats within the United States for the benefit of present and future generations of Americans.

Description of Use:

This compatibility determination examines existing and proposed sport hunting for waterfowl on designated units of the Refuge under Alternative 2 (preferred alternative) of the CCP/EIS. The Refuge currently provides 2,894 acres available for waterfowl hunting on Leadbetter Point and the South Bay Units. Under alternative 2, waterfowl hunting (geese included) would be expanded to 6,058 acres once the proposed estuarine restoration project is completed in the South Bay.

Existing waterfowl hunting

Portions of the Leadbetter Point Unit are open to walk-in duck and goose hunting. Access is by Stackpole Road. Hunting is prohibited in the snowy plover closure area. The Stanley, Potshot, and North Potshot units are also open during the Washington State hunting season for waterfowl.

The Riekkola Unit is open to goose hunting only from blinds. Blind selection is done by lottery early the morning of each hunt. There is a small fee for use of the blinds. Funds from the fee go to help maintain the blinds. Although dogs are normally not permitted on the Refuge, they are allowed when actively engaged in hunting waterfowl and must be kept under control at all times.

Access to the Porter Point Unit occurs through the Riekkola Unit, off 67th Street in Long Beach. The Porter Point Unit is suitable for car-top boats and small craft that can be easily moved. No gas-powered engines are allowed in the freshwater wetland. Parking is available across the Riekkola Unit pastures in a delineated graveled parking area with 10 sites for waterfowl hunters. The freshwater wetland can be accessed by the Porter Point Unit levee or boating the wetland. The saltwater marsh of Willapa Bay can be reached from the existing footbridge on the east end of Porter Point Unit or by walking into the bay from the levee on the west end of the unit. Signs are placed on the east and west boundary of the Porter Point Unit, extending into the bay, to delineate the hunt area.

The schedule for the waterfowl hunt has been designed to best accommodate multiple users on adjacent areas throughout the week. A regulated goose hunt occurs on an adjacent pasture on the Riekkola Unit Wednesday and Saturday. To reduce impacts to the goose hunt, waterfowl hunting is open Sunday, Monday and Thursday on the Porter Point Unit. Gates are open from 6 am until

5 pm. The Porter Point Unit is open for other wildlife observation on Tuesday and Friday during the waterfowl hunt season. All users other than waterfowl hunters walk in through the pedestrian gate at the main Riekkola Unit entrance by way of 67th Street.

Expanded waterfowl hunt areas proposed include

The proposed expanded waterfowl hunt area identified in Alternative 2 (preferred alternative) of the draft CCP/EIS would include opening to waterfowl hunting all newly restored areas in the South Bay (Porter Point Unit, Lewis Unit, Riekkola Unit, and portions of the Tarlatt Unit). All areas of the Refuge (excluding the Presidential Proclamation Boundary and portions of the Tarlatt Unit) would be open in accordance with the state season for waterfowl hunting. While the location of the existing temporary goose blinds would no longer exist due to the proposed tidal restoration of the area in the Riekkola Unit, the Refuge would evaluate locations for construction of several wood blinds and ensure that hunters with disabilities are adequately accommodated.

Waterfowl Closure Areas

The new headquarters office/visitor contact station would be located on the Tarlatt Unit, necessitating closure to goose hunting. The Presidential Proclamation Boundary surrounding Long Island would remain closed to all waterfowl hunting.

Specific species/numbers to be taken and hunting periods would be set by Washington Department of Fish and Wildlife (WDFW) to match adjacent areas open to waterfowl hunting. Under this proposal, hunting would be allowed consistent with state regulations except as specifically noted herein. Geese, ducks, coots, and common snipe would be permitted to be taken. Hunters may use dogs to aid in retrieval of birds but dogs would need to be kept under control at all times. Hunters may set up temporary blinds along the shoreline which must be removed at the conclusion of each hunting period. Under the preferred alternative, waterfowl hunting would occur within the tidally influenced Willapa Bay. Access to the waterfowl hunting areas would be by boat and/or foot access only.

Both existing and proposed waterfowl hunting opportunities would complement state-permitted activities. Hunting is currently permitted on State of Washington–owned waters and tidelands within Willapa Bay. These adjacent waters are all tidally influenced submerged lands below mean high water. The Presidential Proclamation Boundary would remain closed for protection of migratory birds.

Recreational hunting (a wildlife-dependent activity) has been identified in the National Wildlife Refuge System Administration Act, as amended, as a priority public use, provided it is compatible with the mission of the National Wildlife Refuge System and purpose for which a refuge was established. The Act declares that compatible wildlife-dependent recreational uses are legitimate and appropriate priority general public uses of the Refuge System. The six uses—hunting, fishing, wildlife observation and photography, and environmental education and interpretation—are to receive enhanced consideration in planning and management over all other general public uses of the Refuge System. When found compatible, these wildlife-dependent recreational uses are to be strongly encouraged.

Availability of Resources:

This expanded hunt opportunity would not require any new infrastructure or personnel. Administration of the hunt and annual coordination with the State of Washington would be required as would some law enforcement patrols. However, refuge staff is in place and capable of conducting these additional duties. The annual revision and printing of the refuge brochure and updates to the refuge website and other outreach information would be required at an estimated cost of $9,000. Refuge base funding is available to cover these costs.

Anticipated Impacts of Described Use:

The number of hunters expected to use the South Bay and Leadbetter Point Units for hunting would be small, probably two to five parties at most per day. Waterfowl hunting already occurs on portions of the Refuge, state-owned waters, and tidelands in adjacent waters. The Presidential Proclamation Boundary area is closed to all migratory bird hunting and provides 11,000 acres of protected area for migratory birds within Willapa Bay.

Bird species which could be temporarily disturbed by the proposed alternative include bald eagles, great blue herons, shorebirds, and other birds that reside within the riparian and saltwater estuary habitat of Willapa Bay. No effects are expected for fish populations of Willapa Bay or the Refuge.

It is the policy of the Service to protect and preserve all native species of fish, amphibians, reptiles, birds, mammals, fish, invertebrates, and plants, including their habitats, which are designated, threatened or endangered with extinction. This includes protecting their habitats. Endangered, threatened, proposed, and candidate species that occur on or near the Refuge include marbled murrelet, northern spotted owl, western snowy plover, streaked horned lark, and pink sandverbena.

Under Section 7 of the Endangered Species Act of 1973, the Service is required to complete an evaluation of the proposed activity to ensure that the action does not unacceptably affect listed species such as those identified above. This Section 7 evaluation is attached to the CCP/EIS.

Effects to other public uses are expected to be minimal due to the time of year waterfowl hunting takes place. Public use of the South Bay Units is minimal during the fall and winter due to inclement weather. Other recreational uses such as kayaking or boating in Willapa Bay have ceased by this time of year or are at minimal levels in the fall/winter months.

Although hunting directly impacts individuals, the amount of waterfowl harvest is not expected to change or to have a measurable effect on refuge, Willapa Bay, or Pacific Flyway populations, as waterfowl hunting is already occurring on the shorelines and in the estuarine sloughs of Willapa Bay and waterfowl hunting activity is not extremely high. Hunting may be either compensatory or additive to natural mortality (Anderson 1995). Compensatory mortality occurs when hunting substitutes for other forms of mortality (disease, competition, predation, severe weather, etc.) Additive mortality occurs when hunting compounds the total mortality. In some cases, hunting can be used as a management tool to control populations. In concert with Canada, Mexico, and multi-state flyway councils, the Service and state wildlife agencies regulate hunting so that harvest does not reduce populations to unsustainable levels.

Direct effects of hunting on waterfowl are mortality, wounding, and disturbance (DeLong 2002). Hunting can alter behavior (e.g., foraging time), population structure, and distribution patterns of wildlife (Bartelt 1987; Cole and Knight 1990 Madsen 1985; Owens 1977; Raveling 1979; Thomas 1983; White-Robinson 1982). In Denmark, hunting was documented to affect the diversity and number of birds using a site (Madsen 1995). Avian diversity changed from predominantly mute swan and mallard to a more even distribution of a greater number of species when a sanctuary was established. Hence, species diversity increased with the elimination of hunting. There also appears to be an inverse relationship between the numbers of birds using an area and hunting intensity (DeLong 2002). In Connecticut, lesser scaup were observed to forage less in areas that were heavily hunted (Cronan 1957). In California, the numbers of northern pintails on Sacramento NWR non-hunt areas increased after the first week of hunting and remained high until the season was over in early January (Heitmeyer and Raveling 1988). Following the close of hunting season, ducks generally increased their use of the hunt area; however, use was lower than before the hunting season began.

Human disturbance to wintering birds and other wildlife using the open waters of the Willapa Bay and associated tributaries would occur as a result of hunting activity. Migratory and wintering waterfowl generally attempt to minimize time spent in flight and maximize foraging time because flight requires considerably more energy than any other activity, other than egg laying. Human disturbance associated with hunting includes loud noises and rapid movements, such as those produced by shotguns and boats powered by outboard motors. This disturbance, especially when repeated over a period of time, compels waterfowl to change food habits, feed only at night, lose weight, or desert feeding areas (Madsen 1995; Wolder 1993). Disturbance levels from hunting activity outside Chincoteague NWR were found to be high enough to force wintering black ducks into a pattern of nocturnal feeding within surrounding salt marsh and diurnal resting within Refuge impoundments (Morton et al. 1989a, 1989b). Unhunted populations have been documented to behave differently from hunted ones (Wood 1993).

These impacts can be reduced by the presence of adjacent sanctuary areas where hunting does not occur, and birds can feed and rest relatively undisturbed. Sanctuaries or non-hunt areas have been identified as the most common solution to disturbance problems caused from hunting (Havera et al 1992). Prolonged and extensive disturbances may cause large numbers of waterfowl to leave disturbed areas and migrate elsewhere (Madsen 1995; Paulus 1984). In Denmark, hunting disturbance effects were experimentally tested by establishing two sanctuaries (Madsen 1995). Over a five-year period, these sanctuaries became two of the most important staging areas for coastal waterfowl. Numbers of dabbling ducks and geese increased four- to 20-fold within the sanctuary (Madsen 1995). The 11,000-acre Presidential Proclamation Boundary area surrounding Long Island in south Willapa Bay is closed to all migratory bird hunting and acts as a sanctuary during the waterfowl season. Willapa Bay is tidally influenced and encompasses over 72,000 acres. In addition to the Presidential Proclamation Boundary area, vast portions of Willapa Bay’s tidal estuary act as de facto sanctuaries due to the limited accessibility thus reduction to waterfowl hunting pressure.

Intermittent hunting can be a means of minimizing disturbance, especially if rest periods in between hunting events are weeks rather than days (Fox and Madsen 1997). It is common for refuges to manage hunt programs with non-hunt days. At Sacramento NWR, 3% to 16% of pintails were located on hunted units during non-hunt days, but were almost entirely absent in those same units on hunt days (Wolder 1993). In addition, northern pintails, American wigeon, and northern shovelers decreased time spent feeding on days when hunting occurred on public shooting areas, as compared to non-hunt days (Heitmeyer and Raveling 1988). However, intermittent hunting may not always greatly reduce hunting impacts. The intermittent hunting program of three hunt days per week at Sacramento NWR results in lower pintail densities on hunt areas during non-hunt days than non-hunt areas (Wolder 1993). In Germany, several studies reported a range from a few days to approximately three weeks for waterbird numbers to recover to pre-disturbance levels (Fox and Madsen 1997). The proposed hunt will not be intermittent in order to provide consistent management with the existing Refuge waterfowl hunt program as well as on adjacent state lands and waters.

Public Review and Comment:

Open-house style public meetings were held, verbal and written comments were solicited from the public during public scoping for the CCP/EIS for the Willapa NWR. Appendix E of the draft CCP/EIS contains further details of public involvement during development of the CCP. Additional public review and comment will be solicited during the draft CCP/EIS comment period.

Determination:

______Use is Not Compatible

__**X**__Use is Compatible with the Following Stipulations

Stipulations Necessary to Ensure Compatibility:

The Refuge hunting programs is designed to provide a safe, quality experience with reasonable harvest opportunities, while avoiding significant impacts to other users and non-target wildlife resources. The Refuge has developed the following stipulations to reduce impacts and promote safety:

Waterfowl hunters would be expected to comply with all current and applicable state and Refuge regulations. This will be achieved through a combination of printed information, signing, outreach efforts, and enforcement of regulations by state and refuge law enforcement officers.

The salt marsh portions of the Porter Point, Lewis, Potshot, North Potshot, Stanley Peninsula, and Leadbetter Point units under refuge jurisdiction will be opened to public waterfowl hunting. The only exception to the open hunting zones is the Presidential Proclamation Boundary area, which is closed for the protection of all migratory birds.

Geese, ducks, coots, and common snipe will be allowed to be taken. Limits and hunting periods will be set by the WDFW to match adjacent areas open to waterfowl hunting.

Refuge staff and WDFW staff will consult on issues regarding law enforcement and any significant changes in the number or behavior of wildlife. Refuge regulations will be in accord with state regulations. Refuge and WDFW officers will patrol to ensure hunters are complying with all regulations and restrictions.

Temporary blinds may be constructed, but they must be available to everyone on a first-come, first-served basis.

Hunters may use dogs to aid in retrieval of birds but dogs will need to be kept under control at all times.

Only approved non-toxic shot will be allowed for the hunt.

Camping, overnight use, and fires are prohibited.

Justification: Hunting is one of the six designated wildlife-dependent public uses of the National Wildlife Refuge System. Refuges grant these six uses special consideration in planning and management. When on a refuge-specific basis one or more of these uses is determined compatible with the refuge purpose(s) and the NWRS mission, the refuge is to strongly encourage (facilitate) the use(s). Providing a quality hunting program contributes to achievement of refuge goals and purposes. By incorporating the South Bay Units and Leadbetter Point Unit into an existing waterfowl hunt program, no habitat degradation would be anticipated, disturbance to other birds and wildlife, if any, would be temporary and localized, and ample amounts of additional quality habitat for waterfowl and other wetland birds exists on the Refuge and in Willapa Bay. Thus, it is anticipated that wildlife populations will find sufficient food resources and resting places such that their abundance and use of the Refuge and local area will not be measurably lessened from waterfowl hunting activities. The relatively limited number of individuals expected to be removed from waterfowl populations due to hunting will not cause wildlife populations to materially decline, the physiological condition and production of hunted species will not be impaired, their behavior and normal activity patterns will not be altered dramatically, and their overall welfare will not be negatively impacted. The areas of refuge lands designated for waterfowl hunting complements activities permitted by Washington State on adjacent waters and tidelands and provides distinct, manageable hunt units that can be more easily delineated, posted, and enforced, resulting in less confusion for the waterfowl hunting public. In addition, due to the time of year and the limited access, no conflicts among refuge user groups are anticipated.

The waterfowl hunt program as described is determined to be compatible because potential impacts from waterfowl hunting within these specified units on other area waterfowl, and wildlife would be minimal and not materially interfere with or detract from achievement of the NWRS mission or from the Service’s ability to achieve refuge wildlife, habitat, or other public-use-related purposes and goals.

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Mandatory Re-evaluation Date (provide month and year for “allowed” uses only):
__X__ Mandatory 15-year Re-evaluation Date will be provided in the Final CCP/EIS (for priority public uses)

______Mandatory 10-year Re-evaluation (for all uses other than priority public uses)

NEPA Compliance for Refuge Use Decision:

______ Categorical Exclusion without Environmental Action Statement

______ Categorical Exclusion and Environmental Action Statement

______ Environmental Assessment and Finding of No Significant Impact

__**X**__ Environmental Impact Statement and Record of Decision

Signatures:

Hunting (Waterfowl)

Prepared by:	______________________ (Signature)	__________ (Date)
Refuge Manager/ Project Leader Approval:	______________________ (Signature)	__________ (Date)

Concurrence

Refuge Supervisor:	______________________ (Signature)	__________ (Date)
Regional Chief, National Wildlife Refuge System:	______________________ (Signature)	__________ (Date)

C.2 Draft Compatibility Determination for Big Game and Upland Bird Hunting on Willapa National Wildlife Refuge

Use: Hunting (Big Game and Upland Game Bird)

Refuge Name: Willapa National Wildlife Refuge

Location: Pacific County, Washington

Date Established: 1936

Establishing and Acquisition Authorities:

- Migratory Bird Conservation Act of 1929, as amended (16 U.S.C. 715-715s)
- Executive Order 7541, Willapa Harbor Migratory Bird Refuge, Washington, signed: January 22, 1937
- Fish and Wildlife Act of 1956, as amended (16 U.S.C. § 742a-754c)
- Land and Water Conservation Fund Act of 1965, as amended (16 U.S.C. § 4601-4601.11)
- Endangered Species Act of 1973, as amended (16 U.S.C .1532-1544, 87 Stat 884)
- Refuge Recreation Act of 1962, as amended (16 U.S.C. 460k-460k-4)

Refuge Purpose(s):

The purposes for the Willapa NWR have been identified in historic legal documentation establishing and adding refuge lands. The Refuge was originally established to preserve an important wintering and foraging habitat for migratory waterfowl in the Pacific Flyway with Refuges Purposes specified as follows:

... as a refuge and breeding ground for migratory birds and other wildlife: ... Executive Order 7541, dated Jan. 22, 1937

"... for use as an inviolate sanctuary, or for any other management purpose, for migratory birds." 16 U.S.C. § 715d (Migratory Bird Conservation Act)

"... suitable for— (1) incidental fish and wildlife-oriented recreational development, (2) the protection of natural resources, (3) the conservation of endangered species or threatened species ..." 16 U.S.C. § 460k-1

"... the Secretary ... may accept and use ... real ... property. Such acceptance may be accomplished under the terms and conditions of restrictive covenants imposed by donors ...” 16 U.S.C. § 460k-2 (Refuge Recreation Act (16 U.S.C. § 460k-460k-4), as amended).

"... for the development, advancement, management, conservation, and protection of fish and wildlife resources ..." 16 U.S.C. § 742f(a)(4)

"... for the benefit of the United States Fish and Wildlife Service, in performing its activities and services. Such acceptance may be subject to the terms of any restrictive or affirmative covenant, or condition of servitude ..." 16 U.S.C. § 742f(b)(1) (Fish and Wildlife Act of 1956)

In accordance with 601 FW1, all lands acquired since the original establishment of the Refuge retain this purpose.

Management priorities are further stated in subsequent land acquisition documents to preserve, protect, and restore newly acquired habitats and provide habitat for other migratory birds, plants and wildlife with special emphasis for marbled murrelets, bald eagles, Aleutian Canada geese, shorebirds, marsh birds, wading birds, and water howellia (plant). Documentation for additional lands also identified the following habitats, wildlife, public opportunities, and management priorities to support a diverse assemblage of native fish, wildlife, and plants which includes: eelgrass beds, gravel bars, old-growth/mature forests, riverine habitats, intertidal mudflats, sand dune habitat, fish species (coho, Chinook, chum salmon, steelhead, sea-run cutthroat trout), amphibian diversity, compatible wildlife-dependent recreation, educational/research opportunities, and cultural resource sites.

Management priorities are further derived from various legal and land acquisition documents:

"…one of the most important concentration points for migratory waterfowl on the Washington Coast. It has a fine supply of natural aquatic foods, especially eel-grass, and there by has been for years one of the few suitable wintering grounds available for Black Brant…it is essential for the preservation of the Pacific flyway that the Restoration program provide adequate sanctuary facilities for migratory birds in that state." (Migratory Bird Conservation Commission Memorandum, Memo 16, May 7, 1936)

…as a refuge and breeding ground for migratory birds and other wildlife… (Executive Order 7541, dated Jan. 22 1937)

…in order to effectuate further the purposes of the Migratory Bird Conservation Act (45 Stat. 1222)" and states that "Provided, that any private lands within the area described shall become a part of the refuge upon the acquisition of title thereto or lease thereof by the United States. (Executive Order 7721, October 8, 1937)

… for use as an inviolate sanctuary. Or for any other management purpose, for migratory birds." 16 U.S.C. § 715d (Migratory Bird Conservation Act)

…To preserve and protect unique ecosystems associated with Willapa Bay…To provide for maximum use and production by migratory birds other than wintering waterfowl, with special emphasis on bald eagles and marsh and wading birds. (Long Island Land Exchange; September 1983)

…protect habitat for old growth dependent species including the threatened marbled murrelet and threatened northern spotted owl… protect and restore upland forest and associated stream habitat in order to protect and enhance declining fish populations, including coastal cutthroat trout, and Chinook, coho, and chum salmon runs… protect and restore coastal wetlands to provide a diversity of habitats for migratory waterfowl, shorebirds, wading birds, and

songbirds…protect the intertidal mudflats along Willapa Bay by consolidating spartina infested lands for better management of control and eradication efforts on existing Refuge lands and on adjacent tidelands.…provide large scale habitat management through linking existing Refuge lands in a contiguous Refuge boundary, and provide wildlife-dependent public use opportunities compatible with Refuge purposes. (Willapa Addition Environmental Assessment/ Land Protection Plan, and Conceptual Management Plan 1999)

National Wildlife Refuge System Mission:

The mission of the System is to administer a national network of lands and waters for the conservation, management, and where appropriate, restoration of the fish, wildlife, and plant resources and their habitats within the United States for the benefit of present and future generations of Americans

Description of Use:

This compatibility determination examines existing and proposed sport hunting for elk, deer, bear, and grouse on designated units of the Refuge under Alternative 2 (preferred alternative) of the CCP/EIS. The Refuge currently has 8,020 acres available for big game hunting. Under this alternative, Long Island would continue as currently opened to archery only for the take of grouse, bear, deer, and elk. All mainland properties and existing open portions of the Headquarters Unit and Bear River Unit would also continue as they are now open to the take of bear, deer, and elk in accordance with WDFW regulations. Expansion of elk and deer hunting opportunities on the Refuge under this alternative (see Appendix M) would include approximately 1,700 acres on the Leadbetter Point Unit (permit only muzzleloader hunt and as necessary an expanded permit only elk hunt); South Bay Units and East Hills Units would include elk and deer hunting as refuge expansion opportunities occur.

Existing elk and deer hunting areas include the Long Island Unit and designated portions of the East Hills Units from the Bear River to Teal Slough. Hunting for black bear or grouse is allowed on Long Island only—no bear or grouse hunting is allowed on the mainland. Proposed elk and deer hunting areas include the upland areas of the South Bay Units (Lewis, Porter Point, Riekkola, and Tarlatt) and proposed lands acquired in the future through the land acquisition process where deemed compatible. A regulated (permit only) early season muzzleloader elk hunt and special permit hunt at Leadbetter Point Unit is also proposed (see Map 9 in draft CCP/EIS).

All existing and proposed hunting areas are located within Pacific County, Washington. Under this compatibility determination, elk, deer, bear, and grouse hunting would be allowed consistent with Washington State regulations except as specifically noted herein. The Long Island Unit is open to archery hunting only for elk, deer, bear, and grouse and requires a refuge hunting permit. The proposed expansion of deer and elk hunting will include proposed new upland lands in the East Hills Units and the upland areas of the South Bay Units (Lewis, Porter Point, Riekkola, and Tarlatt). Hunters may set up temporary tree stands, which must be removed at the conclusion of each hunting period. Specific species/numbers to be taken and hunting periods will be set by Washington Department of Fish and Wildlife (WDFW) to match adjacent areas open to hunting.

Maintaining and expanding hunting opportunities on the Leadbetter Point Unit, East Hills Units, the South Bay Units for elk and deer and Long Island Unit for elk, deer, bear, and grouse hunting would complement state permitted hunting activities. This would resolve potential problems over the exact position of the refuge boundary on the mainland units that would exist with a deer hunt closure, and associated enforcement of relevant laws and regulations.

Recreational hunting (a wildlife-dependent activity) has been identified in the National Wildlife Refuge System Administration Act, as amended, as a priority public use, provided it is compatible with the purpose for which the refuge was established. The Act declares that compatible wildlife-dependent recreational uses are legitimate and appropriate priority general public uses of the Refuge System. The six uses—hunting, fishing, wildlife observation and photography, and environmental education and interpretation—are to receive enhanced consideration in planning and management over all other general public uses of the Refuge System. When compatible, these wildlife-dependent recreational uses are to be strongly encouraged.

Existing Big Game and Upland Game Bird Hunting Opportunities

- Long Island: The Long Island Unit is annually open to archery hunting of elk, deer, bear, and grouse hunting only and in addition requires a specific refuge hunting permit.
- East Hills Units: Existing elk and deer hunting areas include designated portions of the East Hills Unit (from the Bear River to Teal Slough).

Proposed Elk and Deer Hunting Opportunities (draft CCP/EIS, Alternative 2)

- Leadbetter Point Unit: Expanding wildlife-dependent public use hunting opportunities to include a regulated (permit only) early season muzzleloader elk hunt and a special permit hunt.
- South Bay Units (Lewis, Porter Point, Riekkola, and a portion of the Tarlatt Unit): Expanding wildlife-dependent public use hunting opportunities to include elk and deer hunting once the proposed tidal restoration activities have been completed. New refuge lands acquired under this alternative would also be open to elk and deer hunting once restoration activities are complete.
- Nemah/Naselle Unit, East Hills Units: Elk and deer hunting opportunities would continue upon acquisition of any new areas.

Areas Closed

- Headquarters, Housing Quarters, and Tarlatt Slough area: Areas closed to hunter access include the current refuge headquarters, housing quarters, the proposed area for the new refuge headquarters (Tarlatt Unit), and the proposed wildlife observation trail/overlook area (see Map 9 in draft CCP/EIS).

Proposed Elk and Deer Hunt on South Bay Units

The South Bay Units are currently not open to deer and elk hunting due to existing facilities, Refuge management activities, and public use programs. It is proposed that these areas be opened to elk and deer hunting once tidal restoration activities are complete in the South Bay subunits which include Lewis, Porter Point, Riekkola, and a portion of Tarlatt Slough. All of the existing South Bay subunits and any future acquisitions are located in the same muzzleloader zone as the Leadbetter Point Unit and therefore would typically be open for approximately five days in early October. Once tidal restoration is complete in South Bay, there would be no roads, trails, fences, equipment facilities, or cattle grazing for pasture management. The existing regulated goose hunt program and associated infrastructure would no longer exist, nor would the regulated waterfowl hunt. While these areas would be open to goose and duck hunting in accordance with state season, the use would be along tidal channels and flats and waterfowl hunters would be much less concentrated. The birding public and those out to observe wildlife while having access to the South Bay Units would most likely concentrate their visits to the new office/visitor center and associated trail and observation tower. Therefore, it is not anticipated that any proposed elk or deer hunt would impact, nor create a safety problem with other public uses.

Proposed Elk and Deer Hunt Nemah/Naselle Unit and East Hills Additions

Currently, the land owners allow elk and deer hunting on these proposed refuge acquisition areas. The Refuge would continue this wildlife-dependent public use activity for any new acquisitions in the future. Elk and deer hunting opportunities would be considered upon acquisition of any new areas in the future and would resolve potential problems over the exact position of the refuge boundary and complement local hunting activities on adjacent lands.

Proposed Elk Hunt on the Leadbetter Point Unit

The entire unit would be open to the regulated (permit only) early elk muzzleloader season, which typically lasts approximately five days in early October. The public would be notified that the entire unit would be closed to all other uses including hiking and waterfowl hunting. Public use of the trails during this time is minimal, due to the inclement weather and seasonal rains that regularly flood the trails. The proposed hunt falls outside the general tourist season. Since the waterfowl hunting season is much longer than the elk muzzleloader season, there would be little, if any, impact on this user group. In keeping with existing elk hunting regulations on adjacent private property and for safety purposes, the use of muzzleloader firearms would only be authorized.

The Refuge proposes a special elk hunt to be offered sometime between October and February on this unit only. If elk are not found within the unit during the early muzzleloader hunt season, or the elk hunt proves unsuccessful due to weather or other uncontrollable influences, the special permit hunt could then be implemented. Opening the special permit hunt would offer an opportunity to assist the state in management of the expanding elk herd. This additional hunt would draw from a pool of hunters who have applied for a muzzleloader permit through WDFW. The number of permits in this additional hunt would be determined after consultation with WDFW after the early season hunt.

Issuing the special permit for the muzzleloader elk hunt provides the refuge staff with an opportunity to control the number and timing of hunters in a specific area, thereby reducing potential hunter impacts to the resource and/or other refuge users. Providing permits addresses the elk management issue by limiting the amount of animals taken or not taken in the area. Due to the size and shape of the unit and limited access points, the number of hunters would be regulated. There is the potential for elk hunters to disturb waterfowl and waterfowl hunters at certain times of the year. The permit system offers staff the opportunity to monitor take and potential impacts to resources while providing an opportunity for a quality and safe hunting experience.

Availability of Resources:

The proposed continuation and expansion of big game and upland game bird hunting would not require any new infrastructure or personnel. Administration of the hunt program and annual coordination with the State of Washington would be required as would some law enforcement patrols, however Refuge staff is in place and capable of conducting these additional duties. Revision and printing of the refuge brochure, as well as updating the refuge website and other outreach information, would be required.

This compatibility determination examines the existing and proposed big game and upland game bird hunting that occurs on the Refuge. All big game and upland game bird hunting follows state regulations and seasons along with other refuge-specific regulations. The area from Bear River and Teal Slough on the mainland is open to hunting elk and deer with the exception of the immediate area surrounding the Bear River Refuge housing and headquarters. Elk, deer, bear, and grouse hunting on the Long Island Unit is open to archery use only.

Refuge staff would be required to occasionally monitor hunter activities but since the number of hunters and hunt period is limited in scope, no additional personnel resources are anticipated and the impact on the existing staff should be limited to a few hours a week. It is expected that refuge and WDFW law enforcement personnel would assist with any enforcement related problems.

Maps, printed regulations, and other printed materials would be required to administer the hunt and conduct annual trainings. Annual printing is anticipated to cost approximately $500. Signs designating safety zones may be required in certain areas. Initial signage is expected to cost approximately $500 for signs and posts. Refuge base funding is available to cover these costs.

Anticipated Impacts of Described Use:

This proposed use would result in temporary displacement of bald eagles, songbirds, and other resident wildlife that reside in and near refuge uplands. Hunters can be expected to disturb resident wildlife, migratory birds, and other wildlife species by their movements and/or shooting activities in the field. The hunt season is limited duration (daylight hours only) and limited access to the upland areas of the Refuge should limit the disturbance factor. The Long Island hunting program is an archery hunt only which reduces impacts to migratory birds and resident wildlife of the island.

Nearby resting and feeding areas will be available for use by bald eagles, migratory birds, and other resident wildlife species that are disturbed by hunting activities. These species would likely move to other areas of the Refuge which are less accessible to the hunters. The Big Game Sport Hunting Plan (Appendix M) of the CCP/EIS includes a Section 7 evaluation, which determined that the proposed action would have "no effect" on the following species: marbled murrelet, western snowy plover, and northern spotted owl.

Anticipated impacts to vegetation are expected to be limited due to the short duration of the hunt season, limited hunting and refuge use hours (daylight hours only). There is no camping allowed except in designated camp sites on Long Island. In addition, no effects are expected to refuge fish populations because activities will not take place in environments used by fish.

Effects to other public uses are expected to be minimal due to short duration of the hunt season. To further minimize impact to other user groups, the Refuge provides trails in areas where no hunting is occurring, hunting is limited to specific week days, and/or is located in non-upland habitat where deer hunting occurs.

The big game hunting program is based on healthy, sustainable populations of the species hunted. The numbers of elk, deer, bear, and grouse that populate the Refuge may vary from year to year. As described in the Refuge's Hunting Plan (Appendix M), the elk, deer, bear, and grouse populations are monitored annually.

Roosevelt elk are native to western Oregon and Washington, northwestern California, and Vancouver Island, British Columbia. The Willapa hills which surround the Willapa Refuge support one of the highest concentrations of elk in Washington. The elk and deer populations currently range throughout all of the units of the Refuge and also range into adjacent properties including Washington State Park and private property on the Long Beach peninsula, Willapa Hills, Nemah/Naselle, and South Bay areas.

Elk reproduction continues to add to the estimated population of 40 to 60 animals on the Leadbetter Point Unit. Outside recruitment into the herd may also add to this population annually. Impacts from the proposed hunt to the elk population will be monitored by issuing the special permit for the muzzleloader elk hunt; it provides the refuge staff an opportunity to control the number and timing of hunters in a specific area thereby reducing potential hunter impacts to the resource and/or other Refuge users. Providing permits addresses the elk management issue by limiting the amount of animals taken or not taken in the area. Due to the size and shape of the unit and limited access points, the number of hunters will be regulated. The permit system offers staff the opportunity to monitor take and potential impacts to the local herd while providing an opportunity for a quality and safe hunting experience. It is anticipated that on the Leadbetter Point Unit and South Bay Unit the population may fluctuate due to hunting pressure. Overall impacts to the elk populations either locally or regionally from elk, hunting on the current and proposed Refuge lands is not expected. At the Leadbetter Point Unit, the reduction in herd size may have a positive effect by protecting essential habitat for western snowy plovers, streaked horned larks, and pink sandverbena, which may be impacted by the large herd in the area.

The black bear (*Ursus americanus*) is the most common and widely distributed species of bear found in North America. The black bear population in Washington State may exceed 25,000 animals. Systematic surveys of black bear are not conducted on the Refuge. However, (according to WDFW and observations by Refuge staff) the Willapa Hills and the Long Beach Peninsula support healthy populations of black bear. This species has been observed routinely throughout the Refuge. Bear would continue to be hunted only on Long Island. A small number of bear are harvested annually due to the archery only hunt, and the impact of the hunt on the existing population would not have an impact on the overall populations of Black bear.

On Long Island in 2009, 121 hunters harvested three bear, 10 elk, no deer, and no grouse.

Based on the very limited number of individuals which are harvested, hunting impacts to the overall populations of these species are not expected to impact future recruitment or reproduction.

Public Review and Comment:

Open-house style public meetings were held, and verbal and written comments were solicited from the public during public scoping for the CCP/EIS for the Willapa NWR. Appendix E of the Draft CCP/EIS further details public involvement undertaken during development of the CCP. Additional public review and comment will be solicited during the draft CCP/EIS comment period.

Determination:

______Use is Not Compatible

__**X**__Use is Compatible with the Following Stipulations

Stipulations Necessary to Ensure Compatibility:

Law enforcement patrols to ensure compliance with hunting regulations will be conducted. State Fish and Wildlife Officers also patrol the Refuge. Harvest and season lengths are established by the State of Washington.

Hunters would be expected to comply with all current and applicable State and refuge regulations. This will be achieved through a combination of printed information, signing, outreach efforts, and enforcement of regulations by state and refuge law enforcement officers.

Limited areas of the refuge (the upland portions of the Tarlatt, Riekkola, Porter Point, Lewis, Bear River, Teal Slough and Long Island units) will be opened to public deer and elk hunting to minimize human disturbance and impacts. Long Island Unit will continue to be an archery hunt only and include bear and grouse hunting.

Limits and hunting periods will be set by the WDFW to match adjacent areas open to elk and deer hunting.

The Leadbetter Point Unit regulated (permit only) elk hunt would close the unit to other public use for any hunt period opened (generally one week in early October and a potential special permit hunt).

Refuge staff and WDFW staff will consult on issues regarding law enforcement and any significant changes in the number or behavior of wildlife. Refuge regulations will be in accord with state regulations. Refuge and WDFW officers will patrol to ensure hunters are complying with all regulations and restrictions.

Camping, overnight use, and fires are prohibited except in the designated campsites on Long Island.

Justification:

The proposed use is one of the priority wildlife-dependent uses that refuges are encouraged to facilitate, where compatible, in the National Wildlife Refuge System Improvement Act of 1997.

Hunting is one of the six designated wildlife-dependent public uses of the National Wildlife Refuge System. Refuges grant these six uses special consideration in planning and management. When on a refuge-specific basis one or more of these uses is determined compatible with the refuge purpose(s) and the NWRS mission, the refuge is to strongly encourage (facilitate) the use(s). Providing a quality hunting program contributes to achieving refuge goals and purposes. The program as described was determined to be compatible. Potential impacts from proposed and existing deer, elk, bear, and grouse hunting within these specified units on other birds and wildlife would be minimal and not materially interfere with or detract from achievement of the NWRS mission or from the Service’s ability to achieve refuge wildlife, habitat, or other public-use-related purposes and goals.

By incorporating the proposed units into an existing deer, elk, bear, and grouse hunt program, no habitat degradation would be anticipated; disturbance to birds and other wildlife, if any, would be temporary and localized; and ample amounts of additional quality habitat for these wildlife species exists on the Refuge. Thus, it is anticipated that wildlife populations will find sufficient food resources and resting places such that their abundance and use of the Refuge and local area will not be measurably lessened from hunting activities. The relatively limited number of individuals expected to be removed from the deer and elk populations due to hunting will not cause overall wildlife populations to materially decline; the physiological condition and production of hunted species will not be impaired; and their behavior and normal activity patterns will not be altered dramatically. Expanded hunt opportunities in the South Bay Unit and Leadbetter Point Unit may reduce elk populations in these areas. The hunt at Leadbetter Point would have the effect of reducing the herd size at that site and may result in positive effects for the western snowy plover, which may be impacted by the large elk herd in the area.

The areas of refuge lands designated for deer and elk hunting compliments activities permitted by Washington State on adjacent uplands and provides distinct, manageable hunt units that can be more easily delineated, posted, and enforced, resulting in less confusion for the deer/elk hunting public. In addition, due to the time of year and the limited access, minimal conflicts among refuge user groups are anticipated.

The big game hunt program as described is determined to be compatible because potential impacts from proposed and existing deer, elk, bear, and grouse hunting within these specified units on other area birds and wildlife would be minimal and not materially interfere with or detract from achievement of the NWRS mission or from the Service’s ability to achieve Refuge wildlife, habitat, or other public-use-related purposes and goals

References:

Mandatory Re-evaluation Date (provide month and year for “allowed” uses only):

__**X**__ Mandatory 15-year Re-evaluation Date will be provided in the Final CCP/EIS (for priority public uses)

______Mandatory 10-year Re-evaluation (for all uses other than priority public uses)

NEPA Compliance for Refuge Use Decision:

______ Categorical Exclusion without Environmental Action Statement

______ Categorical Exclusion and Environmental Action Statement

______ Environmental Assessment and Finding of No Significant Impact

__**X**__ Environmental Impact Statement and Record of Decision

Signatures:

Hunting (Big Game and Upland Game Bird)

Prepared by: ______________________ ________
(Signature) (Date)

Refuge Manager/
Project Leader
Approval: ______________________ ________
(Signature) (Date)

Concurrence

Refuge Supervisor: ______________________ ________
(Signature) (Date)

Regional Chief,
National Wildlife
Refuge System:

______________________ ________
(Signature) (Date)

C.3 Draft Compatibility Determination for Sport Fishing on Willapa National Wildlife Refuge

Use: Sport Fishing

Refuge Name: Willapa National Wildlife Refuge

Location: Pacific County, Washington

Date Established: 1936

Establishing and Acquisition Authorities:

- Migratory Bird Conservation Act of 1929, as amended (16 U.S.C. 715-715s)
- Executive Order 7541, Willapa Harbor Migratory Bird Refuge, Washington, signed: January 22, 1937
- Fish and Wildlife Act of 1956, as amended (16 U.S.C. § 742a-754c)
- Land and Water Conservation Fund Act of 1965, as amended (16 U.S.C. § 4601-4601.11)
- Endangered Species Act of 1973, as amended (16 U.S.C .1532-1544, 87 Stat 884)
- Refuge Recreation Act of 1962, as amended (16 U.S.C. 460k-460k-4)

Refuge Purpose(s):

The purposes for the Willapa NWR have been identified in historic legal documentation establishing and adding refuge lands. The Refuge was originally established to preserve an important wintering and foraging habitat for migratory waterfowl in the Pacific Flyway with Refuges Purposes specified as follows:

... as a refuge and breeding ground for migratory birds and other wildlife: ... Executive Order 7541, dated Jan. 22, 1937

"... for use as an inviolate sanctuary, or for any other management purpose, for migratory birds." 16 U.S.C. § 715d (Migratory Bird Conservation Act)

"... suitable for— (1) incidental fish and wildlife-oriented recreational development, (2) the protection of natural resources, (3) the conservation of endangered species or threatened species ..." 16 U.S.C. § 460k-1

"... the Secretary ... may accept and use ... real ... property. Such acceptance may be accomplished under the terms and conditions of restrictive covenants imposed by donors ...” 16 U.S.C. § 460k-2 (Refuge Recreation Act (16 U.S.C. § 460k-460k-4), as amended).

"... for the development, advancement, management, conservation, and protection of fish and wildlife resources ..." 16 U.S.C. § 742f(a)(4)

"... for the benefit of the United States Fish and Wildlife Service, in performing its activities and services. Such acceptance may be subject to the terms of any restrictive or affirmative covenant, or condition of servitude ..." 16 U.S.C. § 742f(b)(1) (Fish and Wildlife Act of 1956)

In accordance with 601 FW1, all lands acquired since the original establishment of the Refuge retain this purpose.

Management priorities are further stated in subsequent land acquisition documents to preserve, protect, and restore newly acquired habitats and provide habitat for other migratory birds, plants and wildlife with special emphasis for marbled murrelets, bald eagles, Aleutian Canada geese, shorebirds, marsh birds, wading birds, and water howellia (plant). Documentation for additional lands also identified the following habitats, wildlife, public opportunities, and management priorities to support a diverse assemblage of native fish, wildlife, and plants which includes: eelgrass beds, gravel bars, old-growth/mature forests, riverine habitats, intertidal mudflats, sand dune habitat, fish species (coho, Chinook, chum salmon, steelhead, sea-run cutthroat trout), amphibian diversity, compatible wildlife-dependent recreation, educational/research opportunities, and cultural resource sites.

Management priorities are further derived from various legal and land acquisition documents:

"…one of the most important concentration points for migratory waterfowl on the Washington Coast. It has a fine supply of natural aquatic foods, especially eel-grass, and thereby has been for years one of the few suitable wintering grounds available for Black Brant…it is essential for the preservation of the Pacific flyway that the Restoration program provide adequate sanctuary facilities for migratory birds in that state." (Migratory Bird Conservation Commission Memorandum, Memo 16, May 7, 1936)

…as a refuge and breeding ground for migratory birds and other wildlife… (Executive Order 7541, dated Jan. 22 1937)

…in order to effectuate further the purposes of the Migratory Bird Conservation Act (45 Stat. 1222)" and states that "Provided, that any private lands within the area described shall become a part of the refuge upon the acquisition of title thereto or lease thereof by the United States. (Executive Order 7721, October 8, 1937)

… for use as an inviolate sanctuary. Or for any other management purpose, for migratory birds." 16 U.S.C. § 715d (Migratory Bird Conservation Act)

…To preserve and protect unique ecosystems associated with Willapa Bay…To provide for maximum use and production by migratory birds other than wintering waterfowl, with special emphasis on bald eagles and marsh and wading birds. (Long Island Land Exchange; September 1983)

…protect habitat for old growth dependent species including the threatened marbled murrelet and threatened northern spotted owl… protect and restore upland forest and associated stream habitat in order to protect and enhance declining fish populations, including coastal cutthroat trout, and Chinook, coho, and chum salmon runs… protect and restore coastal wetlands to provide a diversity of habitats for migratory waterfowl, shorebirds, wading birds, and

songbirds…protect the intertidal mudflats along Willapa Bay by consolidating spartina infested lands for better management of control and eradication efforts on existing Refuge lands and on adjacent tidelands.…provide large scale habitat management through linking existing Refuge lands in a contiguous Refuge boundary, and provide wildlife-dependent public use opportunities compatible with Refuge purposes. (Willapa Addition Environmental Assessment/ Land Protection Plan, and Conceptual Management Plan 1999)

National Wildlife Refuge System Mission:

The mission of the System is to administer a national network of lands and waters for the conservation, management, and where appropriate, restoration of the fish, wildlife, and plant resources and their habitats within the United States for the benefit of present and future generations of Americans.

Description of Use:

Sport fishing commonly occurs in the state-owned waters of Willapa Bay including the Bear River, Naselle River, and within the channels surrounding the Presidential Proclamation Boundary and along the mainland shoreline. The Refuge generally has jurisdiction over the land base, including shorelines to mean high water, but not water in these areas. Anglers accessing the fishing opportunities on the Refuge do so by fishing from the shoreline or from boats launched using the Refuge's boat ramp located across from the southern tip of Long Island, the Nahcotta boat ramp located on the Willapa Bay side of the Long Beach Peninsula, or the Naselle boat ramp located east of the refuge headquarters. Access to the shoreline from the mainland is gained from the adjacent U.S. Highway 101. All fishing is conducted in accordance with State regulations. Fish species caught here are coho salmon, Chinook salmon, chum salmon, and sturgeon.

This compatibility determination will reassess and evaluate sport fishing from all shorelines and Willapa Bay areas within the refuge boundary. Under this use fishing would be allowed consistent with state regulations. Specific species/numbers to be taken and open periods will be set by Washington Department of Fish and Wildlife (WDFW) to match adjacent areas open to fishing.

Recreational fishing (a wildlife-dependent activity) has been identified in the National Wildlife Refuge System Administration Act, as amended, as a priority public use, provided it is compatible with the purpose for which the refuge was established.

Availability of Resources:

The proposed sport fishing program would not require any new infrastructure or personnel. Administration of a fishing program would require coordination with the State of Washington and require some law enforcement patrols; however refuge staff is in place and capable of conducting these additional duties. Revision and printing of the refuge brochure, as well as updating the refuge website and other outreach information, would be required at an estimated cost of $6,000. Base funding is available to cover these costs.

Anticipated Impacts of Described Use:

As a solitary and stationary activity, fishing tends to be less disturbing to wildlife than hunting or motorized boating (Tuite et al. 1983). It is well recognized that fishing can give many people a deeper appreciation of fish and wildlife and a better understanding of the importance of conserving habitat, which has ultimately contributed to the Refuge System mission. A goal of Willapa National Wildlife Refuge is to provide opportunities for wildlife-dependent recreation. Fishing is one of the six priority public uses in the National Wildlife Refuge System. Of key concern, then, is to manage the activity to keep any potential adverse impacts within acceptable limits.

Any angler activities on the Refuge are and will remain consistent with state guidelines. Related impacts for fish stocks associated with sport fishing in Willapa Bay, Naselle River, and Bear River are estimated annually and taken into consideration by the State of Washington in the development of annual fishing agreements and associated regulations. Since sport fishing regulations are established to provide a sustainable fish resource, impacts to fish populations from sport fishing activity are expected to be minor.

Additional disturbance would be caused to birds and other wildlife using the open waters and where fishing would occur. Fishing activities may influence the composition of bird communities, as well as abundance, and productivity of waterbirds (Bell and Austin 1985; Bouffard 1982; Cooke 1987; Edwards and Bell 1985; Tydeman 1977). Anglers often fish in shallow, sheltered bays and creeks that birds prefer, negatively impacting distribution and abundance of waterfowl, grebes, and coots (Cooke 1987). Increases in anglers and associated shoreline activity discouraged waterfowl using otherwise suitable habitat (Jahn and Hunt 1964). Anglers influenced the numbers, behavior, and diurnal distribution of avian scavengers present at sites in Washington, when compared to non-fishing days (Knight et al. 1991). Shoreline activities, such as human noise, would cause some birds to flush and go elsewhere. In addition, trampling of vegetation and deposition of sewage or other chemicals are expected to commonly occur (Liddle and Scorgie 1980). Disturbance and destruction of riparian vegetation, bank stability, and water quality may result from high levels of bank fishing activities.

Boating associated with fishing can alter bird distribution, reduce use of particular habitats or entire areas by waterfowl and other water-birds, alter feeding behavior and nutritional status, and cause premature departure from areas (Knight and Cole 1995). Impacts of motorized boating can occur even at low densities, given their noise, speed, and ability to cover extensive areas in a short amount of time. Anglers accessing the refuge shoreline at high tides by boat may fish from the Refuge in the state waters.

Although fishing activity can result in disturbance to local wildlife, it is important to note that large acreages of undisturbed habitat are adjacent to areas open to public fishing, thereby affording disturbed wildlife more than adequate escape cover and sanctuary.

Public Review and Comment:

Open-house style public meetings were held, verbal and written comments were solicited from the public during public scoping for the CCP/EIS for the Willapa NWR. Appendix E of the draft

CCP/EIS further details public involvement undertaken during development of the CCP. Additional public review and comment will be solicited during the draft CCP/EIS comment period.

Determination:

______Use is Not Compatible

__X__Use is Compatible with the Following Stipulations

Stipulations Necessary to Ensure Compatibility:

Law enforcement patrols to ensure compliance with fishing regulations will be conducted. State Fish and Wildlife officers also patrol the Refuge. Harvest and season lengths are established by the States of Oregon and Washington.

Justification:

Recreational fishing is one of the six priority public uses of the National Wildlife Refuge System. Providing a quality fishing program contributes to achieving one of the Refuge's goals. The fishing opportunities as described were determined to be compatible; despite the potential impacts that fishing and supporting activities (boating) can have on the Service's ability to achieve its purposes. In addition, the majority of waterfowl use on the Refuge occurs in the winter and spring months, with some birds as early as September and October. Since the majority of the fishing activity occurs in the summer and fall (through mid-October), disturbance to waterfowl species is reduced. It is anticipated that an adequate amount of estuary, open water, and riverine habitat would be available to the majority of waterfowl, waterbirds, and other wildlife because of the large area available for fishing and very small numbers of bank fisherman are expected to use the area.

Thus, it is anticipated that wildlife, primarily waterbirds, will find sufficient food resources and resting places and their abundance and use of the Refuge will not be measurably reduced. The fishing pressure received will not cause fish stocks to decline. The physiological condition and production of waterfowl and other waterbirds will not be impaired; their behavior and activity patterns will not be altered dramatically; and their overall welfare will not be impaired. The sport fishing program as described is determined to be compatible because potential impacts from proposed fishing program within these specified units on other area birds and wildlife would be minimal and not materially interfere with or detract from achievement of the NWRS mission or from the Service's ability to achieve refuge wildlife, habitat, or other public-use-related purposes and goals

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Mandatory Re-evaluation Date (provide month and year for "allowed" uses only):

__**X**__ Mandatory 15-year Re-evaluation Date will be provided in the Final CCP/EIS (for priority public uses)

______Mandatory 10-year Re-evaluation (for all uses other than priority public uses)

NEPA Compliance for Refuge Use Decision

______ Categorical Exclusion without Environmental Action Statement

______ Categorical Exclusion and Environmental Action Statement

______ Environmental Assessment and Finding of No Significant Impact

__**X**__ Environmental Impact Statement and Record of Decision

Signatures:

Sport Fishing

Prepared by:	______________________ (Signature)	__________ (Date)
Refuge Manager/ Project Leader Approval:	______________________ (Signature)	__________ (Date)

Concurrence

Refuge Supervisor:	______________________ (Signature)	__________ (Date)
Regional Chief, National Wildlife Refuge System:	______________________ (Signature)	__________ (Date)

C.4 Draft Compatibility Determination for Environmental Education, Interpretation, Wildlife Observation, and Photography on Willapa National Wildlife Refuge

Use: Environmental Education, Interpretation, Wildlife Observation, and Photography.

Refuge Name: Willapa National Wildlife Refuge

Location: Pacific County, Washington

Date Established: 1936

Establishing and Acquisition Authorities:

- Migratory Bird Conservation Act of 1929, as amended (16 U.S.C. 715-715s)
- Executive Order 7541, Willapa Harbor Migratory Bird Refuge, Washington, signed: January 22, 1937
- Fish and Wildlife Act of 1956, as amended (16 U.S.C. § 742a-754c)
- Land and Water Conservation Fund Act of 1965, as amended (16 U.S.C. § 4601-4601.11)
- Endangered Species Act of 1973, as amended (16 U.S.C .1532-1544, 87 Stat 884)
- Refuge Recreation Act of 1962, as amended (16 U.S.C. 460k-460k-4)

Refuge Purpose(s):

The purposes for the Willapa NWR have been identified in historic legal documentation establishing and adding refuge lands. The Refuge was originally established to preserve an important wintering and foraging habitat for migratory waterfowl in the Pacific Flyway with Refuges Purposes specified as follows:

... as a refuge and breeding ground for migratory birds and other wildlife: ... Executive Order 7541, dated Jan. 22, 1937

"... for use as an inviolate sanctuary, or for any other management purpose, for migratory birds." 16 U.S.C. § 715d (Migratory Bird Conservation Act)

"... suitable for— (1) incidental fish and wildlife-oriented recreational development, (2) the protection of natural resources, (3) the conservation of endangered species or threatened species ..." 16 U.S.C. § 460k-1

"... the Secretary ... may accept and use ... real ... property. Such acceptance may be accomplished under the terms and conditions of restrictive covenants imposed by donors ...” 16 U.S.C. § 460k-2 (Refuge Recreation Act (16 U.S.C. § 460k-460k-4), as amended).

"... for the development, advancement, management, conservation, and protection of fish and wildlife resources ..." 16 U.S.C. § 742f(a)(4)

"... for the benefit of the United States Fish and Wildlife Service, in performing its activities and services. Such acceptance may be subject to the terms of any restrictive or affirmative covenant, or condition of servitude ..." 16 U.S.C. § 742f(b)(1) (Fish and Wildlife Act of 1956)

In accordance with 601 FW1, all lands acquired since the original establishment of the Refuge retain this purpose.

Management priorities are further stated in subsequent land acquisition documents to preserve, protect, and restore newly acquired habitats and provide habitat for other migratory birds, plants and wildlife with special emphasis for marbled murrelets, bald eagles, Aleutian Canada geese, shorebirds, marsh birds, wading birds, and water howellia (plant). Documentation for additional lands also identified the following habitats, wildlife, public opportunities, and management priorities to support a diverse assemblage of native fish, wildlife, and plants which includes: eelgrass beds, gravel bars, old-growth/mature forests, riverine habitats, intertidal mudflats, sand dune habitat, fish species (coho, Chinook, chum salmon, steelhead, sea-run cutthroat trout), amphibian diversity, compatible wildlife-dependent recreation, educational/research opportunities, and cultural resource sites.

Management priorities are further derived from various legal and land acquisition documents:

"…one of the most important concentration points for migratory waterfowl on the Washington Coast. It has a fine supply of natural aquatic foods, especially eel-grass, and there by has been for years one of the few suitable wintering grounds available for Black Brant…it is essential for the preservation of the Pacific flyway that the Restoration program provide adequate sanctuary facilities for migratory birds in that state." (Migratory Bird Conservation Commission Memorandum, Memo 16, May 7, 1936)

…as a refuge and breeding ground for migratory birds and other wildlife… (Executive Order 7541, dated Jan. 22 1937)

…in order to effectuate further the purposes of the Migratory Bird Conservation Act (45 Stat. 1222)" and states that "Provided, that any private lands within the area described shall become a part of the refuge upon the acquisition of title thereto or lease thereof by the United States. (Executive Order 7721, October 8, 1937)

… for use as an inviolate sanctuary. Or for any other management purpose, for migratory birds." 16 U.S.C. § 715d (Migratory Bird Conservation Act)

…To preserve and protect unique ecosystems associated with Willapa Bay…To provide for maximum use and production by migratory birds other than wintering waterfowl, with special emphasis on bald eagles and marsh and wading birds. (Long Island Land Exchange; September 1983)

…protect habitat for old growth dependent species including the threatened marbled murrelet and threatened northern spotted owl… protect and restore upland forest and associated stream habitat in order to protect and enhance declining fish populations, including coastal cutthroat trout, and Chinook, coho, and chum salmon runs… protect and restore coastal wetlands to provide a diversity of habitats for migratory waterfowl, shorebirds, wading birds, and

songbirds…protect the intertidal mudflats along Willapa Bay by consolidating spartina infested lands for better management of control and eradication efforts on existing Refuge lands and on adjacent tidelands.…provide large scale habitat management through linking existing Refuge lands in a contiguous Refuge boundary, and provide wildlife-dependent public use opportunities compatible with Refuge purposes. (Willapa Addition Environmental Assessment/ Land Protection Plan, and Conceptual Management Plan 1999)

National Wildlife Refuge System Mission:

The mission of the System is to administer a national network of lands and waters for the conservation, management, and where appropriate, restoration of the fish, wildlife, and plant resources and their habitats within the United States for the benefit of present and future generations of Americans.

Description of Use(s):

The Willapa National Wildlife Refuge (Refuge) is a popular destination for local visitors as well as tourists from outside the area. It is difficult to determine exact number of visitors, but it is estimated the Refuge has 250,000 visitor-use days each year. The majority of visitation to the Refuge occurs during the summer months and during the hunting seasons.

This compatibility determination examines existing and proposed non-consumptive wildlife-dependent recreational uses on Willapa National Wildlife Refuge.

Environmental Education and Interpretation consists of those activities which seek to increase the public's knowledge and understanding of wildlife and contribute to the conservation of such wildlife. Activities would include both staff and non-staff conducted environmental education, teaching students, teacher workshops, interpretation, interpretation, and interpretive sites. Interpretation and environmental education activities generally occur on the Mainland Units of the Refuge. Over a three-day period in late spring, the Refuge hosts students from regional schools who visit educational science stations to learn more about the environment and how to be stewards of the environment. Friends of Willapa National Wildlife Refuge and Willapa National Wildlife Refuge annually co-sponsor this educational event as part of their fourth-grade environmental education program.

Interpretive information and brochures are located at the refuge office. The refuge office is open to the public Monday through Friday, 8 am to 4: pm except federal holidays. There are several information kiosks throughout the Refuge offering maps, educational material, and regulations. The parking lots at both the Headquarters area and Leadbetter Point offer restroom facilities. The Leadbetter Point restroom is maintained by the Washington State Parks and Recreation Commission.

The Willapa Interpretive Art Trail was created to provide visitors with an opportunity to experience nature near the current office site without having to go to another area of the Refuge. Visitors to the stream can now observe wildlife from a curving, ADA-accessible boardwalk. Artwork located along the boardwalk tells the story of the stream and the many species who live there. Students from the University of Washington Public Arts Program designed, constructed, and installed the artwork for the trail under the direction of professors. The Interpretive Art Trail is about one-quarter mile long and is open seven days a week from dawn until dusk.

Wildlife Observation is probably the most popular activity on the Refuge. The Refuge provides a wide variety of opportunities for wildlife observation. Throughout the approximately 15,500 acres of refuge lands there is a network of trails and roads that provide quality opportunities for wildlife observation. Hiking trails at Leadbetter Unit at the tip of the Long Beach Peninsula allow visitors to walk through coastal woodlands, salt marshes, and beaches. Many miles of pedestrian only trails link the Leadbetter Unit with an adjacent Washington State Park. In Willapa Bay, refuge visitors travel by either motorized or non-motorized boats for wildlife viewing and other wildlife oriented activities. Long Island has a three-quarter-mile loop trail and over 10 miles of roads that allows visitors to access forest habitats including a 274-acre old-growth stand.

Wildlife Photography is a popular activity which occurs year round on the Refuge. Visitors drive around the mainland units of the Refuge using their vehicles as blinds to take advantage of photographic opportunities. Long Island and Willapa Bay provide more limited photographic opportunities because visitors must use boats, kayaks, or canoes to access the island and surrounding estuary. The Friends of Willapa National Wildlife Refuge constructed a photography blind on a seasonal freshwater wetland in the Tarlatt Unit in 2003. The best time of year to use the blind is during the winter and early spring when the wetland is full of water and feeding waterfowl. The blind is available by reservation only. In addition, the Friends of Willapa National Wildlife Refuge sponsors an annual wildlife photography contest.

Availability of Resources:

Additional funding for operational costs would be needed to fully implement the environmental education, wildlife observation, and photography programs identified in the CCP. These needs are expected to be added from the CCP and are tied to funding requests in the form of Refuge Operating Needs System and Maintenance Management System projects for these activities. Other funding sources would be sought through strengthened partnerships, grants, and donations to administer and manage a safe and quality environmental education, wildlife observation, and photography program as described above.

The Youth Conservation Corps program provides an avenue for high school–aged students to work on the Refuge and learn more about the refuge resources and careers associated with the field of natural resources. Many students receive credit from their high school for participation in this paid position. Having a crew located on the Refuge would provide local high school students with summer employment while assisting the refuge staff with a variety of resource management activities (fencing, tree planting, invasive species removal).

Anticipated Impacts of Described Uses:

Currently, there are very few places in the surrounding area to view and interpret the diversity of habitats and wildlife that encompass this unique region. The coastal dune, coastal forest upland, saltwater estuary, riverine, and mudflats provide essential habitat to shorebirds, seabirds, water birds, ducks, geese, other migratory birds, and resident wildlife. The Willapa Refuge offers a variety of opportunities for viewing wildlife on the mainland, within the saltwater estuary and on Long Island. Signs are needed to provide updated refuge program and Refuge System information at designated sites. Updating interpretive displays to interpret the Refuge's mission, natural resources, and programs would provide the public an opportunity to understand the purposes and resources of the Refuge.

Activities that occur outside of vehicles (e.g., wildlife observation, trail hiking, and environmental education programs) tend to increase disturbance potential for most wildlife species (Klein 1993). Human activities along trails disturb wildlife, often resulting in flushing from roosting, feeding, nesting, or resting areas. Flushing may result in expenditure of energy reserves, abandonment from preferred habitat, and increased exposure to predation during relocation. In riparian habitats, the abundance of bird species requiring shrub cover (e.g., MacGillivray's warbler and lazuli bunting) may be reduced at recreation sites, while species that forage in tree canopies may be unaffected. Trails in riparian areas may encourage the penetration of new animal species, including nest predators, into formerly protected forests (Knutsen and Neaf 1997). Wildlife photographers tend to have the largest disturbance impacts because they may remain close to wildlife for prolonged periods (Klein 1993). Casual photographers with low-power lenses may approach wildlife closer than other users.

Wildlife viewing and photography opportunities occur within portions of most of the units of the Willapa Refuge. Wildlife of primary concern is marbled murrelet, western snowy plover, waterfowl species such as Pacific brant, geese, ducks, shorebirds, water and wading birds, and raptors. To minimize potential disturbance, public uses on the Refuge are limited to designated potions of the Refuge. Closed areas of the Refuge serve as wildlife sanctuaries, including a portion of Leadbetter Point that is closed seasonally (April 15 through September 15) to protect nesting snowy plovers. The majority of the environmental education, interpretation, wildlife observation and photography use occurs during the summer while peak waterfowl, waterbird, and shorebird use occurs on the Refuge during fall, winter, and spring. In addition, the majority of these uses occur on designated trails which minimizes wildlife disturbance. Furthermore, the level of wildlife disturbance for these activities is minimal during the fall, winter, and spring.

Access to public use areas are the dike roads, logging roads, and designated trails on the mainland units and Long Island Unit. The foot trail to be located at the proposed site for the Visitor Services Contact Station would be designed to maximize quality wildlife-oriented visitor activities and minimize impacts and disturbance to wildlife. The dike's elevation above surrounding terrain allows road/trail users to view wildlife out on the Willapa Bay tide flats at a distance that would not noticeably disturb the wildlife. Logging roads and designated trails provide opportunities for the public that minimize the potential for disturbance.

Impacts from the general public on Long Island are for the most part self-limiting. This is because the island is accessible only by boat, which reduces the number of potential visitors. Daily tidal changes make visitation of the island a challenge. Most visitor impacts come from boating, canoeing, and kayaking in the waters surrounding Long Island. This may cause birds that use the waters of the bay and the forested edges of the island habitat to flush. The disturbance to wildlife is localized and of short duration. Nearby resting and feeding areas will be available for use by any displaced wildlife.

The Refuge currently has walking trails at the Leadbetter Point Unit, Long Island, and the existing refuge headquarters. Logging roads and dikes are used as public access trails on both the mainland and Long Island Units which creates conflict since they double as service roads. Under Alternative 2, the Refuge would improve and expand wildlife observation/photography opportunities to provide a quality viewing experience for the public, while limiting potential disturbance to wildlife and resources we are mandated to protect.

Many members of the public are not familiar with National Wildlife Refuges and confuse them with other federal land management systems such as National Parks or with State Parks. Providing information through programs written materials and interpretive panels helps to build an understanding and appreciation of the unique purposes and activities of National Wildlife Refuges. Providing information regarding the mission of the Service and the purposes of the Refuge, along with specific resource information may alleviate potential negative impacts on wildlife by educating our visitors.

Developing the trail at the proposed new headquarters site will provide the public increased viewing and interpretive opportunities and to develop understanding the importance of these important coastal habitat types. Development of a new walking trail and/or viewpoints will be limited to areas that do not create a wildlife or resource disturbance.

Under the proposed alternative, the existing refuge headquarters area will be restored to more natural conditions. The art interpretive trail, parking lot, and visitor kiosks will continue to provide the public with interpretive/educational opportunities. Developing additional viewing sites adjacent to other habitat types would provide the public with a more varied wildlife viewing opportunity by highlighting different habitats.

Willapa Refuge provides an existing fourth-grade environmental education program that has been developed to meet Washington state education standards. There is an interest by local teachers to develop other programs. An expanded environmental education program will provide better ways of reaching the youth within our communities to help them learn about the Refuge, its resources, and the importance of these wildlife resources. Creating and developing specific study sites for classes to use on the Refuge would reduce potential disturbance to wildlife, yet allow for students to get hands on experiences in science and nature.

Public Review and Comment:

Open-house style public meetings were held, verbal and written comments were solicited from the public during public scoping for the CCP/EIS for the Willapa Refuge. Appendix E of the draft CCP/EIS gives further details of public involvement undertaken during development of the CCP. Additional public review and comment will be solicited during the draft CCP/EIS comment period.

Determination:

______Use is Not Compatible

__**X**__Use is Compatible with the Following Stipulations

Stipulations Necessary to Ensure Compatibility:

In order to minimize disturbance to wildlife from human activities, wildlife-dependent public uses would be restricted to refuge-specific designated trails, public use facilities, or approved guided events. Unguided recreational activity occurring in closed areas would not be allowed unless operating under provisions of a Special Use Permit and stipulations set by the Refuge Manager.

The site proposed for the new refuge headquarters located in the Tarlatt Unit of the Refuge will serve as the main focal point for environmental educational activities. Other portions of the Refuge (including Long Island and the original headquarters area) will provide additional locations for these approved activities.

The refuge trails located on many of the refuge units provide key areas for the general public to learn about and visit the Refuge. These trails and the photo blind located in the Tarlatt Unit provide opportunities for visitors who wish to view and photograph wildlife and walk around the Refuge as well as minimize disturbance to wildlife in refuge sanctuary areas.

Public access to the Leadbetter Point Unit is restricted to pedestrian traffic only to minimize the disturbance to snowy plovers, streaked horned lark, other shorebirds, and resident wildlife. The public walking trails in the Leadbetter Point Unit would remain open. Designated areas of the Leadbetter Point Unit are closed to all public access from March 15 to September 30 for the protection of nesting and rearing western snowy plover and streaked horned larks. All public use areas managed by the Refuge would remain open dawn to dusk.

Wildlife observation and photographic activities would continue to be available on Long Island in Willapa Bay. Impacts associated with differing levels and types of public use would be evaluated by staff annually. Monitoring information gathered by staff would be critically analyzed and used by the Refuge Manager to develop future modifications, if necessary, to ensure compatibility of wildlife observation and photography in all refuge locations.

Justification:

The National Wildlife Refuge System Administration Act of 1966, as amended, identified wildlife observation, photography, interpretation, and environmental education as four of the six priority, wildlife-dependent recreational uses to be facilitated in the Refuge System, and the Act encouraged the Service to provide opportunities for these uses.

Despite the disturbance people can cause to wildlife, there will be relatively few people visiting the Refuge and they will be kept to designated trails and public use sites. Thus, it is anticipated that wildlife populations will find sufficient food resources and resting places such that their abundance and use of the Refuge and surrounding areas will not be measurably lessened from public use activities. Public visitation will not cause wildlife populations to materially decline; the physiological condition and production of species will not be impaired; their behavior and normal activity patterns will not be altered dramatically; and their overall welfare will not be negatively impacted.

Based on the stipulations noted above designed to limit timing and amount of impact, allowing environmental education, interpretation, wildlife observation, and photography to occur on the Refuge will not materially detract or interfere with the purposes for establishment of the Refuge and the mission of the National Wildlife Refuge System.

References:

Klein, M.L. 1993. Waterbird behavioral responses to human disturbances. Wildlife Society Bulletin 21:31-39.

Knutsen, K.L., and V.L. Naef. 1997. Management recommendations for Washington's priority habitats: riparian. Washington Department of Fish and Wildlife. Olympia, WA. 181 pp.

Mandatory Re-evaluation Date (provide month and year for "allowed" uses only):

__**X**__ Mandatory 15-year Re-evaluation Date will be provided in the Final CCP/EIS (for priority public uses)

______Mandatory 10-year Re-evaluation (for all uses other than priority public uses)

NEPA Compliance for Refuge Use Decision:

______ Categorical Exclusion without Environmental Action Statement

______ Categorical Exclusion and Environmental Action Statement

______ Environmental Assessment and Finding of No Significant Impact

__**X**__ Environmental Impact Statement and Record of Decision

Signatures:

Environmental education, interpretation, wildlife observation, and photography.

Prepared by: ______________________________ ____________
(Signature) (Date)

Refuge Manager/
Project Leader
Approval: ______________________________ ____________
(Signature) (Date)

Concurrence

Refuge Supervisor: ______________________________ ____________
(Signature) (Date)

Regional Chief,
National Wildlife
Refuge System:

______________________________ ____________
(Signature) (Date)

C.5 Draft Compatibility Determination for Camping on Willapa National Wildlife Refuge

Use: Camping

Refuge Name: Willapa National Wildlife Refuge

Location: Pacific County, Washington

Date Established: 1936

Establishing and Acquisition Authorities:

- Migratory Bird Conservation Act of 1929, as amended (16 U.S.C. 715-715s)
- Executive Order 7541, Willapa Harbor Migratory Bird Refuge, Washington, signed: January 22, 1937
- Fish and Wildlife Act of 1956, as amended (16 U.S.C. § 742a-754c)
- Land and Water Conservation Fund Act of 1965, as amended (16 U.S.C. § 4601-4601.11)
- Endangered Species Act of 1973, as amended (16 U.S.C .1532-1544, 87 Stat 884)
- Refuge Recreation Act of 1962, as amended (16 U.S.C. 460k-460k-4)

Refuge Purpose(s):

The purposes for the Willapa NWR have been identified in historic legal documentation establishing and adding refuge lands. The Refuge was originally established to preserve an important wintering and foraging habitat for migratory waterfowl in the Pacific Flyway with Refuges Purposes specified as follows:

... as a refuge and breeding ground for migratory birds and other wildlife: ... Executive Order 7541, dated Jan. 22, 1937

"... for use as an inviolate sanctuary, or for any other management purpose, for migratory birds." 16 U.S.C. § 715d (Migratory Bird Conservation Act)

"... suitable for— (1) incidental fish and wildlife-oriented recreational development, (2) the protection of natural resources, (3) the conservation of endangered species or threatened species ..." 16 U.S.C. § 460k-1

"... the Secretary ... may accept and use ... real ... property. Such acceptance may be accomplished under the terms and conditions of restrictive covenants imposed by donors ...” 16 U.S.C. § 460k-2 (Refuge Recreation Act (16 U.S.C. § 460k-460k-4), as amended).

"... for the development, advancement, management, conservation, and protection of fish and wildlife resources ..." 16 U.S.C. § 742f(a)(4)

"... for the benefit of the United States Fish and Wildlife Service, in performing its activities and services. Such acceptance may be subject to the terms of any restrictive or affirmative covenant, or condition of servitude ..." 16 U.S.C. § 742f(b)(1) (Fish and Wildlife Act of 1956)

In accordance with 601 FW1, all lands acquired since the original establishment of the Refuge retain this purpose.

Management priorities are further stated in subsequent land acquisition documents to preserve, protect, and restore newly acquired habitats and provide habitat for other migratory birds, plants and wildlife with special emphasis for marbled murrelets, bald eagles, Aleutian Canada geese, shorebirds, marsh birds, wading birds, and water howellia (plant). Documentation for additional lands also identified the following habitats, wildlife, public opportunities, and management priorities to support a diverse assemblage of native fish, wildlife, and plants which includes: eelgrass beds, gravel bars, old-growth/mature forests, riverine habitats, intertidal mudflats, sand dune habitat, fish species (coho, Chinook, chum salmon, steelhead, sea-run cutthroat trout), amphibian diversity, compatible wildlife-dependent recreation, educational/research opportunities, and cultural resource sites.

Management priorities are further derived from various legal and land acquisition documents:

"…one of the most important concentration points for migratory waterfowl on the Washington Coast. It has a fine supply of natural aquatic foods, especially eel-grass, and there by has been for years one of the few suitable wintering grounds available for Black Brant…it is essential for the preservation of the Pacific flyway that the Restoration program provide adequate sanctuary facilities for migratory birds in that state." (Migratory Bird Conservation Commission Memorandum, Memo 16, May 7, 1936)

…as a refuge and breeding ground for migratory birds and other wildlife… (Executive Order 7541, dated Jan. 22 1937)

…in order to effectuate further the purposes of the Migratory Bird Conservation Act (45 Stat. 1222)" and states that "Provided, that any private lands within the area described shall become a part of the refuge upon the acquisition of title thereto or lease thereof by the United States. (Executive Order 7721, October 8, 1937)

… for use as an inviolate sanctuary. Or for any other management purpose, for migratory birds." 16 U.S.C. § 715d (Migratory Bird Conservation Act)

…To preserve and protect unique ecosystems associated with Willapa Bay…To provide for maximum use and production by migratory birds other than wintering waterfowl, with special emphasis on bald eagles and marsh and wading birds. (Long Island Land Exchange; September 1983)

…protect habitat for old growth dependent species including the threatened marbled murrelet and threatened northern spotted owl… protect and restore upland forest and associated stream habitat in order to protect and enhance declining fish populations, including coastal cutthroat trout, and Chinook, coho, and chum salmon runs… protect and restore coastal wetlands to provide a diversity of habitats for migratory waterfowl, shorebirds, wading birds, and

songbirds…protect the intertidal mudflats along Willapa Bay by consolidating spartina infested lands for better management of control and eradication efforts on existing Refuge lands and on adjacent tidelands.…provide large scale habitat management through linking existing Refuge lands in a contiguous Refuge boundary, and provide wildlife-dependent public use opportunities compatible with Refuge purposes. (Willapa Addition Environmental Assessment/ Land Protection Plan, and Conceptual Management Plan 1999)

National Wildlife Refuge System Mission:

The mission of the System is to administer a national network of lands and waters for the conservation, management, and where appropriate, restoration of the fish, wildlife, and plant resources and their habitats within the United States for the benefit of present and future generations of Americans.

Description of Use:

This compatibility determination re-examines camping on the Long Island Unit of Willapa Refuge located in the southern half of Willapa Bay within Pacific County, Washington. Under this proposal, camping would continue to be allowed consistent with refuge-specific regulations. To accommodate this use, the Refuge has five campgrounds on the Island (three on the west side of the island and two on the east side of the island), each with a different number of campsites. Camping on Long Island is allowed only in the 21 designated campsites on a first-come, first-served basis. The only time registration is required is for the week prior to and during the early elk hunt season. No more than five people are allowed per campsite, and maximum stay is 14 days which helps minimize the impacts to refuge resources. Access to Long Island is by boat, canoe, or kayak only.

Because of the limited access to Long Island, almost all recreational camping is associated with other wildlife-dependent activities (hunting, shellfish harvest, wildlife observation, photography, and environmental education). Willapa Bay is tidally influenced, which further limits access to the island.

Availability of Resources:

This compatibility determination examines the existing camping that occurs on the Long Island Unit of the Refuge. All camping follows Refuge specific regulations.

The continuation of camping would not require any new infrastructure or personnel. Base funding is available to cover these costs. Refuge staff would be required to occasionally monitor camping activities but since the number of campers is limited in scope, no additional personnel resources are anticipated and the impact on the existing staff should be limited to a few hours a week. It is expected that Refuge and WDFW law enforcement personnel will assist with any enforcement related problems.

Maps, printed regulations, and other printed materials would be required to administer the camping program. Annual printing is anticipated to cost approximately $500. Signs designating campgrounds and campsites may need to be replaced on occasion.

Anticipated Impacts of Described Use:

This proposed use would result in limited and temporary displacement of eagles, great blue herons, elk, deer, and beer in the immediate vicinity of the campsites/campground from the activities and movements of the campers themselves. There will be some temporary displacement of waterfowl and waterbirds within the bay from both motorized and non-motorized watercraft. Displaced birds have easy access over short distances to other areas of the bay closed to public use. Minimal impacts to vegetation and soils are expected to result from this activity. Camping results in some vegetation trampling, soil compaction, and localized denuding of vegetation at campsites and where people concentrate. Enhanced enforcement is expected to decrease unauthorized camping outside of designated campsites. Campers may have campfires, which are restricted to designated campfire rings. There is the potential for an increase in wildland fire activity if campers are careless with the fires they ignite.

Public Review and Comment:

Open-house style public meetings were held, verbal and written comments were solicited from the public during public scoping for the CCP/EIS for the Willapa NWR. Appendix E of the draft CCP/EIS further details public involvement undertaken during development of the CCP. Additional public review and comment will be solicited during the draft CCP/EIS comment period.

Determination:

______Use is Not Compatible

__**X**__Use is Compatible with the Following Stipulations

Stipulations Necessary to Ensure Compatibility:

To ensure compatibility and minimize impacts to refuge resources, camping is allowed in designated campsites only. There are five primitive campgrounds with a total of 21 campsites on Long Island. A maximum of five people are allowed per campsite for up to 14 consecutive days. Fires are allowed in designated campfire rings located in each campsite to reduce potential wildland fires. Only downed wood is allowed to be used for fires. All camping equipment, supplies and other materials brought to campsites (including trash and garbage) will be packed out of the campsites. Law enforcement patrols will be conducted by refuge officers to ensure compliance with refuge regulations. No powered tools and/or equipment are allowed on the island (this includes chainsaws, generators, etc.) No dogs, except those used while hunting waterfowl, are allowed on the Refuge.

Justification:

Because tides limit the timing and safety for accessing Long Island for those intending to engage in wildlife-dependent recreation, safe and adequate access cannot be ensured without providing camping opportunity on-site. Thus, campsites are offered for visitors engaging in one or more of the priority wildlife-dependent uses that all refuges are encouraged to facilitate, where compatible. Camping on Long Island has minimal impacts to wildlife resources and provides a unique opportunity for the general public to participate in hunting, wildlife observation, photography, interpretation, and environmental education. Allowing this use on Long Island does not materially detract or interfere with the mission of the National Wildlife Refuge System or the purposes for which the Refuge was established.

Mandatory Re-evaluation Date (provide month and year for "allowed" uses only):

______ Mandatory 15-year Re-evaluation Date will be provided in the Final CCP/EIS (for priority public uses)

__**X**__ Mandatory 10-year Re-evaluation (for all uses other than priority public uses)

NEPA Compliance for Refuge Use Decision:

__**X**__ Categorical Exclusion without Environmental Action Statement

______ Categorical Exclusion and Environmental Action Statement

______ Environmental Assessment and Finding of No Significant Impact

______ Environmental Impact Statement and Record of Decision

Signatures:

Camping

Prepared by:	(Signature)	(Date)
Refuge Manager/ Project Leader Approval:	(Signature)	(Date)

Concurrence

Refuge Supervisor:	(Signature)	(Date)
Regional Chief, National Wildlife Refuge System:	(Signature)	(Date)

C.6 Draft Compatibility Determination for Haying, Silage Harvest, and Cattle Grazing on Willapa National Wildlife Refuge

Use: Haying, Silage Harvest, and Cattle Grazing.

Refuge Name: Willapa National Wildlife Refuge

Location: Pacific County, Washington

Date Established: 1936

Establishing and Acquisition Authorities:

- Migratory Bird Conservation Act of 1929, as amended (16 U.S.C. 715-715s)
- Executive Order 7541, Willapa Harbor Migratory Bird Refuge, Washington, signed: January 22, 1937
- Fish and Wildlife Act of 1956, as amended (16 U.S.C. § 742a-754c)
- Land and Water Conservation Fund Act of 1965, as amended (16 U.S.C. § 4601-4601.11)
- Endangered Species Act of 1973, as amended (16 U.S.C .1532-1544, 87 Stat 884)
- Refuge Recreation Act of 1962, as amended (16 U.S.C. 460k-460k-4)

Refuge Purpose(s):

The purposes for the Willapa NWR have been identified in historic legal documentation establishing and adding refuge lands. The Refuge was originally established to preserve an important wintering and foraging habitat for migratory waterfowl in the Pacific Flyway with Refuges Purposes specified as follows:

... as a refuge and breeding ground for migratory birds and other wildlife: ... Executive Order 7541, dated Jan. 22, 1937

"... for use as an inviolate sanctuary, or for any other management purpose, for migratory birds." 16 U.S.C. § 715d (Migratory Bird Conservation Act)

"... suitable for— (1) incidental fish and wildlife-oriented recreational development, (2) the protection of natural resources, (3) the conservation of endangered species or threatened species ..." 16 U.S.C. § 460k-1

"... the Secretary ... may accept and use ... real ... property. Such acceptance may be accomplished under the terms and conditions of restrictive covenants imposed by donors ...” 16 U.S.C. § 460k-2 (Refuge Recreation Act (16 U.S.C. § 460k-460k-4), as amended).

"... for the development, advancement, management, conservation, and protection of fish and wildlife resources ..." 16 U.S.C. § 742f(a)(4)

"... for the benefit of the United States Fish and Wildlife Service, in performing its activities and services. Such acceptance may be subject to the terms of any restrictive or affirmative covenant, or condition of servitude ..." 16 U.S.C. § 742f(b)(1) (Fish and Wildlife Act of 1956)

In accordance with 601 FW1, all lands acquired since the original establishment of the Refuge retain this purpose.

Management priorities are further stated in subsequent land acquisition documents to preserve, protect, and restore newly acquired habitats and provide habitat for other migratory birds, plants and wildlife with special emphasis for marbled murrelets, bald eagles, Aleutian Canada geese, shorebirds, marsh birds, wading birds, and water howellia (plant). Documentation for additional lands also identified the following habitats, wildlife, public opportunities, and management priorities to support a diverse assemblage of native fish, wildlife, and plants which includes: eelgrass beds, gravel bars, old-growth/mature forests, riverine habitats, intertidal mudflats, sand dune habitat, fish species (coho, Chinook, chum salmon, steelhead, sea-run cutthroat trout), amphibian diversity, compatible wildlife-dependent recreation, educational/research opportunities, and cultural resource sites.

Management priorities are further derived from various legal and land acquisition documents:

"…one of the most important concentration points for migratory waterfowl on the Washington Coast. It has a fine supply of natural aquatic foods, especially eel-grass, and there by has been for years one of the few suitable wintering grounds available for Black Brant…it is essential for the preservation of the Pacific flyway that the Restoration program provide adequate sanctuary facilities for migratory birds in that state." (Migratory Bird Conservation Commission Memorandum, Memo 16, May 7, 1936)

…as a refuge and breeding ground for migratory birds and other wildlife… (Executive Order 7541, dated Jan. 22 1937)

…in order to effectuate further the purposes of the Migratory Bird Conservation Act (45 Stat. 1222)" and states that "Provided, that any private lands within the area described shall become a part of the refuge upon the acquisition of title thereto or lease thereof by the United States. (Executive Order 7721, October 8, 1937)

… for use as an inviolate sanctuary. Or for any other management purpose, for migratory birds." 16 U.S.C. § 715d (Migratory Bird Conservation Act)

…To preserve and protect unique ecosystems associated with Willapa Bay…To provide for maximum use and production by migratory birds other than wintering waterfowl, with special emphasis on bald eagles and marsh and wading birds. (Long Island Land Exchange; September 1983)

…protect habitat for old growth dependent species including the threatened marbled murrelet and threatened northern spotted owl… protect and restore upland forest and associated stream habitat in order to protect and enhance declining fish populations, including coastal cutthroat trout, and Chinook, coho, and chum salmon runs… protect and restore coastal wetlands to provide a diversity of habitats for migratory waterfowl, shorebirds, wading birds, and

songbirds…protect the intertidal mudflats along Willapa Bay by consolidating spartina infested lands for better management of control and eradication efforts on existing Refuge lands and on adjacent tidelands.…provide large scale habitat management through linking existing Refuge lands in a contiguous Refuge boundary, and provide wildlife-dependent public use opportunities compatible with Refuge purposes. (Willapa Addition Environmental Assessment/ Land Protection Plan, and Conceptual Management Plan 1999)

National Wildlife Refuge System Mission:

The mission of the System is to administer a national network of lands and waters for the conservation, management, and where appropriate, restoration of the fish, wildlife, and plant resources and their habitats within the United States for the benefit of present and future generations of Americans.

Description of Use(s):

This is a re-evaluation of the haying, silage harvest, and cattle grazing program that was initially determined to be compatible with refuge purposes in 1994. The purpose of the program is to manage short-grass foraging habitat for wintering and migrating Canada geese. Grazing/haying is used as a management tool to improve habitat conditions on the Refuge. Privately owned livestock (cattle) will graze on the Refuge to improve vegetative composition by reducing exotic weed species. Grazing/haying will be timed to reduce undesirable vegetation and will be conducted mid-April through mid-October.

Cattle grazing and haying activities are considered Refuge management economic activities. These activities have been and are proposed to continue to be conducted under a cooperative land management agreement (CLMA), which have been established between the Refuge and the livestock operator (cooperator). The CLMA is an in-kind program, which means that both parties receive mutual benefits from the land. In this case, the cooperator receives grazing and haying privileges, and the Service receives management actions conducted primarily for the benefit of Canada geese.

We currently have one cooperator that grazes and hays the Riekkola (199 acres) and Tarlatt (35.2 acres) units and two cooperators that hay the Wheaton Unit (73 acres). Currently, the three local cooperators graze and hay introduced reed canary grass (*Phalaris arundinacea*), native grasses, tame pasture grasses, sedges (*Carex* spp.) and rushes (*Juncus* spp., *Eleocharis* spp.) on refuge pastures. The grazing program is implemented on the Riekkola Unit, and the haying program is implemented on the Riekkola, Tarlatt, and Wheaton units.

Under the preferred alternative of the CCP/EIS, the Refuge haying and grazing programs would be eliminated from the Willapa Refuge following the tidal restoration of the Riekkola and Tarlatt units.

Availability of Resources:

An estimated $6,000 of Refuge staff time is needed annually for planning, oversight, and coordination of this use. Before each field season, the Refuge Manager reviews the annual work plan, discusses it with Refuge Complex headquarters staff, and makes necessary changes to the plan. Then the Refuge Manager identifies changes with the cooperator prior to initiation of grazing/haying.

Periodically, assistance may be required of refuge maintenance staff to maintain the watering and fencing systems. Refuge staff monitors the grazing and haying operations, and periodically evaluate habitat conditions before, during and after the grazing season. At the end of the season, refuge staff review the worksheets completed by the cooperator to determine if grazing criteria have been met, the amount of hay removed from the Refuge, and the amount of in-kind work provided by the cooperator. The overall cost to the Refuge in terms of labor is considered to be low, especially taking into the consideration the benefits provided to the Refuge in meeting the previously described goal and objectives. Refuge base funding is available to cover the costs associated with this program.

Anticipated Impacts of Described Use:

Negative impacts from grazing are mostly associated with difficulties in containing the cattle. Cattle are attracted to water and therefore can damage sensitive wetland areas if they gain access to those sites. They can also cause damage in riparian forest sites and waterways by trampling the understory, compacting soils, degrading water quality, and making the areas undesirable for other wildlife. By fencing off any sensitive areas and focusing the grazing in the pastures, negative impacts from grazing are minimized. Adverse impacts to wildlife habitats are significantly reduced by restricting livestock use to the spring through early fall time period and by development of site specific watering areas.

All three activities can cause some degree of disturbance to the geese and other migratory bird and other resident wildlife. In addition, haying and silage activities may cause geese and other migratory birds/wildlife to move from the immediate area where the farming equipment is operating. However, since these disturbances are short-term and localized, the geese and migratory birds/wildlife can easily move to an adjacent undisturbed location. Restricting the pasture management activities from spring through early fall provides geese and other migratory birds/wildlife and Canada geese optimum habitat conditions when they most need it, in the fall through winter seasons. Geese use refuge pastures for foraging, preferring young shoots that are higher in protein and lower in fiber than mature stems (McLandress and Raveling 1981). Pasture grasses serve as an important source of amino acids and carbohydrates to meet the energy and nutrient requirements of geese (Baldassare and Bolen 2006). Grazing by livestock simulates some of the effects of natural disturbances by removing woody vegetation, reducing thatch, and encouraging the production of young shoots which are preferred forage for Canada and cackling geese (Raveling 1979). To provide high quality forage for wintering and migrating geese, the Refuge uses grazing and haying to ensure that young shoots between 2 and 4 inches tall are available by early October each year.

Grazing has been demonstrated to impact various grassland birds, nesting waterfowl, and small mammals (Fleischner 1994). Not only are these species subject to injury and mortality from trampling, but the conversion of tall pasture grasses to short-cropped grasses results in habitat loss for some species. The Refuge reduces impacts of pasture management by limiting grazing/haying operations and restricting the introduction of cattle during the breeding season in areas where significant impacts to nesting birds would occur.

Public Review and Comment:

Open-house style public meetings were held, verbal and written comments were solicited from the public during public scoping for the CCP/EIS for the Willapa Refuge. Appendix E of the draft CCP/EIS further details public involvement undertaken during development of the CCP. Additional public review and comment will be solicited during the draft CCP/EIS comment period.

Determination:

______Use is Not Compatible

__**X**__Use is Compatible with the Following Stipulations

Stipulations Necessary to Ensure Compatibility:

Cooperative land management agreements will contain the following special conditions to insure compatibility:

- Special emphasis is applied to fencing wetlands and riparian zones where cattle tend to try to shift use; fencing and ditching are used to contain cattle and focus grazing on specific pastures during the dry season.
- Season of use is from mid-April through mid-October to avoid disturbance to Canada geese and avoid grazing under wet soil conditions.
- Permittees are required to leave fields with 2 to 4 inches of grass and forbs growth at season's end.
- Cooperative farmers are required to perform habitat maintenance work to sustain the field conditions for the benefit of wildlife. Work may include mechanical weed control, fertilization, and pasture mowing.
- The agreement does not imply or establish a use precedent. Future use of the area will be based on the most satisfactory use of the land for wildlife benefits, cooperator performance, habitat management needs, and administrative needs.
- Cooperative will exercise care to prevent fire and will assume responsibility for fire which may result from his/her operations.
- Sub-leasing is prohibited. Animals must be the property of the cooperator.
- At the end of the permit period, cooperator is responsible for removing all his/her equipment and animals from refuge lands.
- Cooperator shall be responsible for repairing damage to refuge facilities or habitat beyond normal wear and tear resulting from his/her operation.
- The discharge or use of firearms or other weapons is prohibited, unless permitted as part of an authorized activity such as hunting,
- Stocking rates of livestock may be altered should pasture conditions warrant, dependent upon judgment of the Refuge Manager.
- The cooperator will notify the Refuge Manager at least three days in advance of the date cattle are to be turned in or removed from the Refuge. Any changes in the number of

animals shall be immediately reported to the Refuge Manager. Livestock will be contained in assigned units and fences must be maintained by the cooperator.
- Cooperator is responsible for removing dead livestock carcasses from the Refuge within three days of discovery.
- The cooperator shall comply with the livestock regulations of the State of Washington relating to health and sanitation requirements.

Justification:

The haying, silage, and grazing cooperative land management program contributes to achieving refuge purposes and goals as identified in the CCP and the National Wildlife Refuge System mission by providing valuable foraging areas for wintering and migrating Canada geese. It also contributes by economically providing weed control and other habitat maintenance functions which are not feasible for limited refuge staff to accomplish.

The short-grass pastures complement the marsh habitat on and around the Refuge in providing forage and resting habitat for migrating and wintering Canada geese. Refuge pastures also provide foraging habitat for ducks, raptors and other resident wildlife. Grazing and haying are desirable means of maintaining this type of habitat because the climate is too wet for prescribed burning, and repeated mowing of the pastures is beyond the capability of the Refuge.

The use of moderate grazing to reduce the build-up of annual introduced grassland biomass is viewed as beneficial to Canada geese. By restricting the intensity and duration of grazing, and by adhering to the stipulations for this use, the environmental health of the Refuge will be maintained.

By conducting haying, silage, and grazing as part of the pasture management program under the practices and stipulations described above, it is anticipated that wildlife species which could be adversely affected would find sufficient food resources and resting places so their abundance and use will not be measurably lessened on the Refuge. Additionally, it is anticipated that monitoring, as needed, will prevent unacceptable or irreversible impacts to fish, wildlife, plants, and their habitats.

The combination of management practices and stipulations identified above will ensure that haying, silage, and grazing contribute to the enhancement, protection, conservation, and management of native wildlife populations and their habitats on the Refuge. As a result, haying and mowing contribute to achieving refuge purpose(s); contribute to the mission of the Refuge System; and help maintain the biological integrity, diversity, and environmental health of the Refuge.

References:

Baldassare, G.A, and E.G. Bolen. 2006. Waterfowl ecology and management. 2nd edition. Malabar, FL: Krieger Publishing Company.

Fleischner, T.L. 1994. Ecological costs of livestock grazing in western North America. Conservation Biology 8(3):629-644

McLandress, M.R. and D.R. Raveling. 1981. Changes in diet and body composition of Canada geese before spring migration. Auk 98:65-79.

Raveling, D.G. 1979. The annual energy cycle of the cackling Canada goose. Pages 81-93 in: R.I. Jarvis and J.C. Bartonek, eds. Management and biology of Pacific Flyway geese. Corvallis, OR: Oregon State University.

Mandatory Re-evaluation Date (provide month and year for "allowed" uses only):

______ Mandatory 15-year Re-evaluation Date will be provided in the Final CCP/EIS (for priority public uses)

__**X**__Mandatory 10-year Re-evaluation (for all uses other than priority public uses)

NEPA Compliance for Refuge Use Decision:

______ Categorical Exclusion without Environmental Action Statement

______ Categorical Exclusion and Environmental Action Statement

______ Environmental Assessment and Finding of No Significant Impact

__**X**__ Environmental Impact Statement and Record of Decision

Signatures:

Haying, Silage Harvest, and Cattle Grazing.

Prepared by:	______________________ (Signature)	__________ (Date)
Refuge Manager/ Project Leader Approval:	______________________ (Signature)	__________ (Date)

Concurrence

Refuge Supervisor:	______________________ (Signature)	__________ (Date)
Regional Chief, National Wildlife Refuge System:	______________________ (Signature)	__________ (Date)

C.7 Draft Compatibility Determination for Research, Scientific Collecting, and Surveys on Willapa National Wildlife Refuge

Use: Research, Scientific Collecting, and Surveys

- **Research:** Planned, organized, and systematic investigation of a scientific nature.
- **Scientific collecting:** Gathering of refuge natural resources or cultural artifacts for scientific purposes.
- **Surveys:** Scientific inventory or monitoring.

Location: Pacific County, Washington

Date Established: 1936

Establishing and Acquisition Authorities:

- Migratory Bird Conservation Act of 1929, as amended (16 U.S.C. 715-715s)
- Executive Order 7541, Willapa Harbor Migratory Bird Refuge, Washington, signed: January 22, 1937
- Fish and Wildlife Act of 1956, as amended (16 U.S.C. § 742a-754c)
- Land and Water Conservation Fund Act of 1965, as amended (16 U.S.C. § 4601-4601.11)
- Endangered Species Act of 1973, as amended (16 U.S.C .1532-1544, 87 Stat 884)
- Refuge Recreation Act of 1962, as amended (16 U.S.C. 460k-460k-4)

Refuge Purpose(s):

The purposes for the Willapa NWR have been identified in historic legal documentation establishing and adding refuge lands. The Refuge was originally established to preserve an important wintering and foraging habitat for migratory waterfowl in the Pacific Flyway with Refuges Purposes specified as follows:

... as a refuge and breeding ground for migratory birds and other wildlife: ... Executive Order 7541, dated Jan. 22, 1937

"... for use as an inviolate sanctuary, or for any other management purpose, for migratory birds." 16 U.S.C. § 715d (Migratory Bird Conservation Act)

"... suitable for— (1) incidental fish and wildlife-oriented recreational development, (2) the protection of natural resources, (3) the conservation of endangered species or threatened species ..." 16 U.S.C. § 460k-1

"... the Secretary ... may accept and use ... real ... property. Such acceptance may be accomplished under the terms and conditions of restrictive covenants imposed by donors ...” 16 U.S.C. § 460k-2 (Refuge Recreation Act (16 U.S.C. § 460k-460k-4), as amended).

"... for the development, advancement, management, conservation, and protection of fish and wildlife resources ..." 16 U.S.C. § 742f(a)(4)

"... for the benefit of the United States Fish and Wildlife Service, in performing its activities and services. Such acceptance may be subject to the terms of any restrictive or affirmative covenant, or condition of servitude ..." 16 U.S.C. § 742f(b)(1) (Fish and Wildlife Act of 1956)

In accordance with 601 FW1, all lands acquired since the original establishment of the Refuge retain this purpose.

Management priorities are further stated in subsequent land acquisition documents to preserve, protect, and restore newly acquired habitats and provide habitat for other migratory birds, plants and wildlife with special emphasis for marbled murrelets, bald eagles, Aleutian Canada geese, shorebirds, marsh birds, wading birds, and water howellia (plant). Documentation for additional lands also identified the following habitats, wildlife, public opportunities, and management priorities to support a diverse assemblage of native fish, wildlife, and plants which includes: eelgrass beds, gravel bars, old-growth/mature forests, riverine habitats, intertidal mudflats, sand dune habitat, fish species (coho, Chinook, chum salmon, steelhead, sea-run cutthroat trout), amphibian diversity, compatible wildlife-dependent recreation, educational/research opportunities, and cultural resource sites.

Management priorities are further derived from various legal and land acquisition documents:

"…one of the most important concentration points for migratory waterfowl on the Washington Coast. It has a fine supply of natural aquatic foods, especially eel-grass, and there by has been for years one of the few suitable wintering grounds available for Black Brant…it is essential for the preservation of the Pacific flyway that the Restoration program provide adequate sanctuary facilities for migratory birds in that state." (Migratory Bird Conservation Commission Memorandum, Memo 16, May 7, 1936)

…as a refuge and breeding ground for migratory birds and other wildlife… (Executive Order 7541, dated Jan. 22 1937)

…in order to effectuate further the purposes of the Migratory Bird Conservation Act (45 Stat. 1222)" and states that "Provided, that any private lands within the area described shall become a part of the refuge upon the acquisition of title thereto or lease thereof by the United States. (Executive Order 7721, October 8, 1937)

… for use as an inviolate sanctuary. Or for any other management purpose, for migratory birds." 16 U.S.C. § 715d (Migratory Bird Conservation Act)

…To preserve and protect unique ecosystems associated with Willapa Bay…To provide for maximum use and production by migratory birds other than wintering waterfowl, with special emphasis on bald eagles and marsh and wading birds. (Long Island Land Exchange; September 1983)

…protect habitat for old growth dependent species including the threatened marbled murrelet and threatened northern spotted owl… protect and restore upland forest and associated stream habitat in order to protect and enhance declining fish populations, including coastal cutthroat trout, and Chinook, coho, and chum salmon runs… protect and restore coastal wetlands to provide a diversity of habitats for migratory waterfowl, shorebirds, wading birds, and songbirds…protect the intertidal mudflats along Willapa Bay by consolidating spartina infested lands for better management of control and eradication efforts on existing Refuge lands and on adjacent tidelands.…provide large scale habitat management through linking existing Refuge lands in a contiguous Refuge boundary, and provide wildlife-dependent public use opportunities compatible with Refuge purposes. (Willapa Addition Environmental Assessment/ Land Protection Plan, and Conceptual Management Plan 1999)

National Wildlife Refuge System Mission:

The mission of the System is to administer a national network of lands and waters for the conservation, management, and where appropriate, restoration of the fish, wildlife, and plant resources and their habitats within the United States for the benefit of present and future generations of Americans.

Description of Use(s):

The refuge staff receives periodic requests from non-Service entities (e.g., universities, state or territorial agencies, other Federal agencies, nongovernmental organizations) to conduct research, scientific collecting, and surveys on refuge lands. These project requests can involve a wide range of natural and cultural resources as well as public-use management issues including basic absence/presence surveys, collection of new species for identification, habitat use and life-history requirements for specific species/species groups, practical methods for habitat restoration, extent and severity of environmental contaminants, techniques to control or eradicate pest species, effects of climate change on environmental conditions and associated habitat/wildlife response, identification and analyses of paleontological specimens, wilderness character, modeling of wildlife populations, bioprospecting, and assessing response of habitat/wildlife to disturbance from public uses. Projects may be species-specific, refuge-specific, or evaluate the relative contribution of the refuge lands to larger landscapes (e.g., ecoregion, region, flyway, national, international) issues and trends.

The Service's Research and Management Studies (4 RM 6) and Appropriate Refuge Uses (603 FW1.10D(4)) policies indicate priority for scientific investigatory studies that contribute to the enhancement, protection, use, preservation, and management of native wildlife populations and their habitat as well as their natural diversity. Projects that contribute to refuge-specific needs for resource and/or wilderness management goals and objectives, where applicable, would be given a higher priority over other requests.

Availability of Resources:

Refuge staff responsibilities for projects by non-Service entities will be primarily be limited to the following: review of proposals, prepare SUP(s) and other compliance documents (e.g., Section 7 of the Endangered Species Act of 1973, Section 106 of the National Historic Preservation Act), and monitor project implementation to ensure that impacts and conflicts remain within acceptable levels (compatibility) over time. Additional administrative support, logistical and operational support may also be provided depending on each specific request. Estimated costs for one-time (e.g., prepare SUP) and annually re-occurring tasks by refuge staff and other Service employees will be determined for each project. Sufficient funding in the general operating budget of the refuge must be available to cover expenses for these projects.

The terms and conditions for funding and staff support necessary to administer each project on the refuge will be clearly stated in the SUP(s).

The Refuge has staffing and funding to administratively support and monitor research that is currently taking place on refuge lands. Any substantial increase in the number of projects may create the need for additional resources to oversee the administration and monitoring of the investigators and their projects. Any additional costs may result in finding a project not compatible unless expenses are offset by the investigator(s), sponsoring agency, or organization.

Anticipated Impacts of the Use:

Use of the refuge(s) to conduct research, scientific collecting, and surveys will generally provide information that would benefit fish, wildlife, plants, and their habitats. Scientific findings gained through these projects provide important information regarding life-history needs of species and species groups as well as identify or refine management actions to achieve resource management objectives in refuge management plans (especially CCPs). Reducing uncertainty regarding wildlife and habitat responses to refuge management actions in order to achieve desired outcomes reflected in resource management objectives is essential for adaptive management in accordance with 522 DM 1.

If project methods impact or conflict with refuge-specific resources, priority wildlife-dependent public uses, other high-priority research, wilderness, and refuge habitat and wildlife management programs, then it must be clearly demonstrated that its scientific findings will contribute to resource management and that the project cannot be conducted off refuge lands for the project to be compatible. The investigator(s) must identify methods/strategies in advance required to minimize or eliminate the potential impact(s) and conflict(s). If unacceptable impacts cannot be avoided, then the project will not be compatible. Projects that represent public or private economic use of the natural resources of any national wildlife refuge (e.g., bioprospecting), in accordance with 16 U.S.C. 715s, must contribute to the achievement of the national wildlife refuge purposes or the National Wildlife Refuge System mission to be compatible (50 C.F.R. 29.1).

Impacts would be project- and site-specific, where they will vary depending upon nature and scope of the field work. Data collection techniques will generally have minimal animal mortality or disturbance, habitat destruction, no introduction of contaminants, or no introduction of non-indigenous species. In contrast, projects involving the collection of biotic samples (plants or animals) or requiring intensive ground-based data or sample collection will have short-term impacts. To reduce impacts, the minimum number of samples (e.g., water, soils, vegetative litter, plants, macroinvertebrates, vertebrates) will be collected for identification and/or experimentation and statistical analysis. Where possible, researchers would coordinate and share collections to reduce sampling needed for multiple projects. For example, if one investigator collects fish for a diet study and another research examines otoliths, then it may be possible to accomplish sampling for both projects with one collection effort.

Investigator(s) obtaining required State or Territorial, and Federal collecting permits will also ensure minimal impacts to fish, wildlife, plants, and their habitats. If after incorporating the above strategies, projects will not be compatible if they will result in long-term or cumulative effects. A Section 7 consultation under the Endangered Species Act (16 U.S.C. 1531-1544, 87 Stat. 884, as amended Public Law 93-205) will be required for activities that may affect a federally listed species and/or critical habitat. Only projects which have no effect or will result in not likely to adversely affect determinations will be considered compatible.

Spread of invasive plants and/or pathogens is possible from ground disturbance and/or transportation of project equipment and personnel, but it will be minimized or eliminated by requiring proper cleaning of investigator equipment and clothing as well as quarantine methods, where necessary. If after all practical measures are taken and unacceptable spread of invasive species is anticipated to occur, then the project will be found not compatible without a restoration or mitigation plan.

There also could be localized and temporary effects from vegetation trampling, collecting of soil and plant samples, or trapping and handling of wildlife. Impacts may also occur from infrastructure necessary to support a projects (e.g., permanent transects or plot markers, exclosure devices, monitoring equipment, solar panels to power unattended monitoring equipment). Some level of disturbance is expected with these projects, especially if investigator(s) enter areas closed to the public and collect samples or handle wildlife. However, wildlife disturbance (including altered behavior) will usually be localized and temporary in nature. Where long-term or cumulative unacceptable effects cannot be avoidable, the project will not be found compatible. Project proposals will be reviewed by refuge staff and others, as needed, to assess the potential impacts (short, long-term, and cumulative) relative to benefits of the investigation to refuge management issues and understanding of natural systems.

At least 6 months before initiation of field work (unless an exception is made by prior approval of the Refuge Manager), project investigator(s) must submit a detailed proposal using the format provided in Attachment 1. Project proposals will be reviewed by refuge staff and others, as needed, to assess the potential impacts (short, long-term, and cumulative) relative to benefits of the investigation to refuge management issues and understanding of natural systems. This assessment will form the primary basis for allowing or denying a specific project. Projects which result in unacceptable refuge impacts will not be found compatible. If allowed and found compatible after approval, all projects also will be assessed during implementation to ensure impacts and conflicts remain within acceptable levels.

If the proposal is approved, then the Refuge Manager will issue a SUP(s) with required stipulations (terms and conditions) of the project to avoid and/or minimize potential impacts to refuge resources as well as conflicts with other public-use activities and refuge field management operations. After approval, projects also are monitored during implementation to ensure impacts and conflicts remain within acceptable levels based upon documented stipulations.

The combination of stipulations identified above and conditions included in any SUP(s) will ensure that proposed projects contribute to the enhancement, protection, conservation, and management of native wildlife populations and their habitats on the refuge. As a result, these projects will help fulfill refuge purpose(s); contribute to the Mission of the NWRS; and maintain the biological integrity, diversity, and environmental health of the refuge.

Future projects which are not covered by the CCP may require additional NEPA documentation.

Public Review and Comment:

Open-house style public meetings were held, verbal and written comments were solicited from the public during public scoping for the CCP/EIS for the Willapa NWR. Appendix E of the draft CCP/EIS further details public involvement undertaken during development of the CCP. Additional public review and comment will be solicited during the draft CCP/EIS comment period.

Determination: (check one below)

______ The use is not compatible.

___X__ The use is compatible with the following stipulations.

Stipulations Necessary to Ensure Compatibility:

Each project will require a SUP. Annual or other short-term SUPs are preferred; however, some permits will be a longer period, if needed, to allow completion of the project. All SUPs will have a definite termination date in accordance with 5 RM 17.11. Renewals will be subject to Refuge Manager review and approval based timely submission of and content in progress reports, compliance with SUP stipulations, and required permits.

- Projects will adhere to scientifically defensible protocols for data collection, where available and applicable.
- Investigators must possess appropriate and comply with conditions of State or Territorial and Federal permits for their projects.
- If unacceptable impacts to natural resources or conflicts arise or are documented by the refuge staff, then the Refuge Manager can suspend, modify conditions of, or terminate an on-going project already permitted by SUP(s) on a refuge.
- Progress reports are required at least annually for multiple-year projects. The minimum required elements for a progress report will be provided to investigator(s).
- Final reports are due one year after completion of the project unless negotiated otherwise with the Refuge Manager.
- Continuation of existing projects will require approval by the Refuge Manager.
- The refuge staff will be given the opportunity to review draft manuscript(s) from the project before being submitted to a scientific journal(s) for consideration of publication.
- The refuge staff will be provided with copies (reprints) of all publications resulting from a refuge project.
- The refuge staff will be provided with copies of raw data (preferably electronic database format) at the conclusion of the project.
- Upon completion of the project or annually, all equipment and markers (unless required for long-term projects), must be removed and sites must restored to the Refuge Manager's satisfaction. Conditions for clean-up and removal of equipment and physical markers will be stipulated in the SUP(s).
- All samples collected on refuge lands are the property of the Service even while in the possession of the investigator(s). Any future work with previously collected samples not

clearly identified in the project proposal will require submission of a subsequent proposal for review and approval. In addition, a new SUP will be required for additional project work. For samples or specimens to be stored at other facilities (e.g., museums), a memorandum of understand will be necessary.

- Sampling equipment as well as investigator(s) clothing and vehicles (e.g., ATV, boats) will be thoroughly cleaned (free of dirt and plant material) before being allowed for use refuge lands to prevent the introduction and/or spread of pests. Where necessary, utilize quarantine methods provided by the Refuge Manager..
- The NWRS, specific refuge, names of refuge staff and other Service personnel that supported or contributed to the project will be appropriately cited and acknowledged in all written and oral presentations resulting from projects on refuge lands.
- At any time, refuge staff may accompany investigator(s) in the field.
- Investigator(s) and support staff will follow all refuge-specific regulations that specify access and travel on the refuge(s).

Justification:

Research, scientific collecting, and surveys on refuge lands are inherently valuable to the Service because they will expand scientific information available for resource management decisions. In addition, only projects which directly or indirectly contribute to the enhancement, protection, use, preservation, and management of refuge wildlife populations and their habitats generally will be authorized on refuge lands. In many cases, if it were not for the refuge staff providing access to refuge lands and waters along with some support, the project would never occur and less scientific information would be available to the Service to aid in managing and conserving the refuge resources. By allowing the use to occur under the stipulations described above, it is anticipated that wildlife species which could be disturbed during the use would find sufficient food resources and resting places so their abundance and use will not be measurably lessened on the refuge. Additionally, it is anticipated that monitoring, as needed, will prevent unacceptable or irreversible impacts to fish, wildlife, plants, and their habitats. As a result, these projects will not materially interfere with or detract from fulfilling refuge purpose(s) (including wilderness); contributing to the Mission of the NWRS; and maintaining the biological integrity, diversity, and environmental health of the refuge.

Mandatory Re-evaluation Date:

_______ Mandatory 15-year re-evaluation date (wildlife-dependent public uses)

___X___ Mandatory 10-year re-evaluation date (uses other than wildlife-dependent public uses)

NEPA Compliance for Refuge Use Decision: (check one below)

_______ Categorical Exclusion and Environmental Action Statement

_______ Environmental Assessment and Finding of No Significant Impact

___X___ Environmental Impact Statement and Record of Decision

Refuge Determination:

Research, Scientific Collecting, and Surveys

Prepared by:	______________________ (Signature)	__________ (Date)
Refuge Manager/ Project Leader Approval:	______________________ (Signature)	__________ (Date)

Concurrence:

Refuge Supervisor:	______________________ (Signature)	__________ (Date)
Regional Chief, National Wildlife Refuge System:	______________________ (Signature)	__________ (Date)

Attachment 1

FORMAT FOR PROPOSALS TO CONDUCT RESEARCH OR LONG-TERM MONITORING ON NATIONAL WILDLIFE REFUGES

A Special Use Permit (SUP) is required to conduct research and/or long-term monitoring on refuge lands. To receive a SUP, a detailed project proposal using the following format must be submitted to the Refuge Manager approximately 6 months prior to the start of the project.

Title:

Principal Investigator(s):

Provide the name(s) and affiliation(s) of all principal investigator(s) that will be responsible for implementation of the research and/or long-term monitoring described in the proposal. In addition, provide a brief description or attach vitae of expertise for principal investigator(s) germane to work described in the proposal.

Background and Justification:

In a narrative format, describe the following as applicable:

- *The resource management issue (e.g., decline in Pisonia rainforest) and/or knowledge gap regarding ecological function that currently exists with any available background information.*
- *Benefit of project findings (e.g., management implications) to resources associated with refuge.*
- *Potential consequences if the conservation issue and/or knowledge gap regarding ecological function is not addressed.*

Objectives:

Provide detailed objective(s) for the proposed project.

Methods and Materials:

Provide a detailed description of the methods and materials associated with field and laboratory work (if applicable) to be conducted for the project. Methods should include the following:

- *study area(s)*
- *number of samples;*
- *sampling dates and locations*
- *sampling techniques*
- *data analyses including* ***statistical methods*** *and* ***significance levels****.*

Previously published methods should be cited without explanation; whereas, new or modified techniques should be described in detail. Include number of personnel as well as all facilities and equipment (e.g., vehicles, boats, structures, markers) required to collect samples/data. Provide a clear description of the relationships among study objectives, field methods, and statistical analyses.

Permits:

Identify all State or Territorial and Federal permits required if applicable.

Potential Impacts to Refuge Resources:

Describe potential impacts to threatened or endangered species as well as other refuge plants, wildlife, and fish species that could result from the implementation of project activities on the refuge. Consider the cumulative impacts associated with this project.

Animal Welfare Plan:

If appropriate, attach a copy of the Institutional Animal Care and Use review and/or animal welfare plans that are required by the principle investigator's affiliation.

Partnerships and Funding Sources:

List other participating institutions, agencies, organizations, or individuals as well as the nature and magnitude of their cooperative involvement (e.g., funding, equipment, personnel).

Project Schedule:

Provide estimated initiation and completion dates for field sampling, laboratory work, data analyses, and report/manuscript preparation. If the project is divided into phases to be accomplished separately provide separate initiation and completion dates for each phase.

Reports and Raw Data:

Establish a schedule for annual progress and final reports; include adequate time for peer review of the final report/manuscript. Draft reports/manuscripts should be submitted to the Refuge Manager for review prior to submission for consideration of publication. At the conclusion of a research study (manuscripts accepted for publication), an electronic copy of the data (e.g., GIS vegetation layers, animal species composition and numbers, genetics) should be provided to the Refuge Manager. For long-term monitoring projects, the Service also requires raw data for management and planning purposes for the refuge(s).

Publications:

Describe the ultimate disposition of study results as publications in scientific journals, presentation at professional symposiums, or final reports.

Disposition of Samples:

If the project entails the collection of biotic and/or abiotic (e.g., sediment) samples, then describe their storage. Although the samples may be in the possession of scientists for the purposes of conducting the project in accordance with the SUP, the Service retains ownership of all samples collected on refuge lands. If the samples will be used for subsequent research activities that are not described within the original proposal, a new proposal must be submitted to the Refuge Manager to obtain a SUP before initiation of the follow-up project. After conclusion of the research activities, consult with the Refuge Manager regarding the final disposition of the samples. If specimens will be curated at a museum, then prepare a MOU using the format provided by the Refuge Manager.

Appendix D. CCP Team Members

The following Service personnel served as core team members on the Willapa National Wildlife Refuge Comprehensive Conservation Plan planning team.

Name	Position	Degree(s)	Years of Exp.
U.S. Fish and Wildlife Service			
Charlie Stenvall	Project Leader	BS, Wildlife Biology	22
Marie Fernandez	Wildlife Biologist	MS, Biology and Wildlife, and Range Mgt. BS, Zoology, BS, Geology	27
David Gonzales	Refuge Manager	BS, Wildlife Science BS, Fishery Science	13
William Ritchie	Wildlife Biologist	BS, Environmental Science	22
Mariana Bergerson	Visitor Services Manager	MS, Biology BS, Biology and Environmental Studies	13
Terri Butler-Bates	Deputy Project Leader	BS, Biology	22
Khem So	Geography	BS, Geography	8
Rebecca Young	Conservation Planner	BS, Natural Resource Management	22

Early in the planning process, the core team presented the issues to an extended team of tribal, state, and Federal professionals who served as a peer review for the issues, goals, objectives, and strategies for their respective agencies. We would like to thank the following individuals for their interest and assistance throughout this planning process:

Mr. Gary Burns, Environmental Director of the Shoalwater Bay Tribe
Mr. Dave Hays, Wildlife Biologist, Washington Department of Fish and Wildlife
Ms. Lisa Lantz, Resource Stewardship Manager, Washington State Parks
Mr. Scott Pearson Senior Research Scientist, Washington Department of Fish and Wildlife
Ms. Ginger Phalen, Coastal Programs Coordinator, U.S. Fish and Wildlife Service
Mr. Jack Smith, Regional Wildlife Program Manager (Retired), Washington Department. of Fish and Wildlife
Mr. Max Zahn, Area Wildlife Biologist, Washington Department of Fish and Wildlife
Dr. Sam Lohr, Ph.D., Fisheries Biologist, U.S. Fish and Wildlife Service

Special thanks for assistance and collaboration with mapping data goes to Mr. Tom Kolash, Ellsworth Creek Manager, with The Nature Conservancy.

Appendix E. Public Scoping Report

This scoping report summarizes the issues, concerns, and opportunities identified by the U.S. Fish and Wildlife Service (USFWS), its partners, and the public during the public scoping phase for Willapa National Wildlife Refuge Comprehensive Conservation Plan/Environmental Impact Statement (CCP/EIS). Early in the planning process, the USFWS developed a list of preliminary issues and concerns for the CCP/EIS. These planning issues were presented at public scoping meetings on March 25 and 26, 2008, as well as in a publicly distributed Planning Update and Federal Register Notice. Information gathered through these means and other sources is reflected in this scoping report through May 16, 2008.

Public Outreach

On March 27, 2008, the Notice of Intent to Prepare a Draft CCP/EIS was published in the Federal Register. Planning Update 1 was published, with a comment form, and was distributed in March 2008 to a mailing list of approximately 400 recipients. A press release advertising the public meetings was distributed to eight western Washington and Oregon newspapers, six state and federal congressional members, five regional television stations, and one local radio station approximately one week before each meeting scheduled in the respective area of the coast. CCP partners were also notified by email or phone of the upcoming public meetings and the availability of the Planning Update. The press release was published in three of the local newspapers: *Daily Astorian*, *Chinook Observer*, and *Daily News*. Willapa National Wildlife Refuge held two public meetings for the CCP: one in South Bend, Washington, and one in Ilwaco, Washington. A total of 61 private citizens and representatives from various organizations attended the public meetings (20 at South Bend and 41 at Ilwaco) and provided verbal comments on the issues and opportunities presented. Comment forms were made available at each public meeting. All of the public comments heard during the meetings were recorded on easel paper and transcribed to a written document after the final meeting. During the scoping period March 27, 2008, through May 16, 2008, a total of 36 responses were received from individuals or organizations in writing.

Summary of the Oral and Written Comments Received During Public Scoping

Tidal Marsh Restoration Comments Received

A comment was received asking that the recently acquired farmland/pasture remain at least in part grassland habitat for waterfowl, because large tracts of this land are diminishing in the Willapa Bay area, and because a change in landscape would mean a downturn in hunting and place waterfowl in areas not accessible to hunters. A comment was made on breaching a dike and eliminating an established community. In a follow-up remark, a commenter wondered whether that loss of grassland habitat would equal a loss of Canada geese and what would happen if numbers of Canada geese go down after salt marsh restoration. A remark from a public participant in favor of salt marsh restoration was noted, as were questions about the tidal elevation of potential restored areas and whether there could there be multiple uses of these restored areas. A commenter suggested examination of climate implications and sea level rise. A commenter suggested that grazing cattle to maintain pastures, which are beneficial for geese and other species that avoid tall vegetation due to predators, is effective. A commenter noted that anything the Refuge does to enhance tidal marsh habitats is good. Remarks were submitted with strong encouragement to restore diked areas to tidal salt marsh. A follow-up comment concerned the costs and personnel hours spent maintaining the dike and water control structures to the detriment of numerous species. Another comment suggested that the Service learn more about restoration from other projects that have succeeded or failed. A comment noted that waterfowl need fresh water and pastures for feeding, not saltwater marshes.

Land Acquisition Comments Received

Concerns were expressed that land is purchased and no trespassing signs go up; that there is less land for all outdoor activities; and that more trails and access should be allowed and planned. Another comment was pro land acquisition but expressed concern that the primary use could be perceived to be hunting. A commenter asked whether the Refuge has identified areas in proximity that would be beneficial to acquire for habitat. An additional suggestion stated that Willapa Bay is an incredible place and the commenter would like to see as much done as possible to keep land acquisition a priority of the Refuge where the land is sensitive habitats in need of protection, noting that over time, things can be done to enhance or restore existing lands in the Refuge, and that the available land will continue to increase in cost and increase in development, so that the time is now to buy as much land as possible. Another comment suggested that lands around Bear River should be considered for acquisition as valuable areas for salmon and other anadromous fish. Top priorities for one commenter are expanding territory and controlling invasive species. A remark stated the Refuge should strive for continued acquisition of lands that would create a more efficient land pattern to manage. Another comment strongly supported expansion of the refuge boundary and acquisition of lands in fee title and easements to protect habitat in Willapa Bay. Another comment expressed that the Refuge should seriously consider the land base it will need to effectively conserve its trust species within functional landscapes long into the future.

Wildlife and Species Management Comments Received

Several comments were received regarding specific wildlife species and their management and protection. One attendee inquired about threatened and endangered species, especially western snowy plover and marbled murrelet, specifically, what the strategies are in place to protect these species. A comment was made that the respondent did not want another tern nesting site up at the Leadbetter Unit with removal of all the grasses. A comment was made that terns consumed up to 14 million salmon smolts on Columbia River last year. One commenter suggested elk exclusion from nesting areas should be considered. A remark was made that there is only one effective measure to prevent elk from continually impacting the resources of the snowy plover HRA: building an elk-proof fence around it. One commenter suggested the expansion of exotic beach grass removal and lethal removal of corvids and elk.

Leadbetter Point Unit: Elk Management Comments Received:

Comments were in favor of a hunt to decrease the number of elk at the Leadbetter Point Unit but not to remove them completely. Several comments suggested special hunting permits or tags for an elk hunt be established in conjunction with Washington State Department of Fish and Wildlife (e.g., provide five tags). One commenter suggested a specific number of tags be given to master hunters and youth hunters. A suggestion was made that an early hunt season would have too many conflicts with other users (birdwatchers, hikers, wildlife observation). A comment was recorded regarding the sound of gunshots, specifically that when shots are heard at nearby residences, it is unnerving. An observation was made that elk seem to be flourishing in the Leadbetter Point Unit. A comment noted that most visitors at the Leadbetter Point Unit are walking the beaches and trails and may be at odds with hunting in this unit. It was asked whether netting and relocating the elk at the Leadbetter Point Unit have been considered. There was a concern that the elk will move out of the Leadbetter Point Unit if hunt is activated and move onto adjacent lands, specifically cranberry fields.

Service Response/Change

After further evaluation of the hunting program during the planning process, it was determined that the proposed elk hunt at the Leadbetter Point Unit should be considered as part of the overall Refuges big game hunting program. The details of the proposed expanded elk and deer hunt may be found in Chapter 5 and Appendices C and M.

Forest Management Comments Received

A commenter was in favor of habitat restoration but was concerned about road removal and access into forest areas for hunting. A comment was recorded to not allow any major timber harvesting to occur on refuge lands. Comments were made that the welfare of endangered species such as marbled murrelet and spotted owl should be considered, and that surveys should be conducted periodically for insect infestations or other destructive organisms injurious to trees. Another comment indicated this is a major issue for the Refuge as we have much more forested lands than any other, so the Refuge should consider adding a biologist position dedicated to forestry/silviculture as there is plenty of meaningful work to be conducted. A suggestion was made to continue partnerships with adjacent landowners to restore forest and streams.

Wildlife-Dependent Recreation and Public Use Comments Received

Some comments were in favor of increasing opportunities for hunting and suggested that the Service increase these opportunities through refuge expansion and/or in coordination with Washington Department of Fish and Wildlife. Additional comments were supportive of current hunting opportunities, and a recommendation was made to provide bulletin board announcements at the Lewis Unit for clear hunting regulations and access. One individual commented that he/she would like to be able to walk dogs on refuge trails. One suggestion is to have a trail from the Leadbetter Point parking lot along north side of Willapa Bay to Grassy Island. A comment was received about airboats in Willapa Bay disturbing wildlife in the bay and on Long Islands, with a follow-up comment that the airboats detract from the hunt experience on Long Island. Some commenters asked what the USFWS is doing to get the word out about airboat disturbance of wildlife, and it was suggested that the Service increase signage to inform the public about the sensitivity of coastal wildlife resources. Additional feedback indicated concern about too much focus on hunting and not enough on other public uses. A respondent indicated unease with primary acquisition and use of refuge lands for hunters before other users. A suggestion was made to continue to expand environmental education to young people. Another comment suggested that the Salmon Art Trail and trail extension Cutthroat Climb Trail be open more than the current Monday through Friday 7:30 am to 4 pm. An additional comment on hunting and other public uses on the Refuge: it should be marked/signed when hunters may be on the Refuge. A commenter remarked that signs at the Leadbetter yellow trail are in need of attention and there are some additional signage needs at the Leadbetter Point Unit. It was noted that there seems to be some awkward coordination, including unclear, confusing signage, regarding mushroom picking at Leadbetter Point, because it is prohibited on the Refuge but allowed in the State Park adjacent to the Refuge. Another remark was made concerning garbage on beaches and wondered about seasonal crews conducting beach cleanup when snowy plover nesting was not at risk. A respondent indicated that the Refuge should provide safe and accessible dock facilities.

Goose Hunting Comments Received

Several comments concerned the goose hunt at the Riekkola Unit and the maintenance of the pasture for the hunt. It was requested that there be more goose blinds at the Tarlatt/Shier Unit (two blinds). It was also requested that blinds be repositioned and new blinds put in. A user group/nearby hunt club offered to assist with this. A question was raised as to the dollar amount for maintaining the pastures for a goose hunt that does not attract many hunters or geese. Suggestions were made that the Refuge should work with the traditional hunters on blind placement and management of pastures. A written suggestion was made to 1) eradicate all non-grasses within 80 to100 yards of all blinds especially blinds 1 and 2, 2) mow all bull-rushes regularly throughout the year or mowed prior to goose hunting season, 3) paint all pit blinds olive drab outside, 4) paint inside of entrance tube but leave directions legible, 5) change box blind 5 to three pit blinds, and 6) move old box blind 5 to the west of blind 7. Another remark indicated the goose hunt should remain as it is with no expansion.

Big Game Hunting Comments Received

Over half of the hunters in attendance at the Ilwaco meeting on March 26 were muzzleloader hunters. A comment stated that muzzleloader hunters should be allowed to hunt Porter Point and Shier/Tarlatt Unit of Willapa NWR, and that the limited range would not impact the nearby residential area; the comment further stated that the Long Beach Unit is only area where muzzleloaders can hunt elk, but that other users (archery and modern firearm hunters) are not restricted. Requests were made to open the Tarlatt/Shier Unit to muzzleloaders; historically this area was used for muzzleloader until refuge was acquired. A request was made for more bear hunting, because there are too many black bears on Long Beach Peninsula. The continuation of archery hunting and camping on Long Island is extremely important to one respondent, who has enjoyed many trips to Long Island.

Invasive Species (**Spartina*** ***Control) Comments Received***

A comment noted that there is a long list of non-native threats to the Refuge and the bay—*Spartina*, Scotch broom, gorse, tussock, knotweed, Himalayan blackberries, bullfrogs, green crabs, ghost shrimp, and more—all of which will need to be controlled and eliminated (if possible). Top priorities for one commenter are expanding refuge territory and controlling invasive species. A comment expressed that the refuge staff needs to be commended for the huge undertaking of *Spartina* removal. A question was asked about whether the Refuge will have an active monitoring program.

Research/Studies Comments Received

Comments in this category primarily emphasized the need for more collaborative biological research on the Refuge, noting that the USFWS needs better baseline data for management and determining potential methods for accomplishing this research. One attendee recommended that the USFWS partner with universities and other agencies to conduct research that currently is not being done due to limited staff time and funding. A number of meeting attendees had ideas about how the USFWS could work with community groups, federal and state agencies, and other entities to assist the USFWS in accomplishing its mission.

Other Comments Received

Comments placed into this category covered many aspects of general refuge management. Several comments about funding were received, including the need for more funds to manage refuges adequately and to implement ideas and projects resulting from the CCP process. One attendee requested that the Refuge consider camouflaging the outhouses on Long Island as they are visible to all going around island and offensive to see from a distance. One commenter wants the Service to increase advertisement of National Wildlife Refuges along the coast, thus improving the Refuge's identity. A question was asked about the significance of wilderness designation. A comment was made about having a check in station at the boat launch to monitor Long Island hunting. A suggestion was made to provide facilitation for conservation easements around Willapa Bay. An additional comment was made in support of recovery efforts for threatened species but not at the expense of other species.

Appendix F. Implementation Plan

F.1 Overview

Implementation of the CCP will require increased funding, which will be sought from a variety of sources. This plan will depend on additional Congressional allocations, partnerships, and grants. There are no guarantees that additional Federal funds will be made available to implement any of the projects. Other sources of funds will need to be obtained (both public and private). Activities and projects identified will be implemented as funds become available.

Operational management of refuge lands is accomplished by permanent and temporary staffing, volunteers, and partnerships. Operational management includes managing public use, law enforcement, biology, fire, maintenance, administration, and habitat management programs on the Refuge.

Many of the infrastructure and facility projects will be eligible for funding through construction or Transportation Equity Act (TEA 21) funds (i.e., Refuge Roads).

The CCP proposes several projects to be implemented over the next 15 years. All of these projects are included in either the Refuge Operational Needs System (RONS) or the Service Asset Management System (SAMMS). Both are used to request funding from the U.S. Congress. Currently, a large backlog of maintenance needs exists on the Refuge. In 2009, the deferred maintenance backlog for Willapa Refuge was $2.5 million. Reduction of the backlog is an ongoing goal and is included here in the analysis of funding needs. The RONS documents propose new projects to implement the CCP to meet refuge goals and objectives, as well as legal mandates.

Annual revenue sharing payments to Pacific County, Washington, will continue. Total revenue sharing payments made in 2009 was $47,369.

Monitoring activities will be conducted on a percentage of all new and existing projects and activities to document wildlife populations and changes across time, habitat conditions, and responses to management practices. Actual monitoring and evaluation procedures will be detailed in step-down management plans.

F.2 Costs to Implement CCP, by Alternative

The following sections detail both one-time and recurring costs for various projects, by alternative. One-time costs reflect the initial costs associated with a project whether it is purchase of equipment, contracting services, or construction. Recurring costs reflect the future operational and maintenance costs associated with the project.

F.2.1 One-time Costs

One-time costs are project costs that have a start-up cost associated with them, such as purchasing a new vehicle for wildlife and habitat monitoring or designing and installing an interpretive sign. These projects are usually projects that can be completed in three years or less.

These projects do not include permanent operational costs (staff salary and support). They can, however, include the cost of temporary or term salary associated with a short-term project. Salary for new positions and operational costs are reflected in operational or "recurring" costs. Funds for one-time costs will be sought through increases in refuge base funding, special project funds, grants, Refuge Roads or Transportation Equity Act (TEA3) funding, and fire funds.

Projects listed in Tables F-1, F-2, and F-3 show one-time costs, such as those associated with building and facility needs such as offices, public use facilities, road improvements, and new signs. One-time costs are also associated with habitat restoration and protection projects such as specific riparian and wetland projects or research. New research projects, because of their short-term nature are considered one-time projects and include costs of contracting services or hiring a temporary employee for the short-term project. Tables F-1, F-2, and F-3 compare one-time costs between the various alternatives for the Willapa NWR.

Table F-1. One-Time Costs (in Thousands) for Research, Monitoring, and Planning

Project – Research, Monitoring, and Planning	**Priority**	**Unit**	**Unit Cost**	**Alt 1**	**Alt 2**	**Alt 3**	**Potential Fund Source**
Survey and monitor for marbled murrelet presence/absence (Obj. 1.1F)	H Pr	oject	25	$25	$25	$25	*
Monitor for the presence of invasive species such as *Spartina*, tussock, loosestrife spp., thistle spp., Japanese knotweed (Obj. 3.2B)	H Main	land and Long Island	30 $	60	$60	$60	*
Monitor water quality as warranted by conditions of restoration and/or maintenance activities (Obj. 2.1B, 2.2E)	M Pro	ject	7	$7	$7	$7	*
Compile watershed assessments (Obj. 3.2B)	H Main	land and Long Island	20 $	40	$40	$40	*
Monitor western snowy plover breeding and wintering populations (Obj. 6.1A)	H Pr	oject	10	$10	$10	$10	*
Monitor western snowy plover breeding productivity (Obj. 6.1B)	H Pr	oject	10	$10	$10	$10	*
Research actions for western snowy plovers as needed (Obj. 6.1C)	M Pr	oject	10	$10	$10	$10	*
Monitor the status of western snowy plover, marbled murrelet, streaked horned lark, pink sandverbena, mammal, fish and priority amphibian and invertebrate species on the Refuge (Obj. 7.1B)	H Pr	oject	10	$30	$30	$30	*
Work with graduate school programs to conduct research and monitoring, utilize the bunkhouse for students and other researchers (Obj. 7.1F)	M Pr	oject	10	$10	$10	$10	*
Monitor the species composition and distribution of amphibians, mussels (Obj. 7.1G)	H Pr	oject	10	$10	$10	$10	*
All Research, Monitoring, and Planning Projects Subtotal (Thousands)				**$ 212**	**$ 212**	**$ 212**	
High-Priority Research, Planning, and Monitoring Only (Thousands)				**$ 185**	**$ 185**	**$ 185**	

*Projects will be funded as opportunities arise.

Table F-2. One-Time Costs (in Thousands) for Facilities

Project – Facilities	Priority	Unit	Unit Cost	Alt 1	Alt 2	Alt 3	Fund Source
Construct a visitor contact and office facility that would include indoor/outdoor environ-mental education facilities (Obj. 8.6D and 8.8)	H Tar	lett	6,500	$0	$6,500	$6,500	*
Enhance 12 miles of trails with replacement signage and bridges (Obj. 8.2C and 8.1A)	M	Refuge	120	$0	$120	$120	*
Create a new trail based on the restoration along South Bay and new office/visitor center design (Obj. 8.2A and 8.1E)	H	Tarlett	20	$0	$0	$20	*
Create new wildlife observation site (Obj. 8.2A and 8.1F)	H	Tarlett	50	$0	$50	$0	*
Construct car-top canoe/boat put-in to access to South Bay from Riekkola Unit (Obj. 8.1, 8.3F, and 8.5)	M	Riekkola	18	$0	$18	$18	*
Prepare environmental/cultural education materials for interpretation displays/exhibits/ brochures regarding resources of the Refuge (Obj. 9.1C)	M	Refuge	10	$0	$10	$0	*
Install interpretive panel/map at new HQ and along interpretive trail (Obj. 8.1E and 8.2A)	M	Tarlett	40	$0	$40	$40	*
Improve signage to better delineate refuge and hunt boundaries (Obj. 8.3 and 8.4)	H	Refuge	60	$60	$60	$60	*
Remove old buildings and restore habitat of the old building sites.	H	Refuge	100	$0	$100	$100	*
All Facilities Subtotal (thousands)				**$ 60**	**$6,898**	**$6,858**	
High-Priority Facilities Subtotal (thousands)				**$ 60**	**$6,710**	**$6,680**	

*Projects will be funded as opportunities arise.

Table F-3. One-time Costs (in thousands) for Habitat Management.

Project – Habitat	Priority	Unit	Unit Cost (in dollars)	Alt 1**	Alt 2**	Alt 3**	Fund Source
Objective 1.1 Protect and maintain late-successional Sitka spruce zone forest							
number of acres				*557*	*557*	*557*	*
total cost	H	acre	$50	$28	$28	$28	
Objective 1.2 Restore late-successional Sitka spruce zone forest							
number of acres				*6,178*	*6,178*	*6,178*	*
total cost	H	acre	$200	$1,235	$1,235	$1,235	
Objective 2.1 and 2.2 Restore and maintain open water							
number of acres				*878*	*878.2*	*878*	*
total cost	H	acre	$50	$44	$44	$44	
Objective 2.3 and 2.4 Restore and maintain intertidal flats							
number of acres				*4,178*	*4,189*	*4,189*	*
total cost	M	acre	$100	$418	$419	$419	
Objective 2.6 Restore and maintain salt marsh habitat							
number of acres				*0*	*749*	*430*	*
total cost	H	acre	$100	$0	$749	$430	
Objective 3.1 and 3.2 Protect, restore, and maintain riverine habitats							
number of acres				*27*	*27*	*27*	*
total cost	H	acre	$100	$3	$3	$3	
Objective 3.3 Seasonal, managed freshwater wetlands							
number of acres				*317*	*17*	*25*	*
total cost	H	acre	$50	$16	$1	$1	

Project – Habitat	Priority	Unit	Unit Cost (in dollars)	Alt 1**	Alt 2**	Alt 3**	Fund Source
Objective 3.4 Permanent/semi-permanent natural freshwater wetlands (includes beaver ponds and interdunal wetlands)							
number of acres				*610*	*610*	*610*	*
total cost	H	acre	$30	$18	$18	$18	
Objective 4.1 and 4.2 Protect, restore and maintain coastal dune ecosystem							
number of acres				*1,581*	*1,931*	*1,931*	*
total cost	H	acre	$75	$119	$145	$145	
Objective 5.1 Maintain short-grass fields (improved pastures)							
number of acres				*250*	*12*	*250*	*
total cost	H	acre	$40	$10	$1	$10	

*Projects will be funded as opportunities arise.
** Total costs for alternatives given in thousands.

F.2.2. Operational and Maintenance (Recurring) Costs

Operational and maintenance costs reflect refuge spending of base funds allocated each year. These are also known as recurring costs and are usually associated with day-to-day operations and projects that last longer than three years. Operational costs use base funding in Service fund codes 1261, 1262, 1263, 1264, 1265, 9131, 9263, and 9264.

Maintenance includes preventative maintenance; cyclic maintenance; repairs; replacement of parts, components, or items of equipment; adjustments, lubrication, and cleaning (non-janitorial) of equipment, painting; resurfacing; rehabilitation; special safety inspections; and other actions to ensure continuing service and to prevent breakdown.

Alternatives 1, 2, and 3 reflect the backlog and chart the increased maintenance need associated with new facilities and additional acquisitions.

Tables F-4 and F-5 displays the operating and maintenance costs by alternative. Alternatives 1, 2, and 3 reflect increased funding needs for proposed increases in public uses and facilities, increased habitat restoration and conservation activities, and new monitoring needs. These tables include such things as salary, operational expenditures such as travel, training, supplies, utilities and annual maintenance costs.

Table F-4. Operational (Recurring) costs (in thousands).

Project	Action	Resources Needed	Alt 1	Alt 2	Alt 3
1.a Survey and censuses	All methods of enumerating fish and wildlife populations, vegetative habitats, analysis, interpretation and reporting	1260; Biologist, Bio Techs, and Volunteers	$20	$ 30	$20
1.b Studies and investigations	Research projects for managing fish and wildlife populations and habitats	1260; Biologist and Cooperators	$10	$ 20	$10
2.a Wetland restoration	The conversion of altered or degraded on-refuge wetland habitats, including riparian zones back to their original conditions	1260 & special project funds	$0	$3 0	$0
2.b Upland/island/ cliff management	The conversion of altered or degraded on-refuge upland habitats back to their original condition by such actions as road decommissioning, tree stand thinning, replanting native species.	1260 & special project funds	$10	$ 15	$10

Project	Action	Resources Needed	Alt 1	Alt 2	Alt 3
3.a Wetland management	The manipulation of water bodies to affect vegetation and/or create desired wildlife conditions	1260 $	20	$25	$20
3.b Riparian habitat management	Planting of native trees and brush to mimic historic conditions.	$	50	$80	$50
3.c Graze/mow/ hay crop management	The management of grasslands and other habitats for the benefit of wildlife by cropland, grazing, mowing, or haying	$	10	$10	$10
3.f Fire management	Prescribed burning and wildfire preparedness activities. Follow-up monitoring and reporting	$0		$0	$0
3.g Native pest plant control	Integrated pest management activities		$10	$10	$10
3.h Invasive plant management	The eradication, reduction, or control of invasive or exotic plants. Includes monitoring	1260 & special project funds	$25	$ 25	$25
4.a Bird banding	Marking and banding of birds	1260; Volunteers	$2	$2	$2
5.a Interagency coordination	Interactions with other Federal, State and local governments to share information, resolve problems, develop cooperative efforts, and manage species and habitats	1260 $	10	$10	$10
5.b Tribal coordination	Activities associated with the development of cooperative agreements, MOU's, annual funding agreements and similar cooperation/coordination/communications efforts with tribes.	$	10	$10	$10
5.c Private lands activities	Efforts to assist private land owners with habitat improvement and wildlife issues. (Initiate Stewardship Mgt.)	1260 & special project funds	$10	$ 10	$10
Wildlife population management		1260 & special project funds; Biologist	$25	$ 50	$25
6.a Law enforcement	Public Safety, Resource Protection, Hunt Program	1260; Law Enforcement Officer	$100	$ 100	$100
6.e Water rights managements	Activities associated with compliance with state and federal laws to protect and achieve adequate supplies of water. Reading, maintaining and installing measurement devices and gaging stations, preparing water mgt. plans, also monitoring off-refuge water uses	$5		$5	$5
6.f Cultural resource management	Supporting the study and protection of significant prehistoric and historic sites. Evaluation of cultural resources and management of museum property.	$5		$5	$5
6.g Land acquisition support	Staff participation in land acquisition activities, including development of acquisition proposals and appraisals, meetings, inventories and surveys	1260; NAWCA	$5	$5	$5
7.a Visitor services	Providing access, facilities, and programs for refuge visitors. Planning, construction, operation and maintenance of visitor facilities such as roads, trails, signs.	$	20	$20	$40

Project	Action	Resources Needed	Alt 1	Alt 2	Alt 3
	Interpretation, environmental education, hunting and other recreation				
7.b Outreach	Off-site education of public about Service activities through presentations, exhibits, news releases, and radio/TV spots	$7		$7	$11
8.a Planning			$5	$5	$5
TOTALS	**Subtotals annual operational costs (in thousands)**		**$ 359**	**$ 474**	**$ 383**
	Operational costs over 15 years (in thousands)		**$5,385**	**$7,110**	**$5,745**

F.2.3 Staffing

Table F-5 includes costs for permanent and seasonal staff needed each year. It does not include staff costs associated with special projects; these are summarized in Table F-6.

Table F-5. Annual Costs of Salaries and Benefits Associated with Staff, by Alternative

Staff—Refuge Operations	Status	Staff Positions	Alt 1	Alt 2	Alt 3	Cost
Project Leader	PFT	GS-0485-13	X	X	X	$81,823
Deputy Project Leader	PFT	GS-0485-12	X	X	X	$71,000
Visitor Services Specialist	PFT	GS-0023-11	X	X	X	$57,408
Administrative Officer	PFT	GS-0341-09	X	X	X	$47,448
Refuge Manager	PFT	GS-0485-11	X	X	X	$57,408
Supervisory Wildlife Biologist	PFT	GS-0486-11	X	X	X	$71,000
Law Enforcement Officer (for entire complex)	PFT G	S-0025-09	X	X	X	$47,448
Engineering Equipment Operator	PFT	WG-5716-10	X	X	X	$54,080
Engineering Equipment Operator	PFT	WG-5716-9	X	X	X	$52,728
Maintenance Worker	PFT	WG-4749-08	X	X	X	$50,523
Purchasing Agent	PFT	GS-1105-05	X	X	X	$31,087
Private Lands Biologist (for entire complex)	PFT G	S-0401-11	X	X	X	$57,408
Wildlife Biologist	CS	GS-0486-09	X	X	X	$47,448
GIS Specialist* (for entire complex) PFT		GS-2210-09		X	X	$47,448
Refuge Manager Scep*	PFT	GS-0485-09		X	X	$47,448
Engineering Equipment Operator*	CS	WG-5716-10		X	X	$54,080
Forester* PFT		GS-04600486-11		X	X	$71,000
Contract Specialist* (for entire complex)	PFT G	S-1102-7/9		X	X	$47,448
Database Manager* (for entire complex)	PFT G	S-0343-7/9		X	X	$47,448
Environmental Ed Specialist*	PFT	GS-2210-09		X	X	$47,448
Engineering Equipment Operator*	Term	WG-5716-09		X	X	$52,728
Wildlife Biologist*	Term	GS-0486-09		X	X	$47,448
Total Positions			**13**	**22**	**22**	**$1,189,305**

PFT: Permanent Full Time
PS: Permanent Seasonal
Temp: Temporary Position
Term: Term Position
GS: General Schedule Federal Employee
WG: Wage Grade Scale
*: Positions not filled at this time

F.2.4 Budget Summary

Table F-6 summarizes the data from the above tables and displays the overall *annual* funding need, by alternative, for the Refuge by alternative.

Table F-6. Summary of Refuge Annual Funding Need by CCP Alternative

	Alt 1	Alt 2	Alt 3
All projects—one-time expenditures (total costs over 15 years), in thousands			
Research and monitoring	$212	$212	$212
Facilities	$60	$6,898	$6,858
Habitat Management	$1,891	$2,643	$2,333
A. Subtotal one-time expenditures—all projects	**$2,163 $**	**9,753**	**$9,403**
High-priority projects—one-time expenditures (total costs over 15 years), in thousands			
Research and monitoring	$185	$185	$185
Facilities	$60	$6,710	$6,680
Habitat management	$1,473	$2,224	$1,914
B. Subtotal one-time expenditures—high priority projects only	**$1,718 $**	**9,119**	**$8,779**
Recurring costs—all (total costs over 15 years), in thousands			
C. Recurring costs—all projects, salaries, and maintenance	**$14,790 $2**	**4,945**	**$23,580**
Total annual need—all projects (in thousands) (A+C)/15			
	$3,182 $	**11,375**	**$10,920**
Total annual need—high-priority projects only (in thousands) (A+B)/15			
	$2,715 $	**10,705**	**$10,265**

Appendix G. Wilderness Inventory for the Willapa National Wildlife Refuge

G.1 Policy and Direction for Wilderness Reviews

Wilderness review is the process used to determine whether or not to recommend lands or waters in the National Wildlife Refuge System (System) to the U.S. Congress for designation as wilderness. Planning policy for the System (602 FW 3) mandates conducting wilderness reviews every 15 years through the comprehensive conservation planning (CCP) process.

The wilderness review process has three phases: wilderness inventory, wilderness study, and wilderness recommendation. After first identifying lands and waters that meet the minimum criteria for wilderness (inventory phase), the resulting wilderness study areas (WSAs) are further studied to determine if they merit recommendation from the Service to the Secretary of the Interior for inclusion in the National Wilderness Preservation System (NWPS). Areas recommended for designation are managed to maintain wilderness. A brief discussion of the wilderness inventory and recommendation follows.

During the study phase, a WSA is analyzed for all values (ecological, recreational, cultural), resources (wildlife, water, vegetation, minerals, soils), and uses (management and public) within the WSA. The purpose of the study is to determine each WSA's suitability for management as wilderness in light of its primary purpose(s) as a refuge. The findings of the study determine whether or not the WSA merits recommendation for inclusion in the NWPS or should be managed under an alternate set of goals, objectives, and strategies/actions that do not involve wilderness designation.

If the wilderness study determines that a WSA meets the requirements for inclusion in the NWPS, a wilderness study report that presents the results of the wilderness review, accompanied by a Legislative Environmental Impact Statement (LEIS), is prepared. The wilderness study report and LEIS that support wilderness designation are then transmitted through the Secretary of Interior to the President of United States, and ultimately to the U.S. Congress for action.

If it is determined during the inventory that no areas qualify as WSAs or if it is concluded from the study that we should not recommend any areas as wilderness, we prepare a brief report that documents the unsuitability of the lands and waters for wilderness study or recommendation. That report is submitted to the Director of the Fish and Wildlife Service.

G.1.2 Previous Wilderness Reviews

There have been no previous wilderness reviews conducted on this refuge.

G.1.3 Lands Considered Under This Wilderness Review

All Service-owned lands and waters inside the approved boundary were considered during the inventory for wilderness. This is consistent with current Service policy.

G.2 Wilderness Inventory Criteria

The Wilderness Act of 1964, as amended (16 U.S.C. 1131-1136) provides the following description of wilderness: "A wilderness, in contrast with those areas where man and his own works dominate the landscape, is hereby recognized as an area where the earth and its community of life are untrammeled by man, where man himself is a visitor who does not remain." An area of wilderness is further defined to mean in this Act an area of undeveloped Federal land retaining its primeval character and influence, without permanent improvements or human habitation, which is protected and managed so as to preserve its natural conditions.

The following criteria for identifying areas as wilderness are described further in Section 2(c) of the Act and are elaborated upon in the Service Wilderness Management Policy (610 FW 1-5). We inventory Refuge System lands and waters to identify areas that meet the definition of wilderness in Section 2(c) of the Wilderness Act.

(1) Size—an area meets the size criteria if it:
- has no permanent roads and is 5,000 contiguous acres or more,
- has no permanent roads and is of sufficient size as to make practicable its preservation and use in an unimpaired condition, or
- is a roadless island

(2) Naturalness—an area meets the naturalness criteria if it:
- would look fairly natural to the average visitor who would not realize that historic conditions of the ecosystem had been modified by humans

(3) Opportunities for solitude or primitive and unconfined recreation—an area meets this criterion if it offers:
- outstanding opportunities for solitude—visitors can experience nature essentially free of the reminders of society, or
- outstanding opportunities for primitive and unconfined recreation—dispersed, undeveloped recreation not requiring prohibited uses.

Outstanding opportunities do not have to be present on every acre and the area does not have to be open to public entry and use.

At the end of the inventory, we may have identified none, one, or several WSAs based on the above criteria.

G.2.2 Process of Analysis

The CCP team began the inventory phase of the wilderness review and recognized that the only unit meeting the above basic criteria was the Long Island Unit of the Refuge. T he team completed a preliminary assessment of the island and documenting the findings.

The following evaluation process was used in identifying suitability for wilderness designation:

- Determination of refuge unit sizes.

- For any areas that met the size/island criterion, an assessment was made of its naturalness.
- For any areas that met the size/island criterion, an assessment was made of its capacity to provide opportunities for solitude or primitive and unconfined recreation.
- For any areas that met the size/island criterion, an assessment was made of its features of scientific, educational, scenic, or historic value.

More detail on the actual factors considered and used for each assessment step follows.

Identification of Roadless Areas and Roadless Islands

Identification of roadless areas and roadless islands required gathering land status maps, land use and road inventory data, and aerial photographs of existing Refuge mainland tracts and islands. "Roadless" refers to the absence of improved roads suitable and maintained for public travel by means of motorized vehicles primarily intended for highway use. Only lands currently owned by the Service in fee title were evaluated.

The roads on Long Island are visible and used routinely by staff and partners for necessary refuge management purposes. This includes use of heavy equipment, tractors, ATVs, and trucks to conduct forest restoration activities, fire management activities, monitor wildlife, control invasive plants, maintain roads, and other infrastructure.

Unit Size: Roadless Areas that Met the Size Criterion, if Any One of the Following Standards is Applied

- An area with at least 5,000 contiguous acres. Lands owned by states, local governments, and private parties are not included in making this acreage determination.
- A roadless island of any size. A roadless island is defined as an area surrounded by permanent waters or an area that is markedly distinguished from the surrounding lands by topographical or ecological features.
- An area of less than 5,000 contiguous Federal acres that is of sufficient size as to make practicable its preservation and use in an unimpaired condition, and of a size suitable for wilderness management.
- An area of less than 5,000 contiguous Federal acres that is contiguous with a designated wilderness, recommended wilderness, or area under wilderness review by another Federal wilderness managing agency such as the Forest Service, National Park Service, or Bureau of Land Management.

As stated previously none of the current refuge units other than the Long Island Unit meet the 5,000-acre size criterion. Currently, refuge roads on the island are frequently used for management and restoration activities by the refuge staff and their partners. Long Island has 5,451 acres owned by the Service, and it has over 7 miles of roads, which were created for logging operations and are currently maintained for refuge management purposes. Once the planned forest restoration and road decommissioning activities have been completed, this island should be considered and further studied as a WSA.

Solitude or Primitive and Unconfined Recreation

A wilderness area must provide outstanding opportunities for solitude or primitive recreation. The area does not have to possess outstanding opportunities for both solitude and primitive and unconfined recreation and does not need to have outstanding opportunities on every acre. Further, an area does not have to be open to public use and access to qualify under these criteria; the U.S. Congress has designated a number of wilderness areas in the Refuge System that are closed to public access to protect natural resource values.

"Opportunities for solitude" refers to the ability of a visitor to be alone and secluded from other visitors in the area. "Primitive and unconfined recreation" means non-motorized, dispersed outdoor recreation activities that are compatible and do not require developed facilities or mechanical transport. These primitive recreation activities may provide opportunities to experience challenge, risk, self-reliance, and adventure.

These two elements are not well-defined by the Wilderness Act. In some cases, they occur together. However, an outstanding opportunity for solitude may be present in an area offering only limited primitive recreation potential. Conversely, an area may be so attractive for recreational use that experiencing solitude is not an option.

In the wilderness inventory for the roadless islands, the following factors were the primary considerations in evaluating the availability of outstanding opportunities for solitude or primitive and unconfined recreation on Long Island:

- Island size and
- Availability of vegetative screening.

Opportunities for solitude and primitive recreation were judged to be outstanding on Long Island. The young, second-growth forest cover contains dense vegetative undergrowth and vegetative screening, providing a sense of solitude. T he size of the island (5,451 acres) and five dispersed primitive camping areas (a total of 21 camp sites) is large enough to provide the individuals an opportunity for solitude. Hunting and camping opportunities are provided on the island and offer a quality primitive recreation activity. Hiking on the island can be accomplished along the maintained roadways and one developed trail (Cedar Grove Trail). Access to the island can be accomplished via motorized or non-motorized watercraft.

Naturalness and Wildness

In addition to being roadless, a wilderness area must meet the naturalness and wildness criteria. Section 2(c) defines wilderness as an area that "generally appears to have been affected primarily by the forces of nature with the imprint of man's work substantially unnoticeable." If not pristine, an area must at least appear natural to the average visitor. The presence of historic landscape conditions is not required. An area may include some human impacts provided they are substantially unnoticeable in the unit as a whole. Significant human-caused hazards, such as the presence of unexploded ordnance from military activity, and the physical impacts of refuge management facilities and activities are also considered in evaluation of the naturalness criteria. An area may not be considered unnatural in appearance solely on the basis of the "sights and sounds" of human impacts and activities outside the boundary of the unit.

In this wilderness inventory, the following factors were primary considerations in evaluating naturalness of Long Island:

- presence of buildings and roads/vehicles,
- presence of forest harvest/thinning activities, and
- presence of other management activities

Opportunities for naturalness are currently judged to be poor on the Long Island Unit: The second-growth forest is actively managed by mechanical means to improve forest health.

The forest management activities currently require refuge staff to use a variety of heavy equipment, helicopters, trucks, and ATVs. The island has over 7 miles of roads with maintained water culverts, an equipment barn, and a boat dock facility. Wildlife-dependent public recreation activities (wildlife-observation, hunting) are available on the island. To facilitate these activities there are five campgrounds (with a total of 21 camp sites), which require active management using vehicles to maintain the facilities.

This island currently does not have the appearance of a pristine natural island due to the former forest harvest and clear-cutting activities on approximately 75% of the overall island. The activities of the past are reinforced by the ongoing resource and forest management activities. The presence and sounds of forest management activities include power boats, air boats, heavy equipment, and vehicles, all of which would impact that sense of naturalness and wildness on a seasonal basis as refuge management and forest restoration activities are implemented.

Based on the preceding discussion, this island does not meet the minimum standards for a wilderness study. This island should be re-evaluated for wilderness study once the forest management activities and the plans for future road decommissioning have been completed as part of this 15-year CCP.

Supplemental Values or Features

Supplemental values have been determined to occur on Long Island. The values include 270 acres of old-growth western red cedar forest, including the wide variety of wildlife species that occur on the island. Both wildlife habitat and historic Native American cultural values occur as a result of protection and management of this island.

Inventory Findings

Based on this inventory, Long Island appears to possess the best opportunities for future consideration as a WSA. Currently, the scars of past commercial timber harvest activities are visible across the island landscape. Management activities include routine use of island roads for aggressive forest habitat restoration and future road decommissioning (track hoes, chainsaws, and helicopters), fire protection activities, and continued implementation of the forest management plan. There is a large barn located on the island, which is used for storage of necessary mechanical and fire equipment.

The team recommends re-evaluation of the Long Island Unit for a wilderness study in 15 years.

Table G-1. Results of the Willapa NWR Wilderness Inventory

Area	Unit Acres	Meets Island and/or Size Criterion	Meets Naturalness Criterion	Meets Solitude/ Primitive Recreation Criterion	Meets Supplemental Values Criterion (Optional)	Preliminary Conclusion: Suitable for Further Consideration in Wilderness Study
Long Island Unit	5,451	Yes	No	Yes	Yes	No

Appendix H. Integrated Pest Management (IPM) Program

H.1 Background

IPM is an interdisciplinary approach utilizing methods to prevent, eliminate, contain, and/or control pest species in concert with other management activities on refuge lands and waters to achieve wildlife and habitat management goals and objectives. IPM is also a scientifically based, adaptive management process where available scientific information and best professional judgment of the refuge staff as well as other resource experts would be used to identify and implement appropriate management strategies that can be modified and/or changed over time to ensure effective, site-specific management of pest species to achieve desired outcomes. In accordance with 43 C.F.R. 46.145, adaptive management would be particularly relevant where long-term impacts may be uncertain and future monitoring would be needed to make adjustments in subsequent implementation decisions. After a tolerable pest population (threshold) is determined considering achievement of refuge resource objectives and the ecology of pest species, one or more methods, or combinations thereof, would be selected that are feasible, efficacious, and most protective of non-target resources, including native species (fish, wildlife, and plants), and Service personnel, Service authorized agents, volunteers, and the public. Staff time and available funding would be considered when determining feasibility/practicality of various treatments.

IPM techniques to address pests are presented as CCP strategies (see Section H.2 of this CCP) in an adaptive management context to achieve Refuge resource objectives. In order to satisfy requirements for IPM planning as identified in the Director's Memo (dated September 9, 2004) entitled "Integrated Pest Management Plans and Pesticide Use Proposals: Updates, Guidance, and an Online Database," the following elements of an IPM program have been incorporated into this CCP:

- Habitat and/or wildlife objectives that identify pest species and appropriate thresholds to indicate the need for and successful implementation of IPM techniques; and
- Monitoring before and/or after treatment to assess progress toward achieving objectives including pest thresholds.

Where pesticides would be necessary to address pests, this appendix provides a structured procedure to evaluate potential effects of proposed uses involving ground-based applications to refuge biological resources and environmental quality in accordance with effects analyses presented in Chapters 3 through 6 of this CCP. Only pesticide uses that likely would cause minor, temporary, or localized effects to refuge biological resources and environmental quality with appropriate best management practices (BMPs), where necessary, would be allowed for use on the refuge.

This appendix does not describe the more detailed process to evaluate potential effects associated with aerial applications of pesticides. Moreover, it does not address effects of mosquito control with pesticides (larvicides, pupacides, or adulticides) based upon identified human health threats and presence of disease-carrying mosquitoes in sufficient numbers from monitoring conducted on a refuge. However, the basic framework to assess potential effects to refuge biological resources and environmental quality from aerial application of pesticides or use of insecticides for mosquito management would be similar to the process described in this appendix for ground-based treatments of other pesticides.

H.2 Pest Management Laws and Policies

In accordance with Service policy 7 RM 14 (Pest Control), wildlife and plant pests on units of the National Wildlife Refuge System can be controlled to ensure balanced wildlife and fish populations in support of refuge-specific wildlife and habitat management objectives. Pest control on Federal (Refuge) lands and waters also is authorized under the following legal mandates:

- National Wildlife Refuge System Administration Act of 1966, as amended (16 U.S.C. 668dd-668ee);
- Plant Protection Act of 2000 (7 U.S.C. 7701 *et seq*.);
- Noxious Weed Control and Eradication Act of 2004 (7 U.S.C. 7781-7786, Subtitle E);
- Federal Insecticide, Fungicide, and Rodenticide Act of 1996 (7 U.S.C. 136-136y);
- National Invasive Species Act of 1996 (16 U.S.C. 4701);
- Nonindigenous Aquatic Nuisance Prevention and Control Act of 1990 (16 U.S.C. 4701);
- Food Quality Protection Act of 1996 (7 U.S.C. 136);
- Executive Order 13148, Section 601(a);
- Executive Order 13112; and
- Animal Damage Control Act of 1931 (7 U.S.C. 426-426c, 46 Stat. 1468).

Pests are defined as "living organisms that may interfere with the site-specific purposes, operations, or management objectives or that jeopardize human health or safety" from Department policy 517 DM 1 (Integrated Pest Management Policy). Similarly, 7 RM 14 defines pests as "Any terrestrial or aquatic plant or animal which interferes, or threatens to interfere, at an unacceptable level, with the attainment of refuge objectives or which poses a threat to human health." 517 DM 1 also defines an invasive species as "a species that is non-native to the ecosystem under consideration and whose introduction causes or is likely to cause economic or environmental harm or harm to human health." Throughout the remainder of this appendix, the terms *pest* and *invasive species* are used interchangeably because both can prevent/impede achievement of refuge wildlife and habitat objectives and/or degrade environmental quality.

In general, control of pests (vertebrate or invertebrate) on the Refuge would conserve and protect the nation's fish, wildlife, and plant resources as well as maintain environmental quality. From 7 RM 14, animal or plant species, which are considered pests, may be managed if the following criteria are met:

- Threat to human health and well-being or private property, the acceptable level of damage by the pest has been exceeded, or state or local government has designated the pest as noxious;
- Detrimental to resource objectives as specified in a refuge resource management plan (e.g., comprehensive conservation plan, habitat management plan), if available; and
- Control would not conflict with attainment of resource objectives or the purposes for which the refuge was established.

From 7 RM 14, the specific justifications for pest management activities on the Refuge are the following:

- Protect human health and well-being;
- Prevent substantial damage to important to refuge resources;
- Protect newly introduced or re-establish native species;
- Control non-native (exotic) species in order to support existence for populations of native species;
- Prevent damage to private property; and
- Provide the public with quality, compatible wildlife-dependent recreational opportunities.

In accordance with Service policy 620 FW 1 (Habitat Management Plans), there are additional management directives regarding invasive species found on the Refuge:

- "We are prohibited by Executive Order, law, and policy from authorizing, funding, or carrying out actions that are likely to cause or promote the introduction or spread of invasive species in the United States or elsewhere."
- "Manage invasive species to improve or stabilize biotic communities to minimize unacceptable change to ecosystem structure and function and prevent new and expanded infestations of invasive species. Conduct refuge habitat management activities to prevent, control, or eradicate invasive species."

Animal species damaging/destroying Federal property and/or detrimental to the management program of a refuge may be controlled as described in 50 C.F.R. 31.14 (Official Animal Control Operations). Based upon 7 RM 14.7E, a pest control proposal is required, in some cases, to initiate a control program on refuge lands. The required elements of a pest control proposal are described in 7 RM 14.7A-E. However, a pest control proposal is not required under the following scenarios:

- Routine protection of refuge buildings, structures (e.g., dikes, levees, water control structures), and facilities not involving prohibited chemicals.
- Incidental control of exotics (e.g., non-native rats, non-native rabbits) or feral animals on refuge lands that are not protected by either Federal or state laws, except where chemicals may be used.
- The use of routine habitat management techniques, selective trapping, on-refuge transfer, and physical and mechanical protection such as barriers and fences (including electric fences).

For example, the incidental removal of beaver damaging refuge infrastructure (e.g., clogging with subsequent damaging of water control structures) and/or negatively affecting habitats (e.g., removing woody species from existing or restored riparian) managed on refuge lands may be conducted without a pest control proposal. We recognize beavers are native species and most of their activities or refuge lands represent a natural process beneficial for maintaining wetland habitats. Exotic nutria, whose denning and burrowing activities in wetland dikes causes cave-ins and breaches, can be controlled using the most effective techniques considering site-specific factors without a pest control proposal. Along with the loss of quality wetland habitats associated with breaching of impoundments, the safety of refuge staff and public (e.g., auto tour routes) driving on structurally compromised levees and dikes can be threaten by sudden and unexpected cave-ins.

Trespass and feral animals also may be controlled on refuge lands. In accordance with 7 RM 14.9B(1), animals trespassing on refuge lands may be captured and returned to their owners or transferred to humane societies or local animal shelters, where feasible. Based upon 50 C.F.R. 28.43 (Destruction of Dogs and Cats), dogs and cats running at large on a national wildlife refuge and observed in the act of killing, injuring, harassing, or molesting humans or wildlife may be disposed of in the interest of public safety and protection of the wildlife. In accordance with 7 RM 14.9B(2), feral animals should be disposed by the most humane method(s) available and in accordance with relevant Service directives (including Executive Order 11643).

Disposed wildlife specimens may be donated or loaned to public institutions. Donation or loans of resident wildlife species will only be made after securing State approval (50 C.F.R. 30.11 [Donation and Loan of Wildlife Specimens]**).** Surplus wildlife specimens may be sold alive or butchered, dressed, and processed subject to Federal and state laws and regulations (50 C.F.R. 30.12 [Sale of Wildlife Specimens]).

As previously stated, for controlling animals damaging/destroying Federal property and/or detrimental to the management program of a refuge, incidentally removing such animals from refuge lands does not require a pest control proposal.

H.3 Strategies

To fully embrace IPM, the following strategies, where applicable, would be carefully considered on the Refuge for each pest species:

- **Prevention.** This would be the most effective and least expensive long-term management option for pests. It encompasses methods to prevent new introductions or the spread of the established pests to uninfested areas. It requires identifying potential routes of invasion to reduce the likelihood of infestation. Hazard Analysis and Critical Control Points (HACCP) planning can be used determine if current management activities on a refuge may introduce and/or spread invasive species in order to identify appropriate BMPs for prevention. See http://www.haccp-nrm.org/ for more information about HACCP planning.

  Prevention may include source reduction, using pathogen-free or weed-free seeds or fill; exclusion methods (e.g., barriers) and/or sanitation methods (e.g., wash stations) to prevent re-introductions by various mechanisms including vehicles, personnel, livestock, and horses. Because invasive species are frequently the first to establish newly disturbed sites, prevention would require a reporting mechanism for early detection of new pest occurrences with quick response to eliminate any new satellite pest populations. Prevention would require consideration of the scale and scope of land management activities that may promote pest establishment within uninfested areas or promote reproduction and spread of existing populations. Along with preventing initial introduction, prevention would involve halting the spread of existing infestations to new sites (Mullin et al. 2000). The primary reason for prevention would be to keep pest-free lands or waters from becoming infested. Executive Order 11312 emphasizes the priority for prevention with respect to managing pests.

The following would be methods to prevent the introduction and/or spread of pests on refuge lands:

- Before beginning ground-disturbing activities (e.g., disking, scraping), inventory and prioritize pest infestations in project operating areas and along access routes. Refuge staff would identify pest species on-site or within reasonably expected potential invasion vicinity. Where possible, the refuge staff would begin project activities in uninfested areas before working in pest-infested areas.
- The refuge staff would locate and use pest-free project staging areas. They would avoid or minimize travel through pest-infested areas, or restrict to those periods when spread of seed or propagules of invasive plants would be least likely.
- The refuge staff would determine the need for, and when appropriate, identify sanitation sites where equipment can be cleaned of pests. Where possible, the refuge staff would clean equipment before entering lands at on-refuge approved cleaning site(s). This practice does not pertain to vehicles traveling frequently in and out of the project area that will remain on roadways. Seeds and plant parts of pest plants would need to be collected, where practical. The refuge staff would remove mud, dirt, and plant parts from project equipment before moving it into a project area.
- The refuge staff would clean all equipment, before leaving the project site, if operating in areas infested with pests. The refuge staff would determine the need for, and when appropriate, identify sanitation sites where equipment can be cleaned.
- Refuge staffs, their authorized agents, and refuge volunteers would, where possible, inspect, remove, and properly dispose of seed and parts of invasive plants found on their clothing and equipment. Proper disposal means bagging the seeds and plant parts and then properly discarding of them (e.g., incinerating).
- The refuge staff would evaluate options, including closure, to restrict the traffic on sites with ongoing restoration of desired vegetation. The refuge staff would revegetate disturbed soil (except travel ways on surfaced projects) to optimize plant establishment for each specific site. Revegetation may include topsoil replacement, planting, seeding, fertilization, liming, and weed-free mulching as necessary. The refuge staff would use native material, where appropriate and feasible. The refuge staff would use certified weed-free or weed-seed-free hay or straw where certified materials are reasonably available.
- The refuge staff would provide information, training, and appropriate pest identification materials to other refuge staff members, permit holders, and recreational visitors. The refuge staff would educate them about pest identification, biology, impacts, and effective prevention measures.
- The refuge staff would require grazing permittees to utilize preventative measures for their livestock while on refuge lands.
- The refuge staff would inspect borrow material for invasive plants prior to use and transport onto and/or within refuge lands.
- The refuge staff would consider invasive plants in planning for road maintenance activities.
- The refuge staff would restrict off-road travel to designated routes.

The following would be methods to prevent the introduction and/or spread of pests into refuge waters:

- o The refuge staff would inspect boats (including air boats), trailers, and other boating equipment. Where possible, the refuge staff would remove any visible plants, animals, or mud before leaving any waters or boat launching facilities. Where possible, the refuge staff would drain water from motor, live well, bilge, and transom wells while on land before leaving the site. If possible, the refuge staff would wash and dry boats, downriggers, anchors, nets, floors of boats, propellers, axles, trailers, and other boating equipment to kill pests not visible at the boat launch.
- o Where feasible, the refuge staff would maintain a l00-foot buffer of aquatic pest-free clearance around boat launches and docks or quarantine areas when cleaning around culverts, canals, or irrigation sites. Where possible, the refuge staff would inspect and clean equipment before moving to new sites or one project area to another.

These prevention methods to minimize/eliminate the introduction and/or spread of pests were taken verbatim or slightly modified from Appendix E of U.S. Forest Service (2005).

- **Mechanical/Physical Methods.** These methods would remove and destroy, disrupt the growth of, or interfere with the reproduction of pest species. For plants species, these treatments can be accomplished by hand, hand tool (manual), or power tools (mechanical) and include pulling, grubbing, digging, tilling/disking, cutting, swathing, grinding, sheering, girdling, mowing, and mulching of the pest plants.

  For animal species, Service employees or their authorized agents could use mechanical/ physical methods (including trapping) to control pests as a refuge management activity. Based upon 50 C.F.R. 31.2, trapping can be used on a refuge to reduce surplus wildlife populations for a “balanced conservation program” in accordance with Federal or state laws and regulations. In some cases, non-lethally trapped animals would be relocated to off-refuge sites with prior approval from the state. A pest control proposal (see 7 RM 14.7A-D for required elements) is needed before initiation of trapping activities, except those operations identified in 7 RM 14.7E. In addition, a separate pest control proposal is not necessary if the required information can be incorporated into an EA (or other appropriate NEPA document).

  Each of these tools would be efficacious to some degree and applicable to specific situations. In general, mechanical controls can effectively control annual and biennial pest plants. However, to control perennial plants, the root system has to be destroyed or it would resprout and continue to grow and develop. Mechanical controls are typically not capable of destroying a perennial plant’s root system. Although some mechanical tools (e.g., disking, plowing) may damage root systems, they may stimulate regrowth producing a denser plant population that may aid in the spread depending upon the target species (e.g., Canada thistle). In addition, steep terrain and soil conditions would be major factors that can limit the use of many mechanical control methods.

  Some mechanical control methods (e.g., mowing), which would be used in combination with herbicides, can be a very effective technique to control perennial species. For example, mowing perennial plants followed sequentially by treating the plant regrowth with a systemic herbicide often would improve the efficacy of the herbicide compared to herbicide treatment only.

- **Cultural Methods.** These methods would involve manipulating habitat to increase pest mortality by reducing its suitability to the pest. Cultural methods would include water-level manipulation, mulching, winter cover crops, changing planting dates to minimize pest impact, prescribed burning (facilitate revegetation, increase herbicide efficacy, and remove litter to assist in emergence of desirable species), flaming with propane torches, trap crops, crop rotations that would include non-susceptible crops, moisture management, addition of beneficial insect habitat, reducing clutter, proper trash disposal, planting or seeding desirable species to shade or out-compete invasive plants, applying fertilizer to enhance desirable vegetation, prescriptive grazing, and other habitat alterations.

- **Biological Control Agents.** Classical biological control would involve the deliberate introduction and management of natural enemies (parasites, predators, or pathogens) to reduce pest populations. Many of the most ecologically or economically damaging pest species in the United States originated in foreign countries. These newly introduced pests, which are free from natural enemies found in their country or region of origin, may have a competitive advantage over cultivated and native species. This competitive advantage often allows introduced species to flourish, and they may cause widespread economic damage to crops or out compete and displace native vegetation. Once the introduced pest species population reaches a certain level, traditional methods of pest management may be cost prohibitive or impractical. Biological controls typically are used when these pest populations have become so widespread that eradication or effective control would be difficult or no longer practical.

  Biological control has advantages as well as disadvantages. Benefits would include reducing pesticide usage, host specificity for target pests, long-term self-perpetuating control, low cost/acre, capacity for searching and locating hosts, synchronizing biological control agents to hosts' life cycles, and the unlikelihood that hosts will develop resistance to agents. Disadvantages would include the following: limited availability of agents from their native lands, the dependence of control on target species density, slow rate at which control occurs, biotype matching, the difficulty and expense of conflicts over control of the target pest, and host specificity when host populations are low.

  A reduction in target species populations from biological controls is typically a slow process, and efficacy can be highly variable. It may not work well in a particular area although it does work well in other areas. Biological control agents would require specific environmental conditions to survive over time. Some of these conditions are understood, whereas others are only partially understood or not at all.

  Biological control agents would not eradicate a target pest. When using biological control agents, residual levels of the target pest typically are expected; the agent population level or survival would be dependent upon the density of its host. After the pest population decreases, the population of the biological control agent would decrease correspondingly. This is a natural cycle. Some pest populations (e.g., invasive plants) would tend to persist for several years after a biological control agent becomes established due to seed reserves in the soil, inefficiencies in the agents search behavior, and the natural lag in population buildup of the agent.

The full range of pest groups potentially found on refuge lands and waters would include diseases, invertebrates (insects, mollusks), vertebrates, and invasive plants (the most common group). Often it is assumed that biological control would address many if not most of these pest problems. There are several well-documented success stories of biological control of invasive weed species in the Pacific Northwest including Mediterranean sage, St. Johnswort (Klamath weed), and tansy ragwort. Emerging success stories include Dalmatian toadflax, diffuse knapweed, leafy spurge, purple loosestrife, and yellow star thistle. However, historically, each new introduction of a biological control agent in the United States has only about a 30% success rate (Coombs et al. 2004). Refer to Coombs et al. (2006) for the status of biological control agents for invasive plants in the Pacific Northwest.

Introduced species without desirable close relatives in the United States would generally be selected as biological controls. Natural enemies that are restricted to one or a few closely related plants in their country of origin are targeted as biological controls (Center et al. 1997; Hasan and Ayres 1990).

The refuge staff would ensure introduced agents are approved by the applicable authorities. Except for a small number of formulated biological control products registered by the U.S. Environmental Protection Agency (USEPA) under the Federal Insecticide, Fungicide, and Rodenticide Act of 1996 (FIFRA), most biological control agents are regulated by the U.S. Department of Agriculture (USDA)-Animal Plant Health Inspection Service, Plant Protection and Quarantine (APHIS-PPQ). State departments of agriculture and, in some cases, county agricultural commissioners or weed districts, have additional approval authority.

Federal permits (USDA-APHIS-PPQ Form 526) are required to import biocontrol agents from another state. Form 526 may be obtained by writing:

USDA-APHIS-PPQ
Biological Assessment and Taxonomic Support
4700 River Road, Unit 113
Riverdale, MD 20737

or

through the internet at:
http://www.aphis.usda.gov/ppq/permits/bioligical/weedbio.html

The Service strongly supports the development, and legal and responsible use of appropriate, safe, and effective biological control agents for nuisance and non-indigenous or pest species.

State and county agriculture departments may also be sources for biological control agents or they may have information about where biological control agents may be obtained. Commercial sources should have an Application and Permit to Move Live Plant Pests and Noxious Weeds (USDA-PPQ Form 226 USDA-APHIS-PPQ, Biological Assessment and Taxonomic Support, 4700 River Road, Unit 113, Riverdale, MD 20737) to release specific biological control agents in a state and/or county. Furthermore, certification regarding the biological control agent’s identity (genus, specific epithet, sub-species and variety) and purity (e.g., parasite free, pathogen free, and biotic and abiotic contaminants) should be specified in purchase orders.

Biological control agents are subject to 7 RM 8 (Exotic Species Introduction and Management). In addition, the refuge staff would follow the International Code of Best Practice for Classical Biological Control of Weeds (http://sric.ucdavis.edu/exotic/exotic.htm) as ratified by delegates to the X International Symposium on Biological Control of Weeds, Bozeman, Montana, July 9, 1999. This code identifies the following:

- Release only approved biological control agents,
- Use the most effective agents,
- Document releases, and
- Monitor for impact to the target pest, non-target species and the environment.

Biological control agents formulated as pesticide products and registered by the USEPA (e.g., *Bti*) are also subject to PUP review and approval (see below).

A record of all releases would be maintained with date(s), location(s), and environmental conditions of the release site(s); the identity, quantity, and condition of the biological control agents released; and other relevant data and comments such as weather conditions. Systematic monitoring to determine the establishment and effectiveness of the release is also recommended.

NEPA documents regarding biological and other environmental effects of biological control agents prepared by another Federal agency, where the scope is relevant to evaluation of releases on refuge lands, would be reviewed. Possible source agencies for such NEPA documents include the Bureau of Land Management, U.S. Forest Service, National Park Service, U.S. Department of Agriculture-Animal and Plant Health Inspection Service, and the military services. It might be appropriate to incorporate by reference parts or all of existing document(s) from the review. Incorporating by reference (43 C.F.R. 46.135) is a technique used to avoid redundancies in analysis. It also can reduce the bulk of a Service NEPA document, which only must identify the documents that are incorporated by reference. In addition, relevant portions must be summarized in the Service NEPA document to the extent necessary to provide the decision maker and public with an understanding of relevance of the referenced material to the current analysis.

- **Pesticides.** The selective use of pesticides would be based upon pest ecology (including mode of reproduction), the size and distribution of its populations, site-specific conditions (e.g., soils, topography), known efficacy under similar site conditions, and the capability to utilize BMPs to reduce/eliminate potential effects to non-target species, sensitive habitats, and potential to contaminate surface and groundwater. All pesticide usage (pesticide, target species, application rate, and method of application) would comply with the applicable Federal (FIFRA) and state regulations pertaining to pesticide use, safety, storage, disposal, and reporting. Before pesticides can be used to eradicate, control, or contain pests on refuge lands and waters, pesticide use proposals (PUPs) would be prepared and approved in accordance with 7 RM 14. PUP records would provide a detailed, time-, site-, and target-specific description of the proposed use of pesticides on the refuge. All PUPs would be created, approved or disapproved, and stored in the Pesticide Use Proposal System (PUPS), which is a centralized database only accessible on the Service's intranet (https://systems.fws.gov/pups). Only Service employees would be authorized to access PUP records for a refuge in this database.

Application equipment would be selected to provide site-specific delivery to target pests while minimizing/eliminating direct or indirect (e.g., drift) exposure to non-target areas and degradation of surface and groundwater quality. Where possible, target-specific equipment (e.g., backpack sprayer, wiper) would be used to treat target pests. Other target-specific equipment to apply pesticides would include soaked wicks or paint brushes for wiping vegetation and lances, hatchets, or syringes for direct injection into stems. Granular pesticides may be applied using seeders or other specialized dispensers. In contrast, aerial spraying (e.g., fixed wing or helicopter) would only be used where access is difficult (remoteness) and/or the size/distribution of infestations precludes practical use of ground-based methods.

Because repeated use of one pesticide may allow resistant organisms to survive and reproduce, multiple pesticides with variable modes of action would be considered for treatments on refuge lands and waters. This is especially important if multiple applications within years and/or over a growing season likely would be necessary for habitat maintenance and restoration activities to achieve resource objectives. Integrated chemical and non-chemical controls also are highly effective, where practical, because pesticide-resistant organisms can be removed from the site.

Cost may not be the primary factor in selecting a pesticide for use on a refuge. If the least expensive pesticide would potentially harm natural resources or people, then a different product would be selected, if available. The most efficacious pesticide available with the least potential to degrade environment quality (soils, surface water, and groundwater) as well as least potential effect to native species and communities of fish, wildlife, plants, and their habitats would be acceptable for use on refuge lands in the context of an IPM approach.

- **Habitat restoration/maintenance.** Restoration and/or proper maintenance of refuge habitats associated with achieving wildlife and habitat objectives would be essential for long-term prevention, eradication, or control (at or below threshold levels) of pests. Promoting desirable plant communities through the manipulation of species composition, plant density, and growth rate is an essential component of invasive plant management (Brooks et al. 2004; Masters and Shelly 2001; Masters et al. 1996). The following three components of succession could be manipulated through habitat maintenance and restoration: site availability, species availability, and species performance (Cox and Anderson 2004). Although a single method (e.g., herbicide treatment) may eliminate or suppress pest species in the short term, the resulting gaps and bare soil create niches that are conducive to further invasion by the species and/or other invasive plants. On degraded sites where desirable species are absent or in low abundance, revegetation with native/desirable grasses, forbs, and legumes may be necessary to direct and accelerate plant community recovery, and achieve site-specific objectives in a reasonable time frame. The selection of appropriate species for revegetation would be dependent on a number of factors including resource objectives and site-specific, abiotic factors (e.g., soil texture, precipitation/temperature regimes, and shade conditions). Seed availability and cost, ease of establishment, seed production, and competitive ability also would be important considerations.

H.4 Priorities for Treatments

For many refuges, the magnitude (number, distribution, and sizes of infestations) of pest problems is too extensive and beyond the available capital resources to effectively address during any single field season. To manage pests in the Refuge, it would be essential to prioritize treatment of infestations. Highest priority treatments would be focused on early detection and rapid response to eliminate infestations of new pests, if possible. This would be especially important for aggressive pests potentially impacting species, species groups, communities, and/or habitats associated refuge purpose(s), NWRS resources of concern (federally listed species, migratory birds, selected marine mammals, and interjurisdictional fish), and native species for maintaining/restoring biological integrity, diversity, and environmental health.

The next priority would be treating established pests that appear in one or more previously uninfested areas. Moody and Mack (1988) demonstrated through modeling that small, new outbreaks of invasive plants eventually would infest an area larger than the established, source population. They also found that control efforts focusing on the large, main infestation rather than the new, small satellites reduced the chances of overall success. The lowest priority would be treating large infestations (sometimes monotypic stands) of well-established pests. In this case, initial efforts would focus upon containment of the perimeter followed by work to control/eradicate the established infested area. If containment and/or control of a large infestation is not effective, then efforts would focus upon halting pest reproduction or managing source populations. Maxwell et al. (2009) found treating fewer populations that are sources represents an effective long-term strategy to reduce of total number of invasive populations and decreasing meta-population growth rates.

Although state-listed noxious weeds would always of high priority for management, other pest species known to cause substantial ecological impact would also be considered. For example, cheatgrass may not be listed by a state as noxious, but it can greatly alter fire regimes in shrub steppe habitats resulting in large monotypic stands that displace native bunch grasses, forbs, and shrubs. Pest control would likely require a multi-year commitment from the refuge staff. Essential to the long-term success of pest management would be pre- and post-treatment monitoring, assessment of the successes and failures of treatments, and development of new approaches when proposed methods do not achieve desired outcomes.

H.5 Best Management Practices (BMPs)

BMPs can minimize or eliminate possible effects associated with pesticide usage to non-target species and/or sensitive habitats as well as degradation of water quality from drift, surface runoff, or leaching. Based upon the Department of Interior Pesticide Use Policy (517 DM 1) and the Service Pest Management Policy and Responsibilities (30 AM 12), the use of applicable BMPs (where feasible) also would likely ensure that pesticide uses may not adversely affect federally listed species and/or their critical habitats through determinations made using the process described in 50 C.F.R. part 402.

The following are BMPs pertaining to mixing/handling and applying pesticides for all ground-based treatments of pesticides, which would be considered and utilized, where feasible, based upon target- and site-specific factors and time-specific environmental conditions. Although not listed below, the most important BMP to eliminate/reduce potential impacts to non-target resources would be an IPM approach to prevent, control, eradicate, and contain pests.

H.5.1 Pesticide Handling and Mixing

- As a precaution against spilling, spray tanks would not be left unattended during filling.
- All pesticide containers would be triple rinsed, and the rinsate would be used as water in the sprayer tank and applied to treatment areas.
- All pesticide spray equipment would be properly cleaned. Where possible, rinsate would be used as part of the make-up water in the sprayer tank and applied to treatment areas.
- The refuge staff would empty and triple rinse all pesticide containers that can be recycled at local herbicide container collections.
- All unused pesticides would be properly discarded at a local "safe send" collection.
- Pesticides and pesticide containers would be lawfully stored, handled, and disposed of in accordance with the label and in a manner safeguarding human health, fish, and wildlife and prevent soil and water contaminant.
- The refuge staff would consider the water quality parameters (e.g., pH, hardness) that are important to ensure greatest efficacy where specified on the pesticide label.
- All pesticide spills would be addressed immediately using procedures identified in the refuge spill response plan.

H.5.2 Applying Pesticides

- Pesticide treatments would only be conducted by or under the supervision of Service personnel and non-Service applicators with the appropriate, state or BLM certification to safely and effectively conduct these activities on refuge lands and waters.
- The refuge staff would comply with all Federal, state, and local pesticide use laws and regulations as well as Departmental, Service, and NWRS pesticide-related policies. For example, the refuge staff would use application equipment and apply rates for the specific pest(s) identified on the pesticide label as required under FIFRA.
- Before each treatment season and prior to mixing or applying any product for the first time each season, all applicators would review the labels, material safety data sheets (MSDSs), and PUPs for each pesticide, determining the target pest, appropriate mix rate(s), personal protective equipment (PPE), and other requirements listed on the pesticide label.
- A 1-foot no-spray buffer from the water's edge would be used, where applicable and where it does not detrimentally influence effective control of pest species.
- Use low-impact herbicide application techniques (e.g., spot treatment, cut stump, oil basal, Thinvert system applications) rather than broadcast foliar applications (e.g., boom sprayer, other larger tank wand applications), where practical.
- Use low-volume rather than high-volume foliar applications where low-impact methods above are not feasible or practical, to maximize herbicide effectiveness and ensure correct and uniform application rates.

- Applicators would use and adjust spray equipment to apply the coarsest droplet size spectrum with optimal coverage of the target species while reducing drift.
- Applicators would use the largest droplet size that results in uniform coverage.
- Applicators would use drift reduction technologies such as low-drift nozzles, where possible.
- Where possible, spraying would occur during low (average<7 mph and preferably 3 to 5 mph) and consistent direction wind conditions with moderate temperatures (typically <85^{o}F).
- Where possible, applicators would avoid spraying during inversion conditions (often associated with calm and very low wind conditions) that can cause large-scale herbicide drift to non-target areas.
- Equipment would be calibrated regularly to ensure that the proper rate of pesticide is applied to the target area or species.
- Spray applications would be made at the lowest height for uniform coverage of target pests to minimize/eliminate potential drift.
- If windy conditions frequently occur during afternoons, spraying (especially boom treatments) would typically be conducted during early morning hours.
- Spray applications would not be conducted on days with >30% forecast for rain within 6 hours, except for pesticides that are rapidly rain fast (e.g., glyphosate in 1 hour) to minimize/eliminate potential runoff.
- Where possible, applicators would use drift retardant adjuvants during spray applications, especially adjacent to sensitive areas.
- Where possible, applicators would use a nontoxic dye to aid in identifying target area treated as well as potential over spray or drift. A dye can also aid in detecting equipment leaks. If a leak is discovered, the application would be stopped until repairs can be made to the sprayer.
- For pesticide uses associated with cropland and facilities management, buffers, as appropriate, would be used to protect sensitive habitats, especially wetlands and other aquatic habitats.
- When drift cannot be sufficiently reduced through altering equipment set up and application techniques, buffer zones may be identified to protect sensitive areas downwind of applications. The refuge staff would only apply adjacent to sensitive areas when the wind is blowing the opposite direction.
- Applicators would utilize scouting for early detection of pests to eliminate unnecessary pesticide applications.
- The refuge staff would consider timing of application so native plants are protected (e.g., senescence) while effectively treating invasive plants.
- Rinsate from cleaning spray equipment after application would be recaptured and reused or applied to an appropriate pest plant infestation.
- Application equipment (e.g., sprayer, ATV, tractor) would be thoroughly cleaned and PPE would be removed/disposed of on-site by applicators after treatments to eliminate the potential spread of pests to uninfested areas.

H.6 Safety

H.6.1 Personal Protective Equipment

All applicators would wear the specific PPE identified on the pesticide label. The appropriate PPE will be worn at all times during handling, mixing, and applying. PPE can include the following: disposable (e.g., Tyvek) or laundered coveralls; gloves (latex, rubber, or nitrile); rubber boots; and/or an NIOSH-approved respirator. Because exposure to concentrated product is usually greatest during mixing, extra care should be taken while preparing pesticide solutions. Persons mixing these solutions can be best protected if they wear long gloves, an apron, footwear, and a face shield.

Coveralls and other protective clothing used during an application would be laundered separately from other laundry items. Transporting, storing, handling, mixing and disposing of pesticide containers will be consistent with label requirements, USEPA and Occupational Safety and Health Administration (OSHA) requirements, and Service policy.

If a respirator is necessary for a pesticide use, then the following requirements would be met in accordance with Service safety policy: a written respirator program, fit testing, physical examination (including pulmonary function and blood work for contaminants), and proper storage of the respirator.

H.6.2 Notification

The restricted entry interval is the time period required after the application at which point someone may safely enter a treated area without PPE. Refuge staff, authorized management agents of the Service, volunteers, and members of the public who could be in or near a pesticide treated area within the stated re-entry time period on the label would be notified about treatment areas. Posting would occur at any site where individuals might inadvertently become exposed to a pesticide during other activities on the refuge. Where required by the label and/or state-specific regulations, sites would also be posted on its perimeter and at other likely locations of entry. The refuge staff would also notify appropriate private property owners of an intended application, including any private individuals who have requested notification. Special efforts would be made to contact nearby individuals who are beekeepers or who have expressed chemical sensitivities.

H.6.3 Medical Surveillance

Medical surveillance may be required for Service personnel and approved volunteers who mix, apply, and/or monitor use of pesticides (see 242 FW 7 [Pesticide Users] and 242 FW 4 [Medical Surveillance]). In accordance with 242 FW 7.12A, Service personnel would be medically monitoring if one or more of the following criteria is met: exposed or may be exposed to concentrations at or above the published permissible exposure limits or threshold limit values (see 242 FW 4); use pesticides in a manner considered “frequent pesticide use”; or use pesticides in a manner that requires a respirator (see 242 FW 14 for respirator use requirements). In 242 FW7.7A, “Frequent Pesticide Use means when a person applying pesticide handles, mixes, or applies pesticides, with a Health Hazard rating of 3 or higher, for 8 or more hours in any week or

16 or more hours in any 30-day period." Under some circumstances, individuals may be medically monitored who use pesticides infrequently (see Section H.7.7), experience an acute exposure (sudden, short term), or use pesticides with a health hazard ranking of 1 or 2. This decision would consider the individual's health and fitness level, the pesticide's specific health risks, and the potential risks from other pesticide-related activities. Refuge cooperators (e.g., cooperative farmers) and other authorized agents (e.g., state and county employees) would be responsible for their own medical monitoring needs and costs.

Standard examinations (at refuge expense) of appropriate refuge staff would be provided by the nearest certified occupational health and safety physician as determined by Federal Occupational Health.

H.6.4 Certification and Supervision of Pesticide Applicators

Appropriate refuge staff or approved volunteers handling, mixing, and/or applying or directly supervising others engaged in pesticide use activities would be trained and state or federally (BLM) licensed to apply pesticides to refuge lands or waters. In accordance with 242 FW 7.18A, certification is required to apply restricted use pesticides based upon USEPA regulations. For safety reasons, all individuals participating in pest management activities with general use pesticides also are encouraged to attend appropriate training or acquire pesticide applicator certification. The certification requirement would be for a commercial or private applicator depending upon the state. New staff unfamiliar with proper procedures for storing, mixing, handling, applying, and disposing of herbicides and containers would receive orientation and training before handling or using any products. Documentation of training would be kept in the files at the refuge office.

H.6.5 Record Keeping

H.6.5.1 Labels and material safety data sheets

Pesticide labels and MSDSs would be maintained at the refuge shop and laminated copies in the mixing area. These documents also would be carried by field applicators, where possible. A written reference (e.g., note pad, chalk board, dry erase board) for each tank to be mixed would be kept in the mixing area for quick reference while mixing is in progress. In addition, approved PUPs stored in the PUPS database typically contain website links (URLs) to pesticide labels and MSDSs.

H.6.5.2 Pesticide use proposals (PUPs)

A PUP would be prepared for each proposed pesticide use associated with annual pest management on refuge lands and waters. A PUP would include specific information about the proposed pesticide use including the common and chemical names of the pesticide(s), target pest species, size and location of treatment site(s), application rate(s) and method(s), and federally listed species determinations, where applicable.

In accordance with 30 AM 12 and 7 RM 14, PUPs would be required for the following:

- Uses of pesticides on lands and facilities owned or managed by the Service, including properties managed by Service personnel as a result of the Food Security Act of 1985;
- Service projects by non-Service personnel on Service owned or controlled lands and facilities and other pest management activities that would be conducted by Service personnel; and
- Where the Service would be responsible or provides funds for pest management identified in protective covenants, easements, contracts, or agreements off Service lands.

In accordance with Service guidelines (Director's memo [December 12, 2007]), a refuge staff may receive up to five-year approvals for Washington Office and field reviewed proposed pesticide uses based upon meeting identified criteria including an approved IPM plan, where necessary (see http://www.fws.gov/contaminants/Issues/IPM.cfm). For a refuge, an IPM plan (requirements described herein) can be completed independently or in association with a CCP or a habitat management plan if IPM strategies and potential environmental effects are adequately addressed within appropriate NEPA documentation.

PUPs would be created, approved or disapproved, and stored as records in the Pesticide Use Proposal System (PUPS), which is centralized database on the Service's intranet (https://systems.fws.gov/pups). Only Service employees can access PUP records in this database.

H.6.5.3 Pesticide usage

In accordance with 30 AM 12 and 7 RM 14, the refuge Project Leader would be required to maintain records of all pesticides annually applied on lands or waters under refuge jurisdiction. This would encompass pesticides applied by other Federal agencies, state and county governments, nongovernment applicators including cooperators and their pest management service providers with Service permission. For clarification, pesticide means all insecticides, insect and plant growth regulators, dessicants, herbicides, fungicides, rodenticides, acaricides, nematicides, fumigants, avicides, and piscicides.

The following usage information can be reported for approved PUPs in the PUPS database:

- Pesticide trade name(s)
- Active ingredient(s)
- Total acres treated
- Total amount of pesticides used (lbs or gallons)
- Total amount of active ingredient(s) used (lbs)
- Target pest(s)
- Efficacy (% control)

To determine whether treatments are efficacious (eradicating, controlling, or containing the target pest) and achieving resource objectives, habitat and/or wildlife response would be monitored both pre- and post-treatment, where possible. Considering available annual funding and staffing, appropriate monitoring data regarding characteristics (attributes) of pest infestations (e.g., area, perimeter, degree of infestation-density, % cover, density) as well as habitat and/or wildlife response to treatments may be collected and stored in a relational database (e.g., Refuge Habitat Management Database), preferably a geo-referenced data management system (e.g., Refuge Lands GIS) to facilitate data analyses and subsequent reporting. In accordance with adaptive management, data analysis and interpretation would allow treatments to be modified or changed over time, as necessary, to achieve resource objectives considering site-specific conditions in conjunction with habitat and/or wildlife responses. Monitoring could also identify short- and long-term impacts to natural resources and environmental quality associated with IPM treatments in accordance with adaptive management principles identified in 43 C.F.R. 46.145.

H.7 Evaluating Pesticide Use Proposals

Pesticides would only be used on refuge lands for habitat management as well as croplands/facilities maintenance after approval of a PUP. In general, proposed pesticide uses on refuge lands would only be approved where there would likely be minor, temporary, or localized effects to fish and wildlife species as well as minimal potential to degrade environmental quality. Potential effects to listed and nonlisted species would be evaluated with quantitative ecological risk assessments and other screening measures. Potential effects to environmental quality would be based upon pesticide characteristics of environmental fate (water solubility, soil mobility, soil persistence, and volatilization) and other quantitative screening tools. Ecological risk assessments as well as characteristics of environmental fate and potential to degrade environmental quality for pesticides would be documented in Chemical Profiles (see Section H.7.5). These profiles would include threshold values for quantitative measures of ecological risk assessments and screening tools for environmental fate that represent minimal potential effects to species and environmental quality. In general, only pesticide uses with appropriate BMPs (see Section H.4) for habitat management and cropland/facilities maintenance on refuge lands that would potentially have minor, temporary, or localized effects on refuge biological and environmental quality (threshold values not exceeded) would be approved.

H.7.1 Overview of Ecological Risk Assessment

An ecological risk assessment process would be used to evaluate potential adverse effects to biological resources as a result of a pesticide(s) proposed for use on refuge lands. It is an established quantitative and qualitative methodology for comparing and prioritizing risks of pesticides and conveying an estimate of the potential risk for an adverse effect. This quantitative methodology provides an efficient mechanism to integrate best available scientific information regarding hazard, patterns of use (exposure), and dose-response relationships in a manner that is useful for ecological risk decision-making. It would provide an effective way to evaluate potential effects where there is missing or unavailable scientific information (data gaps) to address reasonable, foreseeable adverse effects in the field as required under 40 C.F.R. Part 1502.22. Protocols for ecological risk assessment of pesticide uses on the refuge were developed through research and established by the USEPA (2004). Assumptions for these risk assessments are presented in Section H.6.2.3.

The toxicological data used in ecological risk assessments are typically results of standardized laboratory studies provided by pesticide registrants to the USEPA to meet regulatory requirements under FIFRA. These studies assess the acute (lethality) and chronic (reproductive) effects associated with short- and long-term exposure to pesticides on representative species of birds, mammals, freshwater fish, aquatic invertebrates, and terrestrial and aquatic plants. Other effects data publicly available would also be utilized for risk assessment protocols described herein. Toxicity endpoint and environmental fate data are available from a variety of resources. Some of the more useful resources can be found in Section H.7.5.

Table H-1. Ecotoxicity tests used to evaluate potential effects to birds, fish, and mammals to establish toxicity endpoints for risk quotient calculations.

Species Group	Exposure	Measurement endpoint
Bird	Acute	Median Lethal Concentration (LC_{50})
	Chronic	No Observed Effect Concentration (NOEC) or No Observed Adverse Effect Concentration (NOAEC)[1]
Fish	Acute	Median Lethal Concentration (LC_{50})
	Chronic	No Observed Effect Concentration (NOEC) or No Observed Adverse Effect Concentration (NOAEC)[2]
Mammal	Acute	Oral Lethal Dose (LD_{50})
	Chronic	No Observed Effect Concentration (NOEC) or No Observed Adverse Effect Concentration (NOAEC)[3]

[1]Measurement endpoints typically include a variety of reproductive parameters (e.g., number of eggs, number of offspring, eggshell thickness, and number of cracked eggs).
[2]Measurement endpoints for early life stage/life cycle typically include embryo hatch rates, time to hatch, growth, and time to swim-up.
[3]Measurement endpoints include maternal toxicity, teratogenic effects or developmental anomalies, evidence of mutagenicity or genotoxicity, and interference with cellular mechanisms such as DNA synthesis and DNA repair.

H.7.2 Determining Ecological Risk to Fish and Wildlife

The potential for pesticides used on the refuge to cause direct adverse effects to fish and wildlife would be evaluated using USEPA's Ecological Risk Assessment Process (USEPA 2004). This deterministic approach, which is based upon a two-phase process involving estimation of environmental concentrations and then characterization of risk, would be used for ecological risk assessments. This method integrates exposure estimates (estimated environmental concentration [EEC] and toxicological endpoints [e.g., LC_{50} and oral LD_{50}]) to evaluate the potential for adverse effects to species groups (birds, mammals, and fish) representative of legal mandates for managing units of the NWRS. This integration is achieved through risk quotients (RQs) calculated by dividing the EEC by acute and chronic toxicity values selected from standardized toxicological endpoints or published effect (Table H-1).

$$RQ = EEC/Toxicological\ Endpoint$$

The level of risk associated with direct effects of pesticide use would be characterized by comparing calculated RQs to the appropriate Level of Concern (LOC) established by the USEPA (1998 [Table 2]). The LOC represents a quantitative threshold value for screening potential adverse effects to fish and wildlife resources associated with pesticide use. The following are four exposure-species group scenarios that would be used to characterize ecological risk to fish and wildlife on the Refuge: acute-listed species, acute-nonlisted species, chronic-listed species, and chronic-nonlisted species.

Acute risk would indicate the potential for mortality associated with short-term dietary exposure to pesticides immediately after an application. For characterization of acute risks, median values from LC_{50} and LD_{50} tests would be used as toxicological endpoints for RQ calculations. In contrast, chronic risks would indicate the potential for adverse effects associated with long-term dietary exposure to pesticides from a single application or multiple applications over time (within a season and over years). For characterization of chronic risks, the no observed concentration (NOAEC) or no observed effect concentration (NOEC) for reproduction would be used as toxicological endpoints for RQ calculations. Where available, the NOAEC would be preferred over a NOEC value.

Listed species are those federally designated as threatened, endangered, or proposed in accordance with the Endangered Species Act of 1973 (16 U.S.C. 1531-1544, 87 Stat. 884, as amended-Public Law 93-205). For listed species, potential adverse effects would be assessed at the individual level because loss of individuals from a population could detrimentally impact a species. In contrast, risks to nonlisted species would consider effects at the population level. An RQ<LOC would indicate the proposed pesticide use "may affect, not likely to adversely affect" individuals (listed species) and it would not pose an unacceptable risk for adverse effects to populations (nonlisted species) for each taxonomic group (Table H-2). In contrast, an RQ>LOC would indicate a "may affect, likely to adversely affect" for listed species and it would also pose unacceptable ecological risk for adverse effects to nonlisted species.

Table H-2. Presumption of unacceptable risk for birds, fish, and mammals (USEPA 1998).

Risk Presumption		Level of Concern	
		Listed Species	Nonlisted Species
Acute	Birds	0.1	0.5
	Fish	0.05	0.5
	Mammals	0.1	0.5
Chronic	Birds	1.0	1.0
	Fish	1.0	1.0
	Mammals	1.0	1.0

H.7.2.1 Environmental exposure

Following release into the environment through application, pesticides would experience several different routes of environmental fate. Pesticides which would be sprayed can move through the air (e.g., particle or vapor drift) and may eventually end up in other parts of the environment such as non-target vegetation, soil, or water. Pesticides applied directly to the soil may be washed off the soil into nearby bodies of surface water (e.g., surface runoff) or may percolate through the soil to lower soil layers and groundwater (e.g., leaching) (Baker and Miller 1999; Butler et al. 1998; EXTOXNET 1993; Pope et al. 1999; Ramsay et al. 1995). Pesticides which would be injected into the soil may also be subject to the latter two fates.

The aforementioned possibilities are by no means complete, but it does indicate movement of pesticides in the environment is very complex with transfers occurring continually among different environmental compartments. In some cases, these exchanges occur not only between areas that are close together, but it also may involve transportation of pesticides over long distances (Barry 2004; Woods 2004).

H.7.2.1.1 Terrestrial exposure

The EEC for exposure to terrestrial wildlife would be quantified using an USEPA screening-level approach (USEPA 2004). This screening-level approach is not affected by product formulation because it evaluates pesticide active ingredient(s). This approach would vary depending upon the proposed pesticide application method: spray or granular.

H.7.2.1.1.1 Terrestrial-spray application

For spray applications, exposure would be determined using the Kanaga nomogram method (Pfleeger et al. 1996; USEPA 2004, 2005a) through the USEPA's Terrestrial Residue Exposure model (T-REX) version 1.2.3 (USEPA 2005b). To estimate the maximum (initial) pesticide residue on short grass (<20 cm tall) as a general food item category for terrestrial vertebrate species, T-REX input variables would include the following from the pesticide label: maximum pesticide application rate (pounds active ingredient [acid equivalent]/acre) and pesticide half-life (days) in soil. Although there are other food item categories (tall grasses; broadleaf plants and small insects; and fruits, pods, seeds and large insects), short grass was selected because it would yield maximum EECs (240 ppm per lb ai/acre) for worst-case risk assessments. Short grass is not representative of forage for carnivorous species (e.g., raptors), but it would characterize the maximum potential exposure through the diet of avian and mammalian prey items. Consequently, this approach would provide a conservative screening tool for pesticides that do not biomagnify.

For RQ calculations in T-REX, the model would require the weight of surrogate species and Mineau scaling factors (Mineau et al. 1996). Body weights of bobwhite quail and mallard are included in T-REX by default, but body weights of other organisms (Table H-3) would be entered manually. The Mineau scaling factor accounts for small-bodied bird species that may be more sensitive to pesticide exposure than would be predicted only by body weight. Mineau scaling factors would be entered manually with values ranging from 1 to 1.55 that are unique to a particular pesticide or group of pesticides. If specific information to select a scaling factor is not available, then a value of 1.15 would be used as a default. Alternatively, zero would be entered if it is known that body weight does not influence toxicity of pesticide(s) being assessed. The upper bound estimate output from the T-REX Kanaga nomogram would be used as an EEC for calculation of RQs. This approach would yield a conservative estimate of ecological risk.

Table H-3. Average body weight of selected terrestrial wildlife species frequently used in research to establish toxicological endpoints (Dunning 1984).

Species	Body Weight (kg)
Mammal (15 g)	0.015
House sparrow	0.0277
Mammal (35 g)	0.035
Starling	0.0823
Red-winged blackbird	0.0526
Common grackle	0.114
Japanese quail	0.178
Bobwhite quail	0.178
Rat	0.200

Species	Body Weight (kg)
Rock dove (aka pigeon)	0.542
Mammal (1,000 g)	1.000
Mallard	1.082
Ring-necked pheasant	1.135

H.7.2.1.1.2 Terrestrial—granular application

Granular pesticide formulations and pesticide-treated seed would pose a unique route of exposure for avian and mammalian species. The pesticide is applied in discrete units which birds or mammals might ingest accidentally with food items or intentionally as in the case of some bird species actively seeking and picking up gravel or grit to aid digestion or seed as a food source. Granules may also be consumed by wildlife foraging on earthworms, slugs or other soft-bodied soil organisms to which the granules may adhere.

Terrestrial wildlife RQs for granular formulations or seed treatments would be calculated by dividing the maximum milligrams of active ingredient (a.i.) exposed (e.g., EEC) on the surface of an area equal to 1 square foot by the appropriate LD_{50} value multiplied by the surrogate's body weight (Table H-3). An adjustment to surface area calculations would be made for broadcast, banded, and in-furrow applications. An adjustment also would be made for applications with and without incorporation of the granules. Without incorporation, it would be assumed that 100% of the granules remain on the soil surface available to foraging birds and mammals. Press wheels push granules flat with the soil surface, but they are not incorporated into the soil. If granules are incorporated in the soil during band or T-band applications or after broadcast applications, it would be assumed only 15% of the applied granules remain available to wildlife. It would be assumed that only 1% of the granules are available on the soil surface following in-furrow applications.

EECs for pesticides applied in granular form and as seed treatments would be determined considering potential ingestion rates of avian or mammalian species (e.g., 10%-30% body weight/day). This would provide an estimate of maximum exposure that may occur as a result of granule or seed treatment spills such as those that commonly occur at end rows during application and planting. The availability of granules and seed treatments to terrestrial vertebrates would also be considered by calculating the loading per unit area (LD_{50}/ft^2) for comparison to USEPA Level of Concerns (USEPA 1998). The T-REX version 1.2.3 (USEPA 2005b) contains a submodel which automates Kanaga exposure calculations for granular pesticides and treated seed.

The following formulas will be used to calculate EECs depending upon the type of granular pesticide application:

- In-furrow applications assume a typical value of 1% granules, bait, or seed remain unincorporated.

$$mg\ a.i./ft.^2 = [(lbs.\ product/acre)(\%\ a.i.)(453{,}580\ mg/lb.)(1\%\ exposed))] \,/\, \{[(43{,}560\ ft.^2/acre)/(row\ spacing\ (ft.))] \,/\, (row\ spacing\ (ft.)\}$$

or

$$mg\ a.i./ft^2 = [(lbs\ product/1{,}000\ ft.\ row)(\%\ a.i.)(1{,}000\ ft\ row)(453{,}580\ mg/lb.)(1\%\ exposed)$$

$$EEC = [(mg\ a.i./ft.^2)(\%\ of\ pesticide\ biologically\ available)]$$

- Incorporated banded treatments assume that 15% of granules, bait, and seeds are unincorporated.

$$mg\ a.i./ft.^2 = [(lbs.\ product/1{,}000\ row\ ft.)(\%\ a.i.)(453{,}580\ mg/lb.)(1\text{-}\%\ incorporated)] / (1{,}000\ ft.)(band\ width\ (ft.))$$

$$EEC = [(mg\ a.i./ft.^2)(\%\ of\ pesticide\ biologically\ available)]$$

- Broadcast treatment without incorporation assumes 100% of granules, bait, seeds are unincorporated.

$$mg\ a.i./ft.^2 = [(lbs.\ product/acre)(\%\ a.i.)(453{,}590\ mg/lb.)] / (43{,}560\ ft.^2/acre)$$

$$EEC = [(mg\ a.i./ft.^2)(\%\ of\ pesticide\ biologically\ available)]$$

Where:

- *% of pesticide biologically available = 100% without species specific ingestion rates*
- *Conversion for calculating mg a.i./ft.2 using ounces: 453,580 mg/lb. /16 = 28,349 mg/oz.*

The following equation would be used to calculate an RQ based on the EEC calculated by one of the above equations. The EEC would divided by the surrogate LD_{50} toxicological endpoint multiplied by the body weight (Table H-3) of the surrogate.

$$RQ = EEC / [LD_{50}\ (mg/kg) * body\ weight\ (kg)]$$

As with other risk assessments, an RQ>LOC would be a presumption of unacceptable ecological risk. An RQ<LOC would be a presumption of acceptable risk with only minor, temporary, or localized effects to species.

H.7.2.1.2 Aquatic exposure

Exposures to aquatic habitats (e.g., wetlands, meadows, ephemeral pools, water delivery ditches) would be evaluated separately for ground-based pesticide treatments of habitats managed for fish and wildlife compared with cropland/facilities maintenance. The primary exposure pathway for aquatic organisms from any ground-based treatments likely would be particle drift during the pesticide application. However, different exposure scenarios would be necessary as a result of contrasting application equipment and techniques as well as pesticides used to control pests on agricultural lands (especially those cultivated by cooperative farmers for economic return from crop yields) and facilities maintenance (e.g., roadsides, parking lots, trails) compared with other managed habitats on the refuge. In addition, pesticide applications may be done <25 feet of the high water mark of aquatic habitats for habitat management treatments, whereas no-spray buffers (≥25 feet) would be used for croplands/facilities maintenance treatments.

H.7.2.1.2.1 Habitat treatments

For the worst-case exposure scenario to non-target aquatic habitats, EECs (Table H-4) would be would be derived from Urban and Cook (1986) that assumes an intentional overspray to an entire, non-target water body (1-foot depth) from a treatment <25 feet from the high water mark using the max application rate (acid basis [see above]). However, use of BMPs for applying pesticides (see Section H.4.2) would likely minimize/eliminate potential drift to non-target aquatic habitats during actual treatments. If there would be unacceptable (acute or chronic) risk to fish and wildlife with the simulated 100% overspray (RQ>LOC), then the proposed pesticide use may be disapproved or the PUP would be approved at a lower application rate to minimize/eliminate unacceptable risk to aquatic organisms (RQ=LOC).

Table H-4. Estimated Environmental Concentrations (ppb) of pesticides in aquatic habitats (1 foot depth) immediately after direct application (Urban and Cook 1986).

Lbs/acre	EEC (ppb)
0.10	36.7
0.20	73.5
0.25	91.9
0.30	110.2
0.40	147.0
0.50	183.7
0.75	275.6
1.00	367.5
1.25	459.7
1.50	551.6
1.75	643.5
2.00	735.7
2.25	827.6
2.50	919.4
3.00	1,103.5
4.00	1,471.4
5.00	1,839
6.00	2,207
7.00	2,575
8.00	2,943
9.00	3,311
10.00	3,678

H.7.2.1.2.2 Cropland/facilities maintenance treatments

Field drift studies conducted by the Spray Drift Task Force, which is a joint project of several agricultural chemical businesses, were used to develop a generic spray drift database. From this database, the AgDRIFT computer model was created to satisfy USEPA pesticide registration spray drift data requirements and as a scientific basis to evaluate off-target movement of pesticides from particle drift and assess potential effects of exposure to wildlife. Several versions of the computer model have been developed (i.e., v2.01 through v2.10). The Spray Drift Task Force AgDRIFT® model version 2.01 (AgDRIFT 2001; SDTF 2003) would be used to derive EECs resulting from drift of pesticides to refuge aquatic resources from ground-based pesticide applications >25 feet from the high water mark. The Spray Drift Task Force AgDRIFT model is publicly available at http://www.agdrift.com. At this website, click "AgDRIFT 2.0" and then click "Download Now" and follow the instructions to obtain the computer model.

The AgDRIFT model is composed of submodels called tiers. Tier I Ground submodel would be used to assess ground-based applications of pesticides. Tier outputs (EECs) would be calculated with AgDRIFT using the following input variables: max application rate (acid basis [see above]), low boom (20 inches), fine to medium droplet size, EPA-defined wetland, and a ≥25-foot distance (buffer) from treated area to water.

H.7.2.2 Use of information on effects of biological control agents, pesticides, degradates, and adjuvants

NEPA documents regarding biological and other environmental effects of biological control agents, pesticides, degradates, and adjuvants prepared by another Federal agency, where the scope would be relevant to evaluation of effects from pesticide uses on refuge lands, would be reviewed. Possible source agencies for such NEPA documents would include the Bureau of Land Management, U.S. Forest Service, National Park Service, U.S. Department of Agriculture-Animal and Plant Health Inspection Service, and the military services. It might be appropriate to incorporate by reference parts or all of existing document(s). Incorporating by reference (40 C.F.R. 1502.21) is a technique used to avoid redundancies in analysis. It also would reduce the bulk of a Service NEPA document, which only would identify the documents that are incorporated by reference. In addition, relevant portions would be summarized in the Service NEPA document to the extent necessary to provide the decision maker and public with an understanding of relevance of the referenced material to the current analysis.

In accordance with the requirements set forth in 43 C.F.R. 46.135, the Service would specifically incorporate through reference ecological risk assessments prepared by the U.S. Forest Service (http://www.fs.fed.us/r6/invasiveplant-eis/Risk-Assessments/Herbicides-Analyzed-InvPlant-EIS.htm) and Bureau of Land Management (http://www.blm.gov/wo/st/en/prog/more/veg_eis.html). These risk assessments and associated documentation also are available in total with the administrative record for the Final Environmental Impact Statement entitled *Pacific Northwest Region Invasive Plant Program – Preventing and Managing Invasive Plants* (U.S. Forest Service 2005) and *Vegetation Treatments Using Herbicides on Bureau of Land Management Lands in 17 Western States Programmatic EIS (PEIS)* (Bureau of Land Management 2007). In accordance with 43 CRF 46.120(d), use of existing NEPA documents by supplementing, tiering to, incorporating by reference, or adopting previous NEPA environmental analyses would avoid redundancy and unnecessary paperwork.

As a basis for completing "Chemical Profiles" for approving or disapproving refuge PUPs, ecological risk assessments for the following herbicide and adjuvant uses prepared by the U.S. Forest Service would be incorporated by reference:

- 2,4-D
- Chlorosulfuron
- Clopyralid
- Dicamba
- Glyphosate
- Imazapic
- Imazapyr
- Metsulfuron methyl
- Picloram
- Sethoxydim
- Sulfometuron methyl
- Triclopyr
- Nonylphenol polyethylate (NPE) based surfactants

As a basis for completing "Chemical Profiles" for approving or disapproving refuge PUPs, ecological risk assessments for the following herbicide uses as well as evaluation of risks associated with pesticide degradates and adjuvants prepared by the Bureau of Land Management would be incorporated by reference:

- Bromacil
- Chlorsulfuron
- Diflufenzopyr
- Diquat
- Diuron
- Fluridone
- Imazapic
- Overdrive (diflufenzopyr and dicamba)
- Sulfometuron methyl
- Tebuthiuron
- Pesticide degradates and adjuvants (*Appendix D – Evaluation of risks from degradates, polyoxyethylene-amine (POEA) and R-11, and endocrine disrupting chemicals*)

H.7.2.3 Assumptions for ecological risk assessments

There are a number of assumptions involved with the ecological risk assessment process for terrestrial and aquatic organisms associated with utilization of the USEPA's (2004) process. These assumptions may be risk neutral or may lead to an over- or under-estimation of risk from pesticide exposure depending upon site-specific conditions. The following describes these assumptions, their application to the conditions typically encountered, and whether or not they may lead to recommendations that are risk neutral, underestimate, or overestimate ecological risk from potential pesticide exposure.

- Indirect effects would not be evaluated by ecological risk assessments. These effects include the mechanisms of indirect exposure to pesticides: consuming prey items (fish, birds, or small mammals), reductions in the availability of prey items, and disturbance associated with pesticide application activities.

- Exposure to a pesticide product can be assessed based upon the active ingredient. However, exposure to a chemical mixture (pesticide formulation) may result in effects that are similar or substantially different compared to only the active ingredient. Non-target organisms may be exposed directly to the pesticide formulation or only various constituents of the formulation as they dissipate and partition in the environment. If toxicological information for both the active ingredient and formulated product are available, then data representing the greatest potential toxicity would be selected for use in the risk assessment process (USEPA 2004). As a result, this conservative approach may lead to an overestimation of risk characterization from pesticide exposure.
- Because toxicity tests with listed or candidate species or closely related species are not available, data for surrogate species would be most often used for risk assessments. Specifically, bobwhite quail and mallard duck are the most frequently used surrogates for evaluating potential toxicity to federally listed avian species. Bluegill sunfish, rainbow trout, and fathead minnow are the most common surrogates for evaluating toxicity for freshwater fishes. However, sheep's head minnow can be an appropriate surrogate marine species for coastal environments. Rats and mice are the most common surrogates for evaluating toxicity for mammals. Interspecies sensitivity is a major source of uncertainty in pesticide assessments. As a result of this uncertainty, data is selected for the most sensitive species tested within a taxonomic group (birds, fish, and mammals) given the quality of the data is acceptable. If additional toxicity data for more species of organisms in a particular group are available, the selected data will not be limited to the species previously listed as common surrogates.
- The Kanaga nomogram outputs maximum EEC values that may be used to calculate an average daily concentration over a specified interval of time, which is referred to as a time-weighted-average (TWA). The maximum EEC would be selected as the exposure input for both acute and chronic risk assessments in the screening-level evaluations. The initial or maximum EEC derived from the Kanaga nomogram represents the maximum expected instantaneous or acute exposure to a pesticide. Acute toxicity endpoints are determined using a single exposure to a known pesticide concentration typically for 48 to 96 hours. This value is assumed to represent ecological risk from acute exposure to a pesticide. On the other hand, chronic risk to pesticide exposure is a function of pesticide concentration and duration of exposure to the pesticide. An organism's response to chronic pesticide exposure may result from either the concentration of the pesticide, length of exposure, or some combination of both factors. Standardized tests for chronic toxicity typically involve exposing an organism to several different pesticide concentrations for a specified length of time (days, weeks, months, years or generations). For example, avian reproduction tests include a 10-week exposure phase. Because a single length of time is used in the test, time response data is usually not available for inclusion into risk assessments. Without time response data it is difficult to determine the concentration which elicited a toxicological response.
- Using maximum EECs for chronic risk estimates may result in an overestimate of risk, particularly for compounds that dissipate rapidly. Conversely, using TWAs for chronic risk estimates may underestimate risk if it is the concentration rather than the duration of exposure that is primarily responsible for the observed adverse effect. The maximum EEC would be used for chronic risk assessments although it may result in an overestimate of risk. TWAs may be used for chronic risk assessments, but they will be applied judiciously considering the potential for an underestimate or overestimate of risk. For example, the

number of days exposure exceeds a Level of Concern may influence the suitability of a pesticide use. The greater the number of days the EEC exceeds the Level of Concern translates into greater the ecological risk. This is a qualitative assessment and is subject to reviewer's expertise in ecological risk assessment and tolerance for risk.

- The length of time used to calculate the TWA can have a substantial effect on the exposure estimates and there is no standard method for determining the appropriate duration for this estimate. The T-REX model assumes a 21-week exposure period, which is equivalent to avian reproductive studies designed to establish a steady-state concentration for bioaccumulative compounds. However, this does not necessarily define the true exposure duration needed to elicit a toxicological response. Pesticides, which do not bioaccumulate, may achieve a steady-state concentration earlier than 21 weeks. The duration of time for calculating TWAs will require justification and it will not exceed the duration of exposure in the chronic toxicity test (approximately 70 days for the standard avian reproduction study). An alternative to using the duration of the chronic toxicity study is to base the TWA on the application interval. In this case, increasing the application interval would suppress both the estimated peak pesticide concentration and the TWA. Another alternative to using TWAs would be to consider the number of days that a chemical is predicted to exceed the LOC.
- Pesticide dissipation is assumed to be first-order in the absence of data suggesting alternative dissipation patterns such as bi-phasic. Field dissipation data would generally be the most pertinent for assessing exposure in terrestrial species that forage on vegetation. However, these data are often not available and it can be misleading particularly if the compound is prone to "wash-off". Soil half-life is the most common degradation data available. Dissipation or degradation data that would reflect the environmental conditions typical of refuge lands would be utilized, if available.
- For species found in the water column, it would be assumed that the greatest bioavailable fraction of the pesticide active ingredient in surface waters is freely dissolved in the water column.
- Actual habitat requirements of any particular terrestrial species are not considered, and it is assumed that species exclusively and permanently occupy the treated area, or adjacent areas receiving pesticide at rates commensurate with the treatment rate. This assumption would produce a maximum estimate of exposure for risk characterization. This assumption would likely lead to an overestimation of exposure for species that do not permanently and exclusively occupy the treated area (USEPA 2004).
- Exposure through incidental ingestion of pesticide contaminated soil is not considered in the USEPA risk assessment protocols. Research suggests <15% of the diet can consist of incidentally ingested soil depending upon species and feeding strategy (Beyer et al. 1994). An assessment of pesticide concentrations in soil compared to food item categories in the Kanaga nomogram indicates incidental soil ingestion will not likely increase dietary exposure to pesticides. Inclusion of soil into the diet would effectively reduce the overall dietary concentration compared to the present assumption that the entire diet consists a contaminated food source (Fletcher et al. 1994). An exception to this may be soil-applied pesticides in which exposure from incidental ingestion of soil may increase. Potential for pesticide exposure under this assumption may be underestimated for soil-applied pesticides and overestimated for foliar-applied pesticides. The concentration of a pesticide in soil would likely be less than predicted on food items.

- Exposure through inhalation of pesticides is not considered in the USEPA risk assessment protocols. Such exposure may occur through three potential sources: spray material in droplet form at time of application, vapor phase with the pesticide volatilizing from treated surfaces, and airborne particulates (soil, vegetative matter, and pesticide dusts). The USEPA (1990) reported exposure from inhaling spray droplets at the time of application is not an appreciable route of exposure for birds. According to research on mallards and bobwhite quail, respirable particle size (particles reaching the lung) in birds is limited to maximum diameter of 2 to 5 microns. The spray droplet spectra covering the majority of pesticide application scenarios indicate that less than 1% of the applied material is within the respirable particle size. This route of exposure is further limited because the permissible spray drop size distribution for ground pesticide applications is restricted to ASAE medium or coarser drop size distribution.
- Inhalation of a pesticide in the vapor phase may be another source of exposure for some pesticides under certain conditions. This mechanism of exposure to pesticides occurs post application, and it would pertain to those pesticides with a high vapor pressure. The USEPA is currently evaluating protocols for modeling inhalation exposure from pesticides including near-field and near-ground air concentrations based upon equilibrium and kinetics-based models. Risk characterization for exposure with this mechanism is unavailable.
- The effect from exposure to dusts contaminated with the pesticide cannot be assessed generically as partitioning issues related to application site soils and chemical properties of the applied pesticides render the exposure potential from this route highly situation specific.
- Dermal exposure may occur through three potential sources: direct application of spray to terrestrial wildlife in the treated area or within the drift footprint, incidental contact with contaminated vegetation, or contact with contaminated water or soil. Interception of spray and incidental contact with treated substrates may pose risk to avian wildlife (Driver et al. 1991). However, available research related to wildlife dermal contact with pesticides is extremely limited, except dermal toxicity values are common for some mammals used as human surrogates (rats and mice). The USEPA is currently evaluating protocols for modeling dermal exposure. Risk characterization may be underestimated for this route of exposure, particularly with high risk pesticides such as some organophosphates or carbamate insecticides. If protocols are established by the USEPA for assessing dermal exposure to pesticides, they will be considered for incorporation into pesticide assessment protocols.
- Exposure to a pesticide may occur from consuming surface water, dew, or other water on treated surfaces. Water soluble pesticides have the potential to dissolve in surface runoff and puddles in a treated area may contain pesticide residues. Similarly, pesticides with lower organic carbon partitioning characteristics and higher solubility in water have a greater potential to dissolve in dew and other water associated with plant surfaces. Estimating the extent to which such pesticide loadings to drinking water occurs is complex and would depend upon the partitioning characteristics of the active ingredient, soils types in the treatment area, and the meteorology of the treatment area. In addition, the use of various water sources by wildlife is highly species-specific. Currently, risk characterization for this exposure mechanism is not available. The USEPA is actively developing protocols to quantify drinking water exposures from puddles and dew. If and when protocols are formally established by the USEPA for assessing exposure to pesticides through drinking water, these protocols will be incorporated into pesticide risk assessment protocols.

- Risk assessments are based upon the assumption that the entire treatment area would be subject to pesticide application at the rates specified on the label. In most cases, there is potential for uneven application of pesticides through such plausible incidents such as changes in calibration of application equipment, spillage, and localized releases at specific areas in or near the treated field that are associated with mixing and handling and application equipment as well as applicator skill. Inappropriate use of pesticides and the occurrence of spills represent a potential underestimate of risk. It is likely not an important factor for risk characterization. All pesticide applicators are required to be certified by the state in which they apply pesticides. Certification training includes the safe storage, transport, handling, and mixing of pesticides; equipment calibration; and proper application with annual continuing education.
- The USEPA relies on Fletcher (1994) for setting the assumed pesticide residues in wildlife dietary items. The USEPA (2004) "believes that these residue assumptions reflect a realistic upper-bound residue estimate, although the degree to which this assumption reflects a specific percentile estimate is difficult to quantify". Fletcher's (1994) research suggests that the pesticide active ingredient residue assumptions used by the USEPA represent a 95th percentile estimate. However, research conducted by Pfleeger et al. (1996) indicates USEPA residue assumptions for short grass was not exceeded. Behr and Habig (2000) compared USEPA residue assumptions with distributions of measured pesticide residues for the USEPA's UTAB database. Overall residue selection level will tend to overestimate risk characterization. This is particularly evident when wildlife individuals are likely to have selected a variety of food items acquired from multiple locations. Some food items may be contaminated with pesticide residues whereas others are not contaminated. However, it is important to recognize differences in species feeding behavior. Some species may consume whole aboveground plant material, but others will preferentially select different plant structures. Also, species may preferentially select a food item although multiple food items may be present. Without species specific knowledge regarding foraging behavior characterizing ecological risk other than in general terms is not possible.
- Acute and chronic risk assessments rely on comparisons of wildlife dietary residues with LC_{50} or NOEC values expressed as concentrations of pesticides in laboratory feed. These comparisons assume that ingestion of food items in the field occurs at rates commensurate with those in the laboratory. Although the screening assessment process adjusts dry-weight estimates of food intake to reflect the increased mass in fresh-weight wildlife food intake estimates, it does not allow for gross energy and assimilative efficiency differences between wildlife food items and laboratory feed. Differences in assimilative efficiency between laboratory and wild diets suggest that current screening assessment methods are not accounting for a potentially important aspect of food requirements.
- There are several other assumptions that can affect non-target species not considered in the risk assessment process. These include possible additive or synergistic effects from applying two or more pesticides or additives in a single application, co-location of pesticides in the environment, cumulative effects from pesticides with the same mode of action, effects of multiple stressors (e.g., combination of pesticide exposure, adverse abiotic and biotic factors) and behavioral changes induced by exposure to a pesticide. These factors may exist at some level contributing to adverse effects to non-target species, but they are usually characterized in the published literature in only a general manner limiting their value in the risk assessment process.

- It is assumed that aquatic species exclusively and permanently occupy the water body being assessed. Actual habitat requirements of aquatic species are not considered. With the possible exception of scenarios where pesticides are directly applied to water, it is assumed that no habitat use considerations specific for any species would place the organisms in closer proximity to pesticide use sites. This assumption produces a maximum estimate of exposure or risk characterization. It would likely be realistic for many aquatic species that may be found in aquatic habitats within or in close proximity to treated terrestrial habitats. However, the spatial distribution of wildlife is usually not random because wildlife distributions are often related to habitat requirements of species. Clumped distributions of wildlife may result in an under- or over-estimation of risk depending upon where the initial pesticide concentration occurs relative to the species or species habitat.
- For species found in the water column, it would be assumed that the greatest bioavailable fraction of the pesticide active ingredient in surface waters is freely dissolved in the water column. Additional chemical exposure from materials associated with suspended solids or food items is not considered because partitioning onto sediments likely is minimal. Adsorption and bioconcentration occurs at lower levels for many newer pesticides compared with older more persistent bioaccumulative compounds. Pesticides with RQs close to the listed species level of concern, the potential for additional exposure from these routes may be a limitation of risk assessments, where potential pesticide exposure or risk may be underestimated.
- Mass transport losses of pesticide from a water body (except for losses by volatilization, degradation and sediment partitioning) would not be considered for ecological risk assessment. The water body would be assumed to capture all pesticide active ingredients entering as runoff, drift, and adsorbed to eroded soil particles. It would also be assumed that pesticide active ingredient is not lost from the water body by overtopping or flow-through, nor is concentration reduced by dilution. In total, these assumptions would lead to a near maximum possible water-borne concentration. However, this assumption would not account for the potential to concentrate pesticide through the evaporative loss. This limitation may have the greatest impact on water bodies with high surface-to-volume ratios such as ephemeral wetlands, where evaporative losses are accentuated and applied pesticides have low rates of degradation and volatilization.
- For acute risk assessments, there would be no averaging time for exposure. An instantaneous peak concentration would be assumed, where instantaneous exposure is sufficient in duration to elicit acute effects comparable to those observed over more protracted exposure periods (typically 48 to 96 hours) tested in the laboratory. In the absence of data regarding time-to-toxic event, analyses and latent responses to instantaneous exposure, risk would likely be overestimated.
- For chronic exposure risk assessments, the averaging times considered for exposure are commensurate with the duration of invertebrate life-cycle or fish-early life stage tests (e.g., 21-28 days and 56-60 days, respectively). Response profiles (time to effect and latency of effect) to pesticides likely vary widely with mode of action and species and should be evaluated on a case-by-case basis as available data allow. Nevertheless, because the USEPA relies on chronic exposure toxicity endpoints based on a finding of no observed effect, the potential for any latent toxicity effects or averaging time assumptions to alter the results of an acceptable chronic risk assessment prediction is limited. The extent to which duration of exposure from water-borne concentrations overestimate or underestimate actual exposure

depends on several factors. These include the following: localized meteorological conditions, runoff characteristics of the watershed (e.g., soils, topography), the hydrological characteristics of receiving waters, environmental fate of the pesticide active ingredient, and the method of pesticide application. It should also be understood that chronic effects studies are performed using a method that holds water concentration in a steady state. This method is not likely to reflect conditions associated with pesticide runoff. Pesticide concentrations in the field increase and decrease in surface water on a cycle influenced by rainfall, pesticide use patterns, and degradation rates. As a result of the dependency of this assumption on several undefined variables, risk associated with chronic exposure may in some situations underestimate risk and overestimate risk in others.

- There are several other factors that can affect non-target species not considered in the risk assessment process. These would include the following: possible additive or synergistic effects from applying two or more pesticides or additives in a single application, co-location of pesticides in the environment, cumulative effects from pesticides with the same mode of action, effects of multiple stressors (e.g., combination of pesticide exposure, adverse abiotic [not pesticides] and biotic factors), and sublethal effects such as behavioral changes induced by exposure to a pesticide. These factors may exist at some level contributing to adverse effects to non-target species, but they are not routinely assessed by regulatory agencies. Therefore, information on the factors is not extensive limiting their value for the risk assessment process. As this type of information becomes available, it would be included, either quantitatively or qualitatively, in this risk assessment process.
- USEPA is required by the Food Quality Protection Act to assess the cumulative risks of pesticides that share common mechanisms of toxicity, or act the same within an organism. Currently, USEPA has identified four groups of pesticides that have a common mechanism of toxicity requiring cumulative risk assessments. These four groups are: the organophosphate insecticides, N-methyl carbamate insecticides, triazine herbicides, and chloroacetanilide herbicides.

H.7.3 Pesticide Mixtures and Degradates

Pesticide products are usually a formulation of several components generally categorized as active ingredients and inert or other ingredients. The term active ingredient is defined by the FIFRA as preventing, destroying, repelling, or mitigating the effects of a pest, or it is a plant regulator, defoliant, desiccant, or nitrogen stabilizer. In accordance with FIFRA, the active ingredient(s) must be identified by name(s) on the pesticide label along with its relative composition expressed in percentage(s) by weight. In contrast, inert ingredient(s) are not intended to affect a target pest. Their role in the pesticide formulation is to act as a solvent (keep the active ingredient is a liquid phase), an emulsifying or suspending agent (keep the active ingredient from separating out of solution), or a carrier (such as clay in which the active ingredient is impregnated on the clay particle in dry formulations). For example, if isopropyl alcohol would be used as a solvent in a pesticide formulation, then it would be considered an inert ingredient. FIFRA only requires that inert ingredients identified as hazardous and associated percent composition, and the total percentage of all inert ingredients must be declared on a product label. Inert ingredients that are not classified as hazardous are not required to be identified.

The USEPA (September 1997) issued Pesticide Regulation Notice 97-6, which encouraged manufacturers, formulators, producers, and registrants of pesticide products to voluntarily substitute the term "other ingredients" for "inert ingredients" in the ingredient statement. This change recognized that all components in a pesticide formulation potentially could elicit or contribute to an adverse effect on non-target organisms and, therefore, are not necessarily inert. Whether referred to as "inerts" or "other ingredients," these constituents within a pesticide product have the potential to affect species or environmental quality. The USEPA categorizes regulated inert ingredients into the following four lists (http://www.epa.gov/opprd001/inerts/index.html):

- List 1—Inert Ingredients of Toxicological Concern
- List 2—Potentially Toxic Inert Ingredients
- List 3—Inerts of Unknown Toxicity
- List 4—Inerts of Minimal Toxicity

Several of the List 4 compounds are naturally occurring earthen materials (e.g., clay materials, simple salts) that would not elicit toxicological response at applied concentrations. However, some of the inerts (particularly the List 3 compounds and unlisted compounds) may have moderate to high potential toxicity to aquatic species based on MSDSs or published data.

Comprehensively assessing potential effects to non-target fish, wildlife, plants, and/or their habitats from pesticide use is a complex task. It would be preferable to assess the cumulative effects from exposure to the active ingredient, its degradates, and inert ingredients as well as other active ingredients in the spray mixture. However, it would only be feasible to conduct deterministic risk assessments for each component in the spray mixture singly. Limited scientific information is available regarding ecological effects (additive or synergistic) from chemical mixtures that typically rely upon broadly encompassing assumptions. For example, the U.S. Forest Service (2005) found that mixtures of pesticides used in land (forest) management likely would not cause additive or synergistic effects to non-target species based upon a review of scientific literature regarding toxicological effects and interactions of agricultural chemicals (ATSDR 2004). Moreover, information on inert ingredients, adjuvants, and degradates is often limited by the availability of and access to reliable toxicological data for these constituents.

Toxicological information regarding "other ingredients" may be available from sources such as the following:

- TOMES (a proprietary toxicological database including USEPA's IRIS, the Hazardous Substance Data Bank, the Registry of Toxic Effects of Chemical Substances [RTECS]).
- USEPA's ECOTOX database, which includes AQUIRE (a database containing scientific papers published on the toxic effects of chemicals to aquatic organisms).
- TOXLINE (a literature searching tool).
- MSDSs from pesticide suppliers.
- Other sources such as the Farm Chemicals Handbook.

Because there is a lack of specific inert toxicological data, inert(s) in a pesticide may cause adverse ecological effects. However, inert ingredients typically represent only a small percentage of the pesticide spray mixture, and it would be assumed that negligible effects would be expected to result from inert ingredient(s).

Although the potential effects of degradates should be considered when selecting a pesticide, it is beyond the scope of this assessment process to consider all possible breakdown chemicals of the various product formulations containing an active ingredient. Degradates may be more or less mobile and more or less hazardous in the environment than their parent pesticides (Battaglin et al. 2003). Differences in environmental behavior (e.g., mobility) and toxicity between parent pesticides and degradates would make assessing potential degradate effects extremely difficult. For example, a less toxic and more mobile, bioaccumulative, or persistent degradate may have potentially greater effects on species and/or degrade environmental quality. The lack of data on the toxicity of degradates for many pesticides would represent a source of uncertainty for assessing risk.

A USEPA-approved label specifies whether a product can be mixed with one or more pesticides. Without product-specific toxicological data, it would not possible to quantify the potential effects of these mixtures. In addition, a quantitative analysis could only be conducted if reliable scientific information allowed a determination of whether the joint action of a mixture would be additive, synergistic, or antagonistic. Such information would not likely exist unless the mode of action would be common among the chemicals and receptors. Moreover, the composition of and exposure to mixtures would be highly site- and/or time-specific and, therefore, it would be nearly impossible to assess potential effects to species and environmental quality.

To minimize or eliminate potential negative effects associated with applying two or more pesticides as a mixture, the use would be conducted in accordance with the labeling requirements. Labels for two or more pesticides applied as a mixture should be completely reviewed, where products with the least potential for negative effects would be selected for use on the refuge. This is especially relevant when a mixture would be applied in a manner that may already have the potential for an effect(s) associated with an individual pesticide (e.g., runoff to ponds in sandy watersheds). Use of a tank mix under these conditions would increase the level of uncertainty in terms of risk to species or potential to degrade environmental quality.

Adjuvants generally function to enhance or prolong the activity of pesticide. For terrestrial herbicides, adjuvants aid in the absorption into plant tissue. Adjuvant is a broad term that generally applies to surfactants, selected oils, anti-foaming agents, buffering compounds, drift control agents, compatibility agents, stickers, and spreaders. Adjuvants are not under the same registration requirements as pesticides and the USEPA does not register or approve the labeling of spray adjuvants. Individual pesticide labels identify types of adjuvants approved for use with it. In general, adjuvants compose a relatively small portion of the volume of pesticides applied. Selection of adjuvants with limited toxicity and low volumes would be recommended to reduce the potential for the adjuvant to influence the toxicity of the pesticide.

H.7.4 Determining Effects to Soil and Water Quality

The approval process for pesticide uses would consider potential to degrade water quality on and off refuge lands. A pesticide can only affect water quality through movement away from the treatment site. After application, pesticide mobilization can be characterized by one or more of the following (Kerle et al. 1996):

- Attach (sorb) to soil, vegetation, or other surfaces and remain at or near the treated area;
- Attach to soil and move off-site through erosion from runoff or wind;
- Dissolve in water that can be subjected to runoff or leaching.

As an initial screening tool, selected chemical characteristics and rating criteria for a pesticide can be evaluated to assess potential to enter ground and/or surface waters. These would include the following: persistence, sorption coefficient (K_{oc}), groundwater ubiquity score (GUS), and solubility.

Persistence, which is expressed as half-life ($t_{½}$), represents the length of time required for 50% of the deposited pesticide to degrade (completely or partially). Persistence in the soil can be categorized as the following: non-persistent <30 days, moderately persistent = 30 to 100 days, and persistent >100 days (Kerle et al. 1996). Half-life data is usually available for aquatic and terrestrial environments.

Another measure of pesticide persistence is dissipation time (DT_{50}). It represents the time required for 50% of the deposited pesticide to degrade and move from a treated site, whereas half-life describes the rate for degradation only. As for half-life, units of dissipation time are usually expressed in days. Field or foliar dissipation time is the preferred data for use to estimate pesticide concentrations in the environment. However, soil half-life is the most common persistence data cited in published literature. If field or foliar dissipation data is not available, soil half-life data may be used. The average or representative half-life value of most important degradation mechanism will be selected for quantitative analysis for both terrestrial and aquatic environments.

Mobility of a pesticide is a function of how strongly it is adsorbed to soil particles and organic matter, its solubility in water, and its persistence in the environment. Pesticides strongly adsorbed to soil particles, relatively insoluble in water, and not environmentally persistent would be less likely to move across the soil surface into surface waters or to leach through the soil profile and contaminate groundwater. Conversely, pesticides that are not strongly adsorbed to soil particles, are highly water soluble, and are persistent in the environment would have greater potential to move from the application site (off-site movement).

The degree of pesticide adsorption to soil particles and organic matter (Kerle et al. 1996) is expressed as the soil adsorption coefficient (K_{oc}). The soil adsorption coefficient is measured as micrograms of pesticide per gram of soil (µg/g) that can range from near zero to the thousands. Pesticides with higher K_{oc} values are strongly sorbed to soil and, therefore, would be less subject to movement.

Water solubility describes the amount of pesticide that will dissolve in a known quantity of water. The water solubility of a pesticide is expressed as milligrams of pesticide dissolved in a liter of water (mg/L or parts per million [ppm]). Pesticide with solubility <0.1 ppm are virtually insoluble in water, 100-1,000 ppm are moderately soluble, and >10,000 ppm highly soluble (U.S.

Geological Survey 2000). As pesticide solubility increases, there would be greater potential for off-site movement.

The groundwater ubiquity score (GUS) is a quantitative screening tool to estimate a pesticide's potential to move in the environment. It utilizes soil persistence and adsorption coefficients in the following formula.

$$GUS = \log_{10}(t_{½}) \times [4 - \log_{10}(K_{oc})]$$

The potential pesticide movement rating would be based upon its GUS value. Pesticides with a GUS <0.1 would considered to have an extremely low potential to move toward groundwater. Values of 1.0-2.0 would be low, 2.0-3.0 would be moderate, 3.0-4.0 would be high, and >4.0 would have a very high potential to move toward groundwater.

Water solubility describes the amount of pesticide dissolving in a specific quantity of water, where it is usually measured as mg/L or ppm. Solubility is useful as a comparative measure because pesticides with higher values are more likely to move by runoff or leaching. GUS, water solubility, $t_{½}$, and K_{oc} values are available for selected pesticides from the Oregon State University Extension Pesticide Properties Database at http://npic.orst.edu/ppdmove.htm. Many of the values in this database were derived from the SCS/ARS/CES Pesticide Properties Database for Environmental Decision Making (Wauchope et al. 1992).

Soil properties influence the fate of pesticides in the environment. The following six properties are mostly likely to affect pesticide degradation and the potential for pesticides to move off-site by leaching (vertical movement through the soil) or runoff (lateral movement across the soil surface).

- Permeability is the rate of water movement vertically through the soil. It is affected by soil texture and structure. Coarse textured soils (e.g., high sand content) have a larger pore size and they are generally more permeable than fine textured soils (i.e., high clay content). The more permeable soils would have a greater potential for pesticides to move vertically down through the soil profile. Soil permeability rates (inches/hour) are usually available in county soil survey reports.
- Soil texture describes the relative percentage of sand, silt, and clay. In general, greater clay content with smaller the pore size would lower the likelihood and rate water that would move through the soil profile. Clay also serves to adsorb (bind) pesticides to soil particles. Soils with high clay content would adsorb more pesticide than soils with relatively low clay content. In contrast, sandy soils with coarser texture and lower water holding capacity would have a greater potential for water to leach through them.
- Soil structure describes soil aggregation. Soils with a well-developed soil structure have looser, more aggregated, structure that would be less likely to be compacted. Both characteristics would allow for less restricted flow of water through the soil profile resulting in greater infiltration.
- Organic matter would be the single most important factor affecting pesticide adsorption in soils. Many pesticides are adsorbed to organic matter which would reduce their rate of downward movement through the soil profile. Also, soils high in organic matter would tend to hold more water, which may make less water available for leaching.

- Soil moisture affects how fast water would move through the soil. If soils are already wet or saturated before rainfall or irrigation, excess moisture would runoff rather than infiltrate into the soil profile. Soil moisture also would influence microbial and chemical activity in soil, which effects pesticide degradation.
- Soil pH would influence chemical reactions that occur in the soil which in turn determines whether or not a pesticide will degrade, rate of degradation, and, in some instances, which degradation products are produced.

Based upon the aforementioned properties, soils most vulnerable to groundwater contamination would be sandy soils with low organic matter. In contrast, the least vulnerable soils would be well-drained clayey soils with high organic matter. Consequently, pesticides with the lowest potential for movement in conjunction with appropriate best management practices (see below) would be used in an IPM framework to treat pests while minimizing effects to non-target biota and protecting environmental quality.

Along with soil properties, the potential for a pesticide to affect water quality through runoff and leaching would consider site-specific environmental and abiotic conditions including rainfall, water table conditions, and topography (Huddleston 1996).

- Water is necessary to separate pesticides from soil. This can occur in two basic ways. Pesticides that are soluble move easily with runoff water. Pesticide-laden soil particles can be dislodged and transported from the application site in runoff. The concentration of pesticides in the surface runoff would be greatest for the first runoff event following treatment. The rainfall intensity and route of water infiltration into soil, to a large extent, determine pesticide concentrations and losses in surface runoff. The timing of the rainfall after application also would have an effect. Rainfall interacts with pesticides at a shallow soil depth (¼ to ½ inch), which is called the mixing zone (Baker and Miller 1999). The pesticide/water mixture in the mixing zone would tend to leach down into the soil or runoff depending upon how quickly the soil surface becomes saturated and how rapidly water can infiltrate into the soil. Leaching would decrease the amount of pesticide available near the soil surface (mixing zone) to runoff during the initial rainfall event following application and subsequent rainfall events.
- Terrain slope would affect the potential for surface runoff and the intensity of runoff. Steeper slopes would have greater potential for runoff following a rainfall event. In contrast, soils that are relatively flat would have little potential for runoff, except during intense rainfall events. In addition, soils in lower areas would be more susceptible to leaching as a result of receiving excessive water from surrounding higher elevations.
- Depth to groundwater would be an important factor affecting the potential for pesticides to leach into groundwater. If the distance from the soil surface to the top of the water table is shallow, pesticides would have less distance to travel to reach groundwater. Shallower water tables that persist for longer periods would be more likely to experience groundwater contamination. Soil survey reports are available for individual counties. These reports provide data in tabular format regarding the water table depths and the months during which it is persists. In some situations, a hard pan exists above the water table that would prevent pesticide contamination from leaching.

H.7.5 Determining Effects to Air Quality

Pesticides may volatilize from soil and plant surfaces and move from the treated area into the atmosphere. The potential for a pesticide to volatilize is determined by the pesticide's vapor pressure which would be affected by temperature, sorption, soil moisture, and the pesticide's water solubility. Vapor pressure is often expressed in mm Hg. To make these numbers easier to compare, vapor pressure may be expressed in exponent form ($I \times 10^{-7}$), where I represents a vapor pressure index. In general, pesticides with $I<10$ would have a low potential to volatilize, whereas pesticides with $I>1,000$ would have a high potential to volatilize (Oregon State University 1996). Vapor pressure values for pesticides are usually available in the pesticide product MSDS or the USDA Agricultural Research Service (ARS) pesticide database.

H.7.6 Preparing a Chemical Profile

The following instructions would be used by Service personnel to complete Chemical Profiles for pesticides. Specifically, profiles would be prepared for pesticide active ingredients (e.g., glyphosate, imazapic) that would be contained in one or more trade name products that are registered and labeled with USEPA. All information fields under each category (e.g., Toxicological Endpoints, Environmental Fate) would be completed for a Chemical Profile. If no information is available for a specific field, then "No data is available in references" would be recorded in the profile. Available scientific information would be used to complete Chemical Profiles. Each entry of scientific information would be shown with applicable references.

Completed Chemical Profiles would provide a structured decision-making process utilizing quantitative assessment/screening tools with threshold values (where appropriate) that would be used to evaluate potential biological and other environmental effects to refuge resources. For ecological risk assessments presented in these profiles, the "worst-case scenario" would be evaluated to determine whether a pesticide could be approved for use considering the maximum single application rate specified on pesticide labels for habitat management and croplands/facilities maintenance treatments pertaining to refuges. Where the "worst-case scenario" likely would only result in minor, temporary, and localized effects to listed and nonlisted species with appropriate BMPs (see Section H.5), the proposed pesticide's use in a PUP would have a scientific basis for approval under any application rate specified on the label that is at or below rates evaluated in a Chemical Profile. In some cases, the Chemical Profile would include a lower application rate than the maximum labeled rate in order to protect refuge resources. As necessary, Chemical Profiles would be periodically updated with new scientific information or as pesticides with the same active ingredient are proposed for use on the Refuge in PUPs.

Throughout this section, threshold values (to prevent or minimize potential biological and environmental effects) would be clearly identified for specific information presented in a completed Chemical Profile. Comparison with these threshold values provides an explicit scientific basis to approve or disapprove PUPs for habitat management and cropland/facilities maintenance on refuge lands. In general, PUPs would be approved for pesticides with Chemical Profiles where there would be no exceedances of threshold values. However, BMPs are identified for some screening tools that would minimize/eliminate potential effects (exceedance of the threshold value) as a basis for approving PUPs.

Date: Service personnel would record the date when the Chemical Profile is completed or updated. Chemical Profiles (e.g., currently approved pesticide use patterns) would be periodically reviewed and updated, as necessary. The most recent review date would be recorded on a profile to document when it was last updated.

Trade Name(s): Service personnel would accurately and completely record the trade name(s) from the pesticide label, which includes a suffix that describes the formulation (e.g., WP, DG, EC, L, SP, I, II or 64). The suffix often distinguishes a specific product among several pesticides with the same active ingredient. Service personnel would record a trade name for each pesticide product with the same active ingredient.

Common chemical name(s): Service personnel would record the common name(s) listed on the pesticide label or MSDS for an active ingredient. The common name of a pesticide is listed as the active ingredient on the title page of the product label immediately following the trade name, and the MSDS, Section 2: Composition/ Information on Ingredients. A Chemical Profile is completed for each active ingredient.

Pesticide Type: Service personnel would record the type of pesticide for an active ingredient as one of the following: herbicide, dessicant, fungicide, fumigant, growth regulator, insecticide, pisicide, or rodenticide.

EPA Registration Number(s): This number (EPA Reg. No.) appears on the title page of the label and MSDS, Section 1: Chemical Product and Company Description. It is not the EPA Establishment Number that is usually located near it. Service personnel would record the EPA Reg. No. for each trade name product with an active ingredient based upon PUPs.

Pesticide Class: Service personnel would list the general chemical class for the pesticide (active ingredient). For example, malathion is an organophosphate and carbaryl is a carbamate.

CAS (Chemical Abstract Service) Number: This number is often located in the second section (Composition/Information on Ingredients) of the MSDS. The MSDS table listing components usually contains this number immediately prior to or following the % composition.

Other Ingredients: From the most recent MSDS for the proposed pesticide product(s), Service personnel would include any chemicals in the pesticide formulation not listed as an active ingredient that are described as toxic or hazardous, or regulated under the Superfund Amendments and Reauthorization Act, Comprehensive Environmental Response, Compensation, and Liability Act, Toxic Substances Control Act, OSHA, State Right-to-Know, or other listed authorities. These are usually found in MSDS sections titled “Hazardous Identifications”, “Exposure Control/Personal Protection”, and “Regulatory Information”. If concentrations of other ingredients are available for any compounds identified as toxic or hazardous, then Service personnel would record this information in the Chemical Profile by trade name. MSDS(s) may be obtained from the manufacturer, manufacturer’s website, or from an on-line database maintained by Crop Data Management Systems, Inc. (see list below).

H.7.6.1 Toxicological Endpoints

Toxicological endpoint data would be collected for acute and chronic tests with mammals, birds, and fish. Data would be recorded for species available in the scientific literature. If no data are found for a particular taxonomic group, then "No data available is references" would be recorded as the data entry. Throughout the Chemical Profile, references (including toxicological endpoint data) would be cited using parentheses (#) following the recorded data.

Mammalian LD_{50}: For test species in the scientific literature, Service personnel would record available data for oral lethal dose (LD_{50}) in mg/kg-bw (body weight) or ppm-bw. Most common test species in scientific literature are the rat and mouse. The lowest LD_{50} value found for a rat would be used as a toxicological endpoint for dose-based RQ calculations to assess acute risk to mammals (see Table H-1 in Section H.7.1).

Mammalian LC_{50}: For test species in the scientific literature, Service personnel would record available data for dietary lethal concentration (LC_{50}) as reported (e.g., mg/kg-diet or ppm-diet). Most common test species in scientific literature are the rat and mouse. The lowest LC_{50} value found for a rat would be used as a toxicological endpoint for diet-based RQ calculations to assess acute risk (see Table H-1 in Section H.7.1).

Mammalian Reproduction: For test species listed in the scientific literature, Service personnel would record the test results (e.g., Lowest Observed Effect Concentration [LOEC], Lowest Observed Effect Level [LOEL], No Observed Adverse Effect Level [NOAEL], No Observed Adverse Effect Concentration [NOAEC]) in mg/kg-bw or mg/kg-diet for reproductive test procedure(s) (e.g., generational studies [preferred], fertility, new born weight). Most common test species available in scientific literature are rats and mice. The lowest NOEC, NOAEC, NOEL, or NOAEL test results found for a rat would be used as a toxicological endpoint for RQ calculations to assess chronic risk (see Table H-1 in Section H.7.1).

Avian LD_{50}: For test species available in the scientific literature, Service personnel would record values for oral lethal dose (LD_{50}) in mg/kg-bw or ppm-bw. Most common test species available in scientific literature are the bobwhite quail and mallard. The lowest LD_{50} value found for an avian species would be used as a toxicological endpoint for dose-based RQ calculations to assess acute risk (see Table H-1 in Section H.7.1).

Avian LC_{50}: For test species available in the scientific literature, Service personnel would record values for dietary lethal concentration (LC_{50}) as reported (e.g., mg/kg-diet or ppm-diet). Most common test species available in scientific literature are the bobwhite quail and mallard. The lowest LC_{50} value found for an avian species would be used as a toxicological endpoint for dietary-based RQ calculations to assess acute risk (see Table H-1 in Section H.7.1).

Avian Reproduction: For test species available in the scientific literature, Service personnel would record test results (e.g., LOEC, LOEL, NOAEC, NOAEL) in mg/kg-bw or mg/kg-diet consumed for reproductive test procedure(s) (e.g., early life cycle, reproductive). Most common test species available in scientific literature are the bobwhite quail and mallard. The lowest NOEC, NOAEC, NOEL, or NOAEL test results found for an avian species would be used as a toxicological endpoint for RQ calculations to assess chronic risk (see Table H-1 in Section H.7.1).

Fish LC_{50}: For test freshwater or marine species listed in the scientific literature, Service personnel would record a LC_{50} in ppm or mg/L. Most common test species available in the scientific literature are the bluegill, rainbow trout, and fathead minnow (marine). Test results for many game species may also be available. The lowest LC_{50} value found for a freshwater fish species would be used as a toxicological endpoint for RQ calculations to assess acute risk (see Table H-1 in Section H.7.1).

Fish Early Life Stage (ELS)/Life Cycle: For test freshwater or marine species available in the scientific literature, Service personnel would record test results (e.g., LOEC, NOAEL, NOAEC, LOAEC) in ppm for test procedure(s) (e.g., early life cycle, life cycle). Most common test species available in the scientific literature are bluegill, rainbow trout, and fathead minnow. Test results for other game species may also be available. The lowest test value found for a fish species (preferably freshwater) would be used as a toxicological endpoint for RQ calculations to assess chronic risk (see Table H-1 in Section H.7.1).

Other: For test invertebrate as well as non-vascular and vascular plant species available in the scientific literature, Service personnel would record $LC_{50,}$ $LD_{50,}$ LOEC, LOEL, NOAEC, NOAEL, or EC_{50} (environmental concentration) values in ppm or mg/L. Most common test invertebrate species available in scientific literature are the honey bee and the water flea. Green algae and pondweed are frequently available test species for aquatic non-vascular and vascular plants, respectively.

Ecological Incident Reports: After a site has been treated with pesticide(s), wildlife may be exposed to these chemical(s). When exposure is high relative to the toxicity of the pesticides, wildlife may be killed or visibly harmed (incapacitated). Such events are called ecological incidents. The USEPA maintains a database (Ecological Incident Information System) of ecological incidents. This database stores information extracted from incident reports submitted by various Federal and state agencies and nongovernment organizations. Information included in an incident report is date and location of the incident, type and magnitude of effects observed in various species, use(s) of pesticides known or suspected of contributing to the incident, and results of any chemical residue and cholinesterase activity analyses conducted during the investigation.

Incident reports can play an important role in evaluating the effects of pesticides by supplementing quantitative risk assessments. All incident reports for pesticide(s) with the active ingredient and associated information would be recorded.

H.7.6.2 Environmental Fate

Water Solubility: Service personnel would record values for water solubility (S_w), which describes the amount of pesticide that dissolves in a known quantity of water. S_w is expressed as mg/L (ppm). Pesticide S_w values would be categorized as one of the following: insoluble <0.1 ppm, moderately soluble = 100 to 1,000 ppm, highly soluble >10,000 ppm (U.S. Geological

Survey 2000). As pesticide S_w increases, there would be greater potential to degrade water quality through runoff and leaching.

S_w would be used to evaluate potential for bioaccumulation in aquatic species [see Octanol-Water Partition Coefficient (K_{ow}) below].

Soil Mobility: Service personnel would record available values for soil adsorption coefficient (K_{oc} [µg/g]). It provides a measure of a chemical's mobility and leaching potential in soil. K_{oc} values are directly proportional to organic content, clay content, and surface area of the soil. K_{oc} data for a pesticide may be available for a variety of soil types (e.g., clay, loam, sand).

K_{oc} values would be used in evaluating the potential to degrade groundwater by leaching (see Potential to Move to Groundwater below).

Soil Persistence: Service personnel would record values for soil half-life ($t_{½}$), which represents the length of time (days) required for 50% of the deposited pesticide to degrade (completely or partially) in the soil. Based upon the $t_{½}$ value, soil persistence would be categorized as one of the following: non-persistent <30 days, moderately persistent = 30 to 100 days, and persistent >100 days (Kerle et al. 1996).

Threshold for approving PUPs:

- *If soil t½ ≤100 days, then a PUP would be approved without additional BMPs to protect water quality.*
- *If soil t½ >100 days, then a PUP would only be approved with additional BMPs specifically to protect water quality. One or more BMPs such as the following would be included in the Specific Best Management Practices (BMPs) section to minimize potential surface runoff and leaching that can degrade water quality:*
  - *Do not exceed one application per site per year.*
  - *Do not use on coarse-textured soils where the ground water table is <10 feet and average annual precipitation >12 inches.*
  - *Do not use on steep slopes if substantial rainfall is expected within 24 hours or ground is saturated.*

Along with K_{oc}, soil $t_{½}$ values would be used in evaluating the potential to degrade groundwater by leaching (see Potential to Move to Groundwater below).

Soil Dissipation: Dissipation time (DT_{50}) represents the time required for 50% of the deposited pesticide to degrade and move from a treated site, whereas soil $t_{½}$ describes the rate for degradation only. As for $t_{½}$, units of dissipation time are usually expressed in days. Field dissipation time would be the preferred data for use to estimate pesticide concentrations in the environment because it is based upon field studies compared to soil $t_{½}$, which is derived in a laboratory. However, soil $t_{½}$ is the most common persistence data available in the published literature. If field dissipation data is not available, soil half-life data would be used in a Chemical Profile. The average or representative half-life value of most important degradation mechanism would be selected for quantitative analysis for both terrestrial and aquatic environments.

Based upon the DT_{50} value, environmental persistence in the soil also would be categorized as one of the following: non-persistent <30 days, moderately persistent = 30 to 100 days, and persistent >100 days.

Threshold for approving PUPs:

- *If soil DT_{50} ≤100 days, then a PUP would be approved without additional BMPs to protect water quality.*
- *If soil DT_{50} >100 days, then a PUP would only be approved with additional BMPs specifically to protect water quality. One or more BMPs such as the following would be included in the Specific Best Management Practices (BMPs) section to minimize potential surface runoff and leaching that can degrade water quality:*
    - *Do not exceed one application per site per year.*
    - *Do not use on coarse-textured soils where the ground water table is <10 feet and average annual precipitation >12 inches.*
    - *Do not use on steep slopes if substantial rainfall is expected within 24 hours or ground is saturated.*

Along with K_{oc}, soil DT_{50} values (preferred over soil $t_{½}$) would be used in evaluating the potential to degrade groundwater by leaching (see Potential to Move to Groundwater below), if available.

Aquatic Persistence: Service personnel would record values for aquatic $t_{½}$, which represents the length of time required for 50% of the deposited pesticide to degrade (completely or partially) in water. Based upon the $t_{½}$ value, aquatic persistence would be categorized as one of the following: non-persistent <30 days, moderately persistent = 30 to 100 days, and persistent >100 days (Kerle et al. 1996).

Threshold for approving PUPs:

- *If aquatic t½ ≤100 days, then a PUP would be approved without additional BMPs to protect water quality.*
- *If aquatic t½ >100 days, then a PUP would only be approved with additional BMPs specifically to protect water quality. One or more BMPs such as the following would be included in the Specific Best Management Practices (BMPs) section to minimize potential surface runoff and leaching that can degrade water quality:*
    - *Do not exceed one application per site per year.*
    - *Do not use on coarse-textured soils where the ground water table is <10 feet and average annual precipitation >12 inches.*
    - *Do not use on steep slopes if substantial rainfall is expected within 24 hours or ground is saturated.*

Aquatic Dissipation: Dissipation time (DT_{50}) represents the time required for 50% of the deposited pesticide to degrade or move (dissipate), whereas aquatic $t_{½}$ describes the rate for degradation only. As for $t_{½}$, units of dissipation time are usually expressed in days. Based upon the DT_{50} value, environmental persistence in aquatic habitats also would be categorized as one of the following: non-persistent <30 days, moderately persistent = 30 to 100 days, and persistent >100 days.

Threshold for approving PUPs:

- *If aquatic DT_{50} ≤100 days, then a PUP would be approved without additional BMPs to protect water quality.*
- *If aquatic DT_{50} >100 days, then a PUP would only be approved with additional BMPs specifically to protect water quality. One or more BMPs such as the following would be included in the Specific Best Management Practices (BMPs) section to minimize potential surface runoff and leaching that can degrade water quality:*
  - *Do not exceed one application per site per year.*
  - *Do not use on coarse-textured soils where the ground water table is <10 feet and average annual precipitation >12 inches.*
  - *Do not use on steep slopes if substantial rainfall is expected within 24 hours or ground is saturated.*

Potential to Move to Groundwater: Groundwater ubiquity score (GUS) = $\log_{10}$(soil t $_{½}$) x [4–$\log_{10}(K_{oc})$]. If a DT_{50} value is available, it would be used rather than a t $_{½}$ value to calculate a GUS score. Based upon the GUS value, the potential to move toward groundwater would be recorded as one of the following categories: extremely low potential <1.0, low 1.0 to 2.0, moderate 2.0 to 3.0, high 3.0 to 4.0, or very high >4.0.

Threshold for approving PUPs:

- *If GUS ≤4.0, then a PUP would be approved without additional BMPs to protect water quality.*
- *If GUS >4.0, then a PUP would only be approved with additional BMPs specifically to protect water quality. One or more BMPs such as the following would be included in the Specific Best Management Practices (BMPs) section to minimize potential surface runoff and leaching that can degrade water quality:*
  - *Do not exceed one application per site per year.*
  - *Do not use on coarse-textured soils where the ground water table is <10 feet and average annual precipitation >12 inches.*
  - *Do not use on steep slopes if substantial rainfall is expected within 24 hours or ground is saturated.*

Volatilization: Pesticides may volatilize (evaporate) from soil and plant surfaces and move off-target into the atmosphere. The potential for a pesticide to volatilize is a function of its vapor pressure that is affected by temperature, sorption, soil moisture, and the pesticide's water solubility. Vapor pressure is often expressed in mm Hg. To make these values easier to compare, vapor pressure would be recorded by Service personnel in exponential form (I x 10^{-7}), where I represents a vapor pressure index. In general, pesticides with I<10 would have low potential to volatilize, whereas pesticides with I >1,000 would have a high potential to volatilize (Oregon State University 1996). Vapor pressure values for pesticides are usually available in the pesticide product MSDS or the USDA ARS pesticide database (see References).

Threshold for approving PUPs:

- *If I ≤ 1,000, then a PUP would be approved without additional BMPs to minimize drift and protect air quality.*
- *If I >1,000, then a PUP would only be approved with additional BMPs specifically to minimize drift and protect air quality. One or more BMPs such as the following would be included in the Specific Best Management Practices (BMPs) section to reduce volatilization and potential to drift and degrade air quality:*
    - *Do not treat when wind velocities are <2 or >10 mph with existing or potential inversion conditions.*
    - *Apply the large-diameter droplets possible for spray treatments.*
    - *Avoid spraying when air temperatures >85ºF.*
    - *Use the lowest spray height possible above target canopy.*
    - *Where identified on the pesticide label, soil incorporate pesticide as soon as possible during or after application.*

Octanol-Water Partition Coefficient (K_{ow}): The octanol-water partition coefficient (K_{ow}) is the concentration of a pesticide in octanol and water at equilibrium at a specific temperature. Because octanol is an organic solvent, it is considered a surrogate for natural organic matter. Therefore, K_{ow} would be used to assess potential for a pesticide to bioaccumulate in tissues of aquatic species (e.g., fish). If K_{ow} >1,000 or S_w<1 mg/L and soil $t_{½}$>30 days, then there would be high potential for a pesticide to bioaccumulate in aquatic species such as fish (U.S. Geological Survey 2000).

Threshold for approving PUPs:

- *If there is not a high potential for a pesticide to bioaccumulate in aquatic species, then the PUP would be approved.*
- *If there is a high potential to bioaccumulate in aquatic species (K_{ow}>1,000 or S_w<1 mg/L and soil t½>30 days), then the PUP would not approved, except under unusual circumstances where approval would only be granted by the Washington Office.*

Bioaccumulation/Bioconcentration: The physiological process where pesticide concentrations in tissue would increase in biota because they are taken and stored at a faster rate than they are metabolized or excreted. The potential for bioaccumulation would be evaluated through bioaccumulation factors (BAFs) or bioconcentration factors (BCFs). Based upon BAF or BCF values, the potential to bioaccumulate would be recorded as one of the following: low 0 to 300, moderate 300 to 1,000, or high >1,000 (Calabrese and Baldwin 1993).

Threshold for approving PUPs:

- *If BAF or BCF≤1,000, then a PUP would be approved without additional BMPs.*
- *If BAF or BCF>1,000, then a PUP would not approved, except under unusual circumstances where approval would only be granted by the Washington Office.*

H.7.6.3 Worst-Case Ecological Risk Assessment

Max Application Rates (acid equivalent): Service personnel would record the highest application rate of an active ingredient (ae basis) for habitat management and cropland/facilities maintenance treatments in this data field of a Chemical Profile. These rates can be found in Table CP.1 under the column heading "Max Product Rate – Single Application (lbs/acre – AI on acid equiv basis)". This table would be prepared for a Chemical Profile from information specified in labels for trade name products identified in PUPs. If these data are not available in pesticide labels, then write "NS" for "not specified on label" in this table.

EECs: An estimated environmental concentration (EEC) represents potential exposure to fish and wildlife (birds and mammals) from using a pesticide. EECs would be derived by Service personnel using an USEPA screening-level approach (USEPA 2004). For each max application rate [see description under Max Application Rates (acid equivalent)], Service personnel would record 2 EEC values in a Chemical Profile; these would represent the worst-case terrestrial and aquatic exposures for habitat management and croplands/facilities maintenance treatments. For terrestrial and aquatic EEC calculations, see description for data entry under Presumption of Unacceptable Risk/Risk Quotients, which is the next field for a Chemical Profile.

Presumption of Unacceptable Risk/Risk Quotients: Service personnel would calculate and record acute and chronic RQs for birds, mammals, and fish using the provided tabular formats for habitat management and/or cropland/facilities maintenance treatments. RQs recorded in a Chemical Profile would represent the worst-case assessment for ecological risk. See Section H.7.2 for discussion regarding the calculations of RQs.

For aquatic assessments associated with habitat management treatments, RQ calculations would be based upon selected acute and chronic toxicological endpoints for fish and the EEC would be derived from Urban and Cook (1986) assuming 100% overspray to an entire 1-foot deep water body using the max application rate (ae basis [see above]).

For aquatic assessments associated with cropland/facilities maintenance treatments, RQ calculations would be done by Service personnel based upon selected acute and chronic toxicological endpoints for fish and an EEC would be derived from the aquatic assessment in AgDRIFT® model version 2.01 under Tier I ground-based application with the following input variables: max application rate (acid basis [see above]), low boom (20 inches), fine to medium/coarse droplet size, 20 swaths, EPA-defined wetland, and 25-foot distance (buffer) from treated area to water.

See Section H.7.2.1.2 for more details regarding the calculation of EECs for aquatic habitats for habitat management and cropland/facilities maintenance treatments.

For terrestrial avian and mammalian assessments, RQ calculations would be done by Service personnel based upon dietary exposure, where the "short grass" food item category would represent the worst-case scenario. For terrestrial spray applications associated with habitat management and cropland/facilities maintenance treatments, exposure (EECs and RQs) would be determined using the Kanaga nomogram method through the USEPA's T-REX version 1.2.3. T-REX input variables would include the following: max application rate (acid basis [see above]) and pesticide half-life (days) in soil to estimate the initial, maximum pesticide residue concentration on general food items for terrestrial vertebrate species in short (<20 cm tall) grass.

For granular pesticide formulations and pesticide-treated seed with a unique route of exposure for terrestrial avian and mammalian wildlife, see Section H.7.2.1.1.2 for the procedure that would be used to calculate RQs.

All calculated RQs in both tables would be compared with LOCs established by USEPA (see Table H-2 in Section H.7.2). If a calculated RQ exceeds an established LOC value (in brackets inside the table), then there would be a potential for an acute or chronic effect (unacceptable risk) to federally listed (threatened and endangered [T&E]) species and nonlisted species. See Section H.7.2 for detailed descriptions of acute and chronic RQ calculations and comparison to LOCs to assess risk.

Threshold for approving PUPs:

- *If RQs≤LOCs, then a PUP would be approved without additional BMPs.*
- *If RQs>LOCs, then a PUP would only be approved with additional BMPs specifically to minimize exposure (ecological risk) to bird, mammal, and/or fish species. One or more BMPs such as the following would be included in the Specific Best Management Practices (BMPs) section to reduce potential risk to nonlisted or listed species:*
    - *Lower application rate and/or fewer number of applications so RQs≤LOCs*
    - *For aquatic assessments (fish) associated with cropland/facilities maintenance, increase the buffer distance beyond 25 feet so RQs≤LOCs.*

Justification for Use: Service personnel would describe the reason for using the pesticide based control of specific pests or groups of pests. In most cases, the pesticide label will provide the appropriate information regarding control of pests to describe in the section.

Specific Best Management Practices (BMPs): Service personnel would record specific BMPs necessary to minimize or eliminate potential effects to non-target species and/or degradation of environmental quality from drift, surface runoff, or leaching. These BMPs would be based upon scientific information documented in previous data fields of a Chemical Profile. Where necessary and feasible, these specific practices would be included in PUPs as a basis for approval.

If there are no specific BMPs that are appropriate, then Service personnel would describe why the potential effects to refuge resources and/or degradation of environmental quality is outweighed by the overall resource benefit(s) from the proposed pesticide use in the BMP section of the PUP. See Section H.4 of this document for a complete list of BMPs associated with mixing and applying pesticides appropriate for all PUPs with ground-based treatments that would be additive to any necessary, chemical-specific BMPs.

References: Service personnel would record scientific resources used to provide data/information for a chemical profile. Use the number sequence to uniquely reference data in a chemical profile.

The following online data resources are readily available for toxicological endpoint and environmental fate data for pesticides:

1. California Product/Label Database. Department of Pesticide Regulation, California Environmental Protection Agency. (http://www.cdpr.ca.gov/docs/label/labelque.htm#regprods)

2. ECOTOX database. Office of Pesticide Programs, U.S. Environmental Protection Agency, Washington, D.C. (http://cfpub.epa.gov/ecotox/)

3. Extension Toxicology Network (EXTOXNET) Pesticide Information Profiles. Cooperative effort of University of California-Davis, Oregon State University, Michigan State University, Cornell University and University of Idaho through Oregon State University, Corvallis, Oregon. (http://extoxnet.orst.edu/pips/ghindex.html)

4. FAO specifications and evaluations for plant protection products. Pesticide Management Unit, Plant Protection Services, Food and Agriculture Organization, United Nations. (http://www.fao.org/WAICENT/FAOINFO/AGRICULT/AGP/AGPP/Pesticid/)

5. Human health and ecological risk assessments. Pesticide Management and Coordination, Forest Health Protection, U.S. Department of Agriculture, U.S. Forest Service. (http://www.fs.fed.us/foresthealth/pesticide/risk.htm)

6. Pesticide Chemical Fact Sheets. Clemson University Pesticide Information Center. (http://entweb.clemson.edu/pesticid/Document/Labels/factshee.htm)

7. Pesticide Fact Sheets. Published by Information Ventures, Inc. for Bureau of Land Management, Department of Interior; Bonneville Power Administration, U.S. Department of Energy; and Forest Service, U.S. Department of Agriculture. (http://infoventures.com/e-hlth/pesticide/pest-fac.html)

8. Pesticide Fact Sheets. National Pesticide Information Center. (http://npic.orst.edu/npicfact.htm)

9. Pesticide Fate Database. U.S. Environmental Protection Agency, Washington, D.C. (http://cfpub.epa.gov/pfate/home.cfm).

10. Pesticide product labels and material safety data sheets. Crop Data Management Systems, Inc. (CDMS) (http://www.cdms.net/pfa/LUpdateMsg.asp) or multiple websites maintained by agrichemical companies.

11. Registered Pesticide Products (Oregon database). Oregon Department of Agriculture. (http://www.oda.state.or.us/dbs/pest_products/search.lasso)

12. Regulatory notes. Pest Management Regulatory Agency, Health Canada, Ontario, Canada. (http://www.hc-sc.gc.ca/pmra-arla/)

13. Reptile and Amphibian Toxicology Literature. Canadian Wildlife Service, Environment Canada, Ontario, Canada. (http://www.cws-scf.ec.gc.ca/nwrc-cnrf/ratl/index_e.cfm)

14. Specific Chemical Fact Sheet – New Active Ingredients, Biopesticide Fact Sheet and Registration Fact Sheet. U.S. Environmental Protection Agency, Washington, D.C. (http://www.epa.gov/pestidides/factsheets/chemical_fs.htm)

15. Weed Control Methods Handbook: Tools and Techniques for Use in Natural Areas. The Invasive Species Initiative. The Nature Conservancy. (http://tnsweeds.ucdavis.edu/handbook.html)

16. Wildlife Contaminants Online. U.S. Geological Survey, Department of Interior, Washington, D.C. (http://www.pwrc.usgs.gov/contaminants-online/)

17. One-liner database. 2000. U.S. Environmental Protection Agency, Office of Pesticide Programs, Washington, D.C.

Chemical Profile

Date:			
Trade Name(s):		**Common Chemical Name(s):**	
Pesticide Type:		**EPA Registration Number:**	
Pesticide Class:		**CAS Number:**	
Other Ingredients:			

Toxicological Endpoints

Mammalian LD_{50}:	
Mammalian LC_{50}:	
Mammalian Reproduction:	
Avian LD_{50}:	
Avian LC_{50}:	
Avian Reproduction:	
Fish LC_{50}:	
Fish ELS/Life Cycle:	
Other:	

Ecological Incident Reports

Environmental Fate

Water solubility (S_w):	
Soil Mobility (K_{oc}):	
Soil Persistence ($t_{½}$):	
Soil Dissipation (DT_{50}):	
Aquatic Persistence ($t_{½}$):	
Aquatic Dissipation (DT_{50}):	
Potential to Move to Groundwater (GUS score):	
Volatilization (mm Hg):	
Octanol-Water Partition Coefficient (K_{ow}):	
Bioaccumulation/Biocentration: BAF:`	**BCF:**

Worst Case Ecological Risk Assessment

Max Application Rate (ai lbs/acre – ae basis)	**Habitat Management:** **Croplands/Facilities Maintenance:**
EECs Terrestrial	**(Habitat Management):** **Terrestrial (Croplands/Facilities Maintenance):** **Aquatic (Habitat Management):** **Aquatic (Croplands/Facilities Maintenance):**

Habitat Management Treatments:

Presumption of Unacceptable Risk		**Risk Quotient (RQ)**	
		Listed (T&E) Species	**Nonlisted Species**
Acute	Birds	[0.1]	[0.5]
	Mammals	[0.1]	[0.5]
	Fish	[0.05]	[0.5]
Chronic	Birds	[1]	[1]
	Mammals	[1]	[1]
	Fish	[1]	[1]

Cropland/Facilities Maintenance Treatments:

Presumption of Unacceptable Risk		Risk Quotient (RQ)	
		Listed (T&E) Species	Nonlisted Species
Acute	Birds	[0.1]	[0.5]
	Mammals	[0.1]	[0.5]
	Fish	[0.05]	[0.5]
Chronic	Birds	[1]	[1]
	Mammals	[1]	[1]
	Fish	[1]	[1]

Justification for Use:	
Specific Best Management Practices (BMPs):	
References:	

Table CP.1 Pesticide Name

Trade Name[a]	Treatment Type[b]	Max Product Rate – Single Application (lbs/acre or gal/acre)	Max Product Rate -Single Application (lbs/acre - AI on acid equiv basis)	Max Number of Applications Per Season	Max Product Rate Per Season (lbs/acre/season or gal/acre/season)	Minimum Time Between Applications (Days)

[a]From each label for a pesticide identified in pesticide use proposals (PUPs), Service personnel would record application information associated with possible/known uses on Service lands.
[b]Treatment type: H – habitat management or CF – cropland/facilities maintenance. If a pesticide is labeled for both types of treatments (uses), then record separate data for H and CF applications.

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Appendix I. Statement of Compliance

The following executive orders and legislative acts have been reviewed as they apply to the implementation of the Comprehensive Conservation Plan (CCP) for Willapa National Wildlife Refuge (NWR), located in Washington State.

National Environmental Policy Act (1969). The planning process has been conducted in accordance with National Environmental Policy Act Implementing Procedures, Department of Interior and Fish and Wildlife Service procedures, and has been performed in coordination with the affected public. The requirements of the National Environmental Policy Act (42 U.S.C. §4321 *et seq*.) and its implementing regulations in 40 C.F.R. Parts 1500-1508 have been satisfied in the procedures used to reach this decision. These procedures included the development of a range of alternatives for the Willapa NWR CCP; analysis of the likely effects of each alternative; and public involvement throughout the planning process. The draft CCP/EIS shall be released for a minimum 45-day public comment period in the fall of 2010. The affected public shall be notified of the availability of these documents through a Federal Register notice, news releases to local newspapers, the Service's refuge planning website, and a planning update. Copies of the draft CCP/EIS and/or planning updates shall be distributed to an extensive mailing list. In addition, the Service hosted two public open houses in 2008. The draft CCP shall be revised based on public comment received on the draft documents.

National Historic Preservation Act (1966) (16 U.S. C.470 *et seq*.) The management of archaeological and cultural resources of Willapa NWR will comply with the regulations of Section 106 of the National Historic Preservation Act. No historic properties are known to be affected by the proposed action based on the criteria of an effect or adverse effect as an undertaking defined in 36 C.F.R. 800.9 and Service Manual 614 FW 2; however, determining whether a particular action has a potential to affect cultural resources is an ongoing process that occurs as step-down and site-specific project plans are developed. Should historic properties be identified or acquired in the future, the Service will comply with the National Historic Preservation Act if any management actions have the potential to affect any these properties.

Endangered Species Act (16 U.S.C. 1531-1544). This Act provides for the conservation of threatened and endangered species of fish, wildlife, and plants by Federal action and by encouraging the establishment of state programs. Documentation is required under Section 7 of the Act. Refuge policy requires the Refuge Manager to document issues which affect or may affect endangered species before initiating projects such as the restoration project. (Appendix O)

Executive Order 12372 Intergovernmental Review. Coordination and consultation with affected tribal, local, and state governments, other Federal agencies, and local interested persons has been completed through personal contact by Service Planners, Refuge staff, and Refuge Supervisors.

Executive Order 11988 Floodplain Management. Under this order, Federal agencies; "shall take action to reduce the risk of flood loss, to minimize the impact of floods on human safety, health and welfare, and to restore and preserve the natural and beneficial values served by floodplains."

Wilderness Preservation Act of 1964. The Service has evaluated the suitability of the Refuge for wilderness designation (Appendix G) and has found there are no areas that are currently suitable for wilderness designation.

Executive Order 11990 Protection of Wetlands. The CCP is consistent with Executive Order 11990 because CCP implementation would potentially enhance and restore wetland resources on the Refuge.

National Wildlife Administration Act of 1966, as amended by the National Wildlife Refuge System Improvement Act of 1997 (16 U.S.C. 668dd-668ee). The National Wildlife Refuge System Improvement Act (Public Law 105-57, Improvement Act) requires the Service to develop and implement a comprehensive conservation plan for each refuge. The CCP identifies and describes refuge purposes; refuge vision and goals; fish, wildlife, and plant populations and related habitats; archaeological and cultural values of the Refuge; issues that may affect populations and habitats of fish, wildlife, and plants; actions necessary to restore and improve biological diversity on the Refuge; and opportunities for wildlife-dependent recreation, as required by the Act.

During the CCP process the Refuge Manager evaluated all existing and proposed refuge uses at Willapa NWR. Priority wildlife-dependent uses (hunting, fishing, wildlife observation and photography, environmental education and interpretation) are considered automatically appropriate under Service policy and thus exempt from appropriate uses review. The following use was found to be appropriate: camping.

Compatibility determinations have been prepared for the following uses: waterfowl hunting, big game hunting, sport fishing, environmental education, wildlife observation, interpretation, and photography, and camping.

Executive Order 12898 Federal Actions to Address Environmental Justice in Minority and Low-Income Populations. All Federal actions must address and identify, as appropriate, disproportionately high and adverse human health or environmental effects of its programs, policies, and activities on minority populations, low-income populations, and Indian tribes in the United States. The CCP was evaluated and no adverse human health or environmental effects were identified for minority or low-income populations, Indian tribes, or anyone else.

Executive Order 13186 Responsibilities of Federal Agencies to Protect Migratory Birds. This Order directs agencies to take certain actions to further implement the Migratory Bird Treaty Act. A provision of the Order directs Federal agencies to consider the impacts of their activities, especially in reference to birds on the Fish and Wildlife Service's list of Birds of Conservation Concern. It also directs agencies to incorporate conservation recommendations and objectives in the North American Waterbird Conservation Plan and bird conservation plans developed by Partners in Flight into agency planning as described in Chapter 1. The effects of all alternatives to refuge habitats used by migratory birds were assessed within the CCP/EIS.

Americans with Disabilities Act of 1990. Requires access to Federal facilities for people with disabilities.

Appendix J. Acronyms and Glossary

Acronyms

a.i.	Active Ingredient
ABC	American Bird Conservancy
ADA	Americans with Disabilities Act
AHM	Adaptive Harvest Management
AM	Adaptive Management
APHIS-PPQ	U.S. Department of Agriculture, Animal Plant Health Inspection Service, Plant Protection and Quarantine
APHIS-WS	U.S. Department of Agriculture, Animal Plant Health Inspection Service, Wildlife Services
ARS	U.S. Department of Agriculture Agricultural Research Service
BAF	Bioaccumulation Factor
BCC	Birds of Conservation Concern
BCF	Bioconcentration Factor
BIDEH	Biological Integrity Diversity and Environmental Health
BMC	Birds of Management Concern
BMP	Best Management Practice
BPA	Bonneville Power Administration
C.F.R.	Code of Federal Regulations
CARL	Pacific County Critical Areas and Resources Land Ordinance No. 147
CAS	Chemical Abstract Service
CCP	Comprehensive Conservation Plan
CEQ	Council on Environmental Quality
CLMA	Cooperative Land Management Agreement
CWCS	Comprehensive Wildlife Conservation Strategy
dbh	Diameter at Breast Height
DPS	Distinct Population Segment
EA	Environmental Assessment
EE	Environmental Education
EEC	Estimated Environmental Concentration
EIS	Environmental Impact Statement
ENSO	El Niño–Southern Oscillation
ESA	Endangered Species Act
FIFRA	Federal Insecticide, Fungicide, and Rodenticide Act
FMP	Fire Management Plan
FONSI	Finding of No Significant Impact
GAP	Gap Analysis Program
GIS	Geographic Information System
GMU	Game Management Units
GUS	Groundwater Ubiquity Score
IAC	Interagency Committee for Outdoor Recreation (Washington State)
IBA	Important Bird Area
IPCC	Intergovernmental Panel on Climate Change

IPM	Integrated Pest Management
LEED	Leadership in Energy and Environmental Design
LEIS	Legislative Environmental Impact Statement
LOC	Level of Concern
LOEC	Lowest Observed Effect Concentration
LOEL	Lowest Observed Effect Level
MBTA	Migratory Bird Treaty Act
MHW	Mean High Water
MHHW	Mean Higher High Water
MIS	Management Information System
MLLW	Mean Lower Low Water
MMS	Maintenance Management System
MOA	Memorandum of Agreement
MOU	Memorandum of Understanding
MPA	Marine Protected Area
mph	Miles Per Hour
MSDS	Material Safety Data Sheet
NAWCA	North American Wetlands Conservation Act
NAWCP	North American Waterbird Conservation Plan
NAWMP	North American Waterfowl Management Plan
NEPA	National Environmental Policy Act
NGVD	National Geodetic Vertical Datum
NHPA	National Historic Preservation Act
NOAA	National Oceanic and Atmospheric Administration
NOAEC	No Observed Adverse Effect Concentration
NOAEL	No Observed Adverse Effect Level
NOEC	No Observed Effect Concentration
NPCRSCP	Northern Pacific Coast Region Shorebird Conservation Plan
NRC	National Research Council
NRCS	Natural Resources Conservation Service
NWPS	National Wilderness Preservation System
NWR	National Wildlife Refuge
NWRS	National Wildlife Refuge System
ONRC	Olympic Natural Resources Center
ORS	Washington Outdoor Recreation Survey
OSHA	Occupational Safety and Health Administration
PIF	Partners in Flight
PPE	Personal Protective Equipment
ppm	Parts Per Million
PUD	Pacific County Public Utilities District
PUP	Pesticide Use Proposal
PUPS	Pesticide Use Proposal System
RCO	Washington State Recreation and Conservation Office
RCW	Revised Code of Washington
RNA	Research Natural Area
RONS	Refuge Operating Needs System

RQ	Risk Quotient
SAMMS	Service Asset Management System
SCORP	Statewide Comprehensive Outdoor Recreation Plan
Service	U.S. Fish and Wildlife Service (also USFWS)
SWBCA	South Willapa Bay Conservation Area
T&E	Threatened and Endangered
TNC	The Nature Conservancy
T-REX	Terrestrial Residue Exposure model
TWA	Time-Weighted-Average
U.S.C.	U.S. Code
USDA	U.S. Department of Agriculture
USEPA	U.S. Environmental Protection Agency
USFWS	U.S. Fish and Wildlife Service
WAP	Wildlife Action Plan
WDFW	Washington State Department of Fish and Wildlife
WDNR	Washington Department of Natural Resources
WDOE	Washington Department of Ecology
WFPB	Washington Forest Practices Board
WRP	Wetland Reserve Program
WSDA	Washington State Department of Agriculture
WSPHRA	Western Snowy Plover Habitat Restoration Area
WSPRC	Washington State Parks and Recreation Commission

Glossary

Adaptive Management. Refers to a process in which policy decisions are implemented within a framework of scientifically driven experiments to test predictions and assumptions inherent in management planning. Analysis of results help managers determine whether current management should continue as is or whether it should be modified to achieve desired conditions.

Alternative. Alternatives are different means of accomplishing refuge purposes and goals and contributing to the System mission (Service Manual 602 FW 1.5). The no action alternative is current refuge management while the action alternatives are all other alternatives.

Anadromous. Migratory fishes that spend most of their lives in the sea and migrate to fresh water to breed.

Approved Acquisition Boundary. A National Wildlife Refuge boundary approved by the National or Regional Fish and Wildlife Service Director for potential acquisition of lands by the Service.

Archaeology. The scientific study of material evidence remaining from past human life and culture.

Biological Diversity (also Biodiversity). The variety of life and its processes, including the variety of living organisms, the genetic differences among them, and the communities and ecosystems in which they occur (Service Manual 601 FW 3). The System's focus is on indigenous species, biotic communities, and ecological processes.

Biological Integrity. Biotic composition, structure, and functioning at genetic, organism, and community levels comparable with historic conditions, including the natural biological processes that shape genomes, organisms, and communities (Service Manual 601 FW 3).

Birds of Conservation Concern. Species, subspecies, and populations of migratory nongame birds identified by the U. S. Fish and Wildlife Service as likely to become candidates for listing under the Endangered Species Act unless additional conservation actions are taken.

Blockage. When used in reference to anadromous fish habitat, a "complete blockage" occurs when conditions fully block all life stages of all salmonid fish species to upstream migration. A "partial blockage" occurs when conditions prevent species or life stages of a species of salmon from completing its upstream migration. See WDFW website http//wdfw.wa.gov/mapping/salmonscape.

Candidate Species (Federal). Fish, wildlife, and plant species that the U.S. Fish and Wildlife Service will review for possible listing as federally endangered or threatened. A species will be considered for designation as a Federal candidate if sufficient evidence suggests that its status may meet the listing criteria defined for federally endangered or threatened.

Candidate Species (State). Fish, wildlife, and plant species that a state will review for possible listing as state endangered, threatened, or sensitive species. A species will be considered for designation as a state candidate if sufficient evidence suggests that its status may meet the listing criteria defined for state endangered, threatened, or sensitive.

Categorical Exclusion. A category of actions that do not individually or cumulatively have a significant effect on the human environment and have been found to have no such effect in procedures adopted by a Federal agency pursuant to the National Environmental Policy Act (40 C.F.R. 1508.4).

Colonial Nesting Birds. Birds that nest in groups. At this refuge, most of the colonial nesting birds are waterbirds, such as gulls, terns, cormorants, and herons.

Columbia River Estuary. The area where the fresh water of a river meets the salt water of an ocean. The boundary of the Columbia River Estuary is considered the lower 46 miles (Lower Columbia River Estuary Partnership).

Compatibility Determination. A written determination signed and dated by the refuge manager and Regional Chief signifying that a proposed or existing use of a national wildlife refuge is a compatible use or is not a compatible use. The Director makes this delegation through the Regional Director. (Service Manual 603 FW 2)

Compatible Use. A wildlife-dependent recreational use or any other use of a refuge that, in the sound professional judgment of the Director, will not materially interfere with or detract from the fulfillment of the Mission of the System or the purposes of the refuge (Service Manual 603 FW 3). A compatibility determination supports the selection of compatible uses and identifies stipulations or limits necessary to ensure compatibility.

Comprehensive Conservation Plan. A document that describes the desired future conditions of the refuge, and provides long-range guidance and management direction for the refuge manager to accomplish the purposes of the refuge, contribute to the mission of the System, and to meet other relevant mandates (Service Manual 602 FW 1.5).

Connectivity. The arrangement of habitats that allows organisms and ecological processes to move across the landscape; patches of similar habitats are either close together or linked by corridors of appropriate vegetation. The opposite of fragmentation.

Conservation Target. A set of features or elements of biological diversity that are the focus of conservation within a system of conservation areas.

Consumptive Use. Recreational activities, such as hunting and fishing that involve harvest or removal of wildlife or fish, generally to be used as food by humans.

Contaminants or Environmental Contaminants - Chemicals present at levels greater than those naturally occurring in the environment resulting from anthropogenic or natural processes that potentially result in changes to biota at any ecological level. Pollutants that degrade other resources upon contact or mixing. Pollutants that degrade other resources upon contact or mixing (Adapted from Webster's II.)

Cooperative Agreement. This is a simple habitat protection action, and no property rights are acquired. An agreement is usually long term but can be modified by either party. They are most effective in establishing multiple use management of land.

Cover Type. The present vegetation of an area.

Cultural Resources. The physical remains, objects, historic records, and traditional lifeways that connect us to our nation's past.(USFWS, Considering Cultural Resources).

Cultural Resource Inventory. A professionally conducted study designed to locate and evaluate evidence of cultural resources present within a defined geographic area. Inventories may involve various levels, including background literature search, comprehensive field examination to identify all exposed physical manifestations of cultural resources, or sample inventory to project site distribution and density over a larger area. Evaluation of identified cultural resources to determine eligibility for the National Register follows the criteria found in 36 C.F.R. 60.4 (Service Manual 614 FW 1.7).

Deciduous. Describes trees and shrubs which shed all of their leaves each year.

Disturbance. Significant alteration of habitat structure or composition. May be natural (e.g., fire) or human-caused events (e.g., aircraft overflight).

Draw-down. The controlled reduction of water in managed wetlands.

Ecological Attribute. A characteristic or condition required to support the life history, habitat, physical processes, or community interaction of conservation targets.

Ecosystem. A dynamic and interrelating complex of plant and animal communities and their associated non-living environment.

Ecosystem Management. Management of natural resources using system-wide concepts to ensure that all plants and animals in ecosystems are maintained at viable levels in native habitats and basic ecosystem processes are perpetuated indefinitely.

Ecotone. A transitional zone between two communities containing the characteristic species of each.

Emergent Vegetation. Herbaceous plants that require a water environment to grow for at least part of their life cycle; stem structure is rigid and self-supporting; and vegetative growth continues above the waterline.

Environmental Assessment. A concise public document, prepared in compliance with the National Environmental Policy Act, that briefly discusses the purpose and need for an action, alternatives to such action, and provides sufficient evidence and analysis of impacts to determine whether to prepare an environmental impact statement or finding of no significant impact (40 C.F.R. 1508.9).

Environmental Impact Statement. A detailed written statement required by section 102(2) (C) of the National Environmental Policy Act, analyzing the environmental impacts of a proposed action, adverse effects of the project that cannot be avoided, alternative courses of action, short-term uses of the environment versus the maintenance and enhancement of long-term productivity, and any irreversible and irretrievable commitment of resources (40 CFR 1508.11).

Endangered Species (Federal). A plant or animal species listed under the Endangered Species Act that is in danger of extinction throughout all or a significant portion of its range.

Endangered Species (State). A plant or animal species in danger of becoming extinct or extirpated in Washington within the near future if factors contributing to its decline continue. Populations of these species are at critically low levels or their habitats have been degraded or depleted to a significant degree.

Environmental Education Facility. A building with one or more classrooms and environmental education materials to accommodate groups of students.

Environmental Education Field Sites. Outdoor locations where groups of students receive hands-on environmental education.

Environmental Health. Composition, structure, and functioning of soil, water, air, and other abiotic features comparable with historic conditions, including the natural abiotic processes that shape the environment (Service Manual 601 FW 3).

Enhancement. Improvement, especially for the benefit of habitats and/or species.

Estuarine. Deepwater tidal habitats and adjacent tidal wetlands that are usually partly enclosed by land but have some access to the open ocean and are diluted by freshwater.

Estuary. The area where the fresh water of a river meets the salt water of an ocean. In the National Estuary Program, this definition is extended to include the tidally influenced waters of a river.

Exotic Species. A species from another part of the world. A non-native species.

Extirpated. Species no longer inhabiting an area that it historically occupied.

Finding of No Significant Impact. A document prepared in compliance with the National Environmental Policy Act, supported by an environmental assessment, that briefly presents why a Federal action will have no significant effect on the human environment and for which an environmental impact statement, therefore, will not be prepared (40 C.F.R. 1508.13).

Focal Conservation Target. A suite of conservation targets that for purposes of planning are sorted and condensed to represent threats to biological integrity, diversity, and environmental health at the refuge level.

GAP analysis. Analysis done to identify and map elements of biodiversity that are not adequately represented in the nation's network of reserves. It provides an overview of the distribution and conservation status of several components of biodiversity, with an emphasis on vegetation and terrestrial vertebrates.

Goal. Descriptive, open-ended, and often broad statement of desired future conditions that conveys a purpose but does not define measurable units (Service Manual 602 FW 1.5).

Habitat. Suite of existing environmental conditions required by an organism for survival and reproduction. The place where an organism typically lives.

Habitat Connectivity (Also Landscape Connectivity). The arrangement of habitats that allows organisms and ecological processes to move across the landscape; patches of similar habitats are either close together or linked by corridors of appropriate vegetation. The opposite of fragmentation.

Habitat Management Plan. A plan that guides refuge activities related to the maintenance, restoration, and enhancement of habitats for the benefit of wildlife, fish, and plant populations.

Habitat Restoration. Management emphasis designed to move ecosystems to desired conditions and processes, and/or to healthy ecosystems.

Headquarters. An administrative center.

Historic Conditions. Composition, structure, and functioning of ecosystems resulting from natural processes that we believe, based on sound professional judgment, were present prior to substantial human related changes to the landscape (Service Manual 601 FW 3).

Hydrology. A science dealing with the properties, distribution, and circulation of water on and below the earth’s surface and in the atmosphere.

Hydrograph. A graph of water flows in a river or stream. A hydrograph provides a way of seeing seasonal and yearly changes in the flow or discharge of a waterway.

Hydroperiod. A segment of a hydrograph for a specific timeframe.

Indicator. Something that serves as a sign or symptom.

Inholding. Refers to lands within a refuge’s approved acquisition boundary that are not owned by the U.S. Fish and Wildlife Service. These can be private lands or lands owned by city, county, state, or other Federal agencies.

Interpretation. A teaching technique that combines factual information with stimulating explanation. Frequently used to help people understand natural and cultural resources.

Interpretive Trail. A trail with informative signs, numbered posts that refer to information in a brochure, or where guided talks are conducted for the purpose of providing factual information and stimulating explanations of what visitors see, hear, feel, or otherwise experience while on the trail.

Invasive Species. Species of plants and animals that have the potential to rapidly colonize and dominate an area.

Issue. Any unsettled matter that requires a management decision (e.g., a Service initiative, opportunity, resource management problem, a threat to the resources of the unit, conflict in uses, public concern, or the presence of an undesirable resource condition) (Service Manual 602 FW 1.5).

Land Protection. The acquisition of fee-title, easement, or lease of a given land parcel to protect important natural resource values on the land from incompatible land uses.

Landform. A natural feature of a land surface.

Maintenance. The upkeep of constructed facilities, structure and capitalized equipment necessary to realize the originally anticipated useful life of a fixed asset. Maintenance includes preventative maintenance; cyclic maintenance; repairs; replacement of parts, components, or items of equipment, periodic condition assessment; periodic inspections, adjustment, lubrication and cleaning (non-janitorial) of equipment; painting, resurfacing, rehabilitation; special safety inspections; and other actions to ensure continuing service and to prevent breakdown.

Maintenance Management System. A national database of refuge maintenance needs and deficiencies. It serves as a management tool for prioritizing, planning, and budgeting purposes.

Managed Field. Refuge grasslands maintained for winter goose forage by mowing, haying, grazing, or burning.

Mean High Water. The average level of the surface of the river, used as a standard in determining land elevation or sea depths.

Mean Higher High Water. The average of the two high waters of any tidal day.

Migration. The seasonal movement from one area to another and back.

Migratory Birds. Those species of birds listed under 50 C.F.R. 10.13, chapter 1-USFWS, DOI.

Monitoring. The process of collecting information to track changes of selected parameters over time.

Monoculture. Vegetation composed primarily of a single species, such as in areas dominated by invasive weeds.

Native Species. With respect to a particular ecosystem, a species that, other than as a result of an introduction, historically occurred or currently occurs in that ecosystem. (Service Manual 601 FW 3).

National Wildlife Refuge. A designated area of land, water, or an interest in land or water within the National Wildlife Refuge System.

National Wildlife Refuge System. Various categories of areas administered by the Secretary of the Interior for the conservation of fish and wildlife, including species threatened with extinction; all lands, waters, and interests therein administered by the Secretary as wildlife refuges; areas for the protection and conservation of fish and wildlife that are threatened with extinction; wildlife ranges; games ranges; wildlife management areas; or waterfowl production areas.

Neotropical Migrant. A bird that winters in southern Mexico, Central and South America, or the West Indies and migrates northward to breed in North America.

Non-native Species. An introduced species that did not naturally occur in an area. See also exotic species.

Nonpoint Source. Coming from more than one location. Frequently refers to pollution or erosion that comes from a widespread area and accumulates in streams and rivers.

Noxious Weed. A plant species designated by Federal or state law as generally possessing one or more of the following characteristics: a ggressive or difficult to manage; parasitic; a carrier or host of serious insect or disease; or non-native, new, or not common to the United States, according to the Federal Noxious Weed Act (PL 93-639), a noxious weed is one that causes disease or had adverse effects on man or his environment and therefore is detrimental to the agriculture and commerce of the United States and to the public health.

Objective. An objective is a concise target statement of what will be achieved, how much will be achieved, when and where it will be achieved, and who is responsible for the work. Objectives are derived from goals and provide the basis for determining management strategies. Objectives should be attainable and time-specific and should be stated quantitatively to the extent possible. If objectives cannot be stated quantitatively, they may be stated qualitatively (Service Manual 602 FW 1.5).

Old Field. Refuge grasslands left relatively unmanaged to provide food and cover for a variety of native wildlife. Control of noxious weeds does occur on old fields.

Operations. Activities related to the normal performance of the functions for which a facility or item of equipment is intended to be used. Costs such as utilities (electricity, water, sewage) fuel, janitorial services, window cleaning, rodent and pest control, upkeep of grounds, vehicle rentals, waste management, and personnel costs for operating staff are generally included within the scope of operations.

Outreach. The process of providing information to the public on a specific issue through the use of the media, printed materials, and presentations.

Pacific Flyway. One of several major north-south travel corridors for migratory birds. The Pacific Flyway is west of the Rocky Mountains.

Palustrine. Freshwater wetlands that are less than 2 meters deep at low water. They do not include areas regularly impacted by waves or part of a bedrock shoreline. They are familiarly known as marshes, swamps, bogs, wet meadows, prairies, and small shallow ponds.

Plant Association. A classification of plant communities based on the similarity in dominants of all layers of vascular species in a climax community.

Plant Community. An assemblage of plant species unique in its composition; occurs in particular locations under particular influences; a reflection or integration of the environmental influences on the site such as soils, temperature, elevation, solar radiation, slope, aspect, and rainfall; denotes a general kind of climax plant community (e.g., ponderosa pine).

Preferred Alternative. This is the alternative determined [by the decision maker] to best achieve the Refuge purpose, vision, and goals; contributes to the Refuge System mission, addresses the significant issues; and is consistent with principles of sound fish and wildlife management.

Preplanning. The first phase of comprehensive conservation planning process. It includes identifying the planning area and data needs; establishing the planning team and planning schedule; reviewing available information; preparing a public involvement plan and conducting internal scoping.

Priority Public Uses. Hunting, fishing, wildlife observation and photography, environmental education and interpretation were identified by the National Wildlife Refuge System Improvement Act of 1997 as the six priority public uses of the National Wildlife Refuge System.

Priority Species. Fish and wildlife species that the Washington Department of Fish and Wildlife believe require protective measures and/or management guidelines to ensure their perpetuation. Priority species include the following: 1) state-listed and candidate species; 2) species or groups of animals susceptible to significant population declines within a specific area or statewide by virtue of their inclination to aggregate (e.g., seabird colonies); and 3) species of recreation, commercial, and/or Tribal importance.

Public. Individuals, organizations, and groups; officials of Federal, state, and local government agencies; Indian Tribes; and foreign nations. It may include anyone outside the core planning team. It includes those who may or may not have indicated an interest in Service issues and those who do or do not realize Service decisions may affect them.

Public Use Area. A designated area within the Willapa NWR which is open to the public.

Raptor. A category of carnivorous birds, most of which have heavy, sharp beaks and strong talons, and take live prey (e.g., peregrine falcon, bald eagle).

Refuge Operating Needs System. A national database of unfunded refuge operating needs required to meet and/or implement station goals, objectives, management plans, and legal mandates. It is used as a planning, budgeting, and communication tool describing funding and staffing needs of the Refuge System.

Refuge Purpose(s). The purpose(s) specified in or derived from the law, proclamation, executive order, agreement, public land order, donation document, or administrative memorandum establishing, authorizing, or expanding a refuge, a refuge unit, or refuge subunit (Service Manual 602 FW 1.5).

Research Natural Area. A federal land designation that establishes areas with predominantly natural conditions and processes for research and educational purposes.

Restoration. The act of bringing back to a former or original condition.

Revenue Sharing. Service payments (government lands are exempt from taxation) made to counties in which national wildlife refuges reside. These payments may be used by the counties for any governmental purpose such as, but not limited to, roads and schools.

Riparian. Refers to an area or habitat that is transitional from terrestrial to aquatic ecosystems; including streams, lakes wet areas, and adjacent plant communities and their associated soils which have free water at or near the surface; an area whose components are directly or indirectly attributed to the influence of water; of or relating to a river; specifically applied to ecology, "riparian" describes the land immediately adjoining and directly influenced by streams. For example, riparian vegetation includes any and all plant life growing on the land adjoining a stream and directly influenced by the stream.

Riverine. Flowing perennial to intermittent waters bounded by a channel. This habitat encompasses a river or stream, its channel, and the associated aquatic vegetation.

Salmonid. A category of fish that includes salmon, steelhead, and trout.

Scoping. Using news releases, and other appropriate media to notify the public of the opportunity to participate in the planning process and to help identify issues, concerns, and opportunities related to the project.

Seral. Of or relating to an ecological sere; a seral stage.

Songbirds (Also Passerines). A category of birds that are medium to small, perching landbirds. Most are territorial singers and migratory.

Special Status Species. Fish, wildlife and plant species that have special conservation status because they have been listed under one or more authorities such as Endangered Species Act, state-listed species, Birds of Conservation Concern, and others.

Step-down Plan. A step-down plan provide the details necessary to implement management strategies identified in the comprehensive conservation plan (Service Manual 602 FW 1.5).

Strategy. A specific action, tool, or technique or combination of actions, tools, and techniques used to meet unit objectives (Service Manual 602 FW 1.5).

Threatened Species (Federal). Species listed under the Endangered Species Act that are likely to become endangered within the foreseeable future throughout all or a significant portion of their range.

Threatened Species (State). A plant or animal species likely to become endangered in Washington within the near future if factors contributing to population decline or habitat degradation or loss continue.

Threshold. The lowest level or intensity at which a stimulus is perceptible or can produce an effect. This term is sometimes used in connection with monitoring the effects of public uses on natural resources.

Turbidity. A measurement of clarity of water based on particles suspended in the water. It is measured with a nephelometer, which indicates the amount of light that passes through (or is scattered by) a column of water.

Vegetation Type (Also Habitat Type, Forest Cover Type). A land classification system based upon the concept of distinct plant associations.

Vision Statement. A concise statement of the desired future condition of the planning unit, based primarily upon the System mission, specific refuge purposes, and other relevant mandates (Draft Service Manual 602 FW 1.5).

Watershed. The region or area drained by a river system or other body of water. (Webster's II).

Wetlands. Wetlands are lands transitional between terrestrial and aquatic systems where the water table is usually at or near the surface or the land is covered by shallow water at some time during the growing season of each year (Service Manual 660 FW 2).

Wildlife-dependent Recreation. Hunting, fishing, wildlife observation and photography, environmental education and interpretation. These are also referred to as priority public uses of the National Wildlife Refuge System.

Appendix K. South Willapa Bay Conservation Area Draft Forest Landscape Restoration Plan

SOUTH WILLAPA BAY CONSERVATION AREA

A joint project of The Nature Conservancy and Willapa National Wildlife Refuge

FOREST LANDSCAPE RESTORATION PLAN

Draft – July 10, 2007

South Willapa Bay Conservation Area Forest Landscape Restoration Plan

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Acknowledgements:

Development of this plan has been a collaborative effort that has received help from numerous individuals and organizations. Leading into this project, Coastal Watersheds Consulting conducted numerous inventories and analysis at Ellsworth Creek over the years that were essential in developing this plan. The foresters at Integrated Resources Management conducted the forest inventories that were essential to considering and modeling treatment options. Steve Rentmeester's work provided valuable insight into health and function of the riparian forests and fish bearing streams at Ellsworth Creek. At the tail end, the Conservancy's new Willapa Forester, Bill Lecture provided a critical review with an eye to the practical and made the plan his own.

This project was envisioned and completed in partnership with the Willapa National Wildlife Refuge and their contributions were indispensable in this cooperative effort. Refuge biologists, Marie Fernandez and Kirsten Brennan, imparted critical insight into refuge specific forest management goals and past research and data availability, and also provided review of the plan. The support and guidance of the refuge Project Leader, Charlie Stenvall was vital to ensuring that the plan is scientifically rigorous, yet useful for operational planning purposes.

Funding for this project was provided, in part, by the U. S. Fish and Wildlife Services Jobs In The Woods Program, the Department of the Interior's Cooperative Conservation Initiative and by the Nestucca Oil Spill Revised Restoration Plan (USFWS 2004).

The Nature Conservancy would like to thank Derek Churchill, Andrew Larson, and Kevin Cedar for the rigor and detail they applied to considering the central question that this plan aims to answer; how do we restore ecological function to young overstocked coastal forests? Their deep personal interest in the finer points of coastal forest ecology is clearly evident in this plan.

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List of Acronyms and Abbreviations

B-IBI -- Benthic Index of Biotic Integrity
BPA -- Bonneville Power Administration
BR -- Biomass removal thinning treatments
CCI -- Cooperative Conservation Initiative
CWD -- Coarse Woody Debris
DBH-- Diameter at Basal Height
DFC -- Desired Future Condition
ENSO -- El Nino/Southern Oscillation
FSC --- Forest Stewardship Council
FVS --- Forest Vegetation Simulator
HD(R) -- Height to Diameter Ratio
IRM --- Integrated Resource Management
LCR --- Live crown ratio
LMS -- Landscape Management System
MDL -------------------------------- Mature drop and leave thinning treatments
MOGI --- Modified Old-Growth Index
MOU --- Memorandum of Understanding
NCC -- Nature Conservancy of Canada
PCT -- Pre-commercial thinning treatments
PDO -- Pacific Decadal Oscillation
QMD --- Quadratic Mean Diameter
RNA -- Research Natural Area
SDI -- Stand Density Index
SVS -- Stand Visualization System
SWBCA ------------------------------------ South Willapa Bay Conservation Area
TIMO ------------------------- Timber Investment Management Organization
TNC --- The Nature Conservancy
TPA -- Trees per Acre
UM ------ Understory, variable density thinning treatments and management
USFWS --------------------------------- United States Fish and Wildlife Service
VDT -- Variable Density Thinning
WADNR ------------------------ Washington Department of Natural Resources
WADOE ----------------------------------- Washington Department of Ecology
WDFW ------------------------- Washington Department of Fish and Wildlife
WNWR -- Willapa National Wildlife Refuge
YDL ---------------------------------- Young drop and leave thinning treatments

Introduction

1. *Purpose and Need*

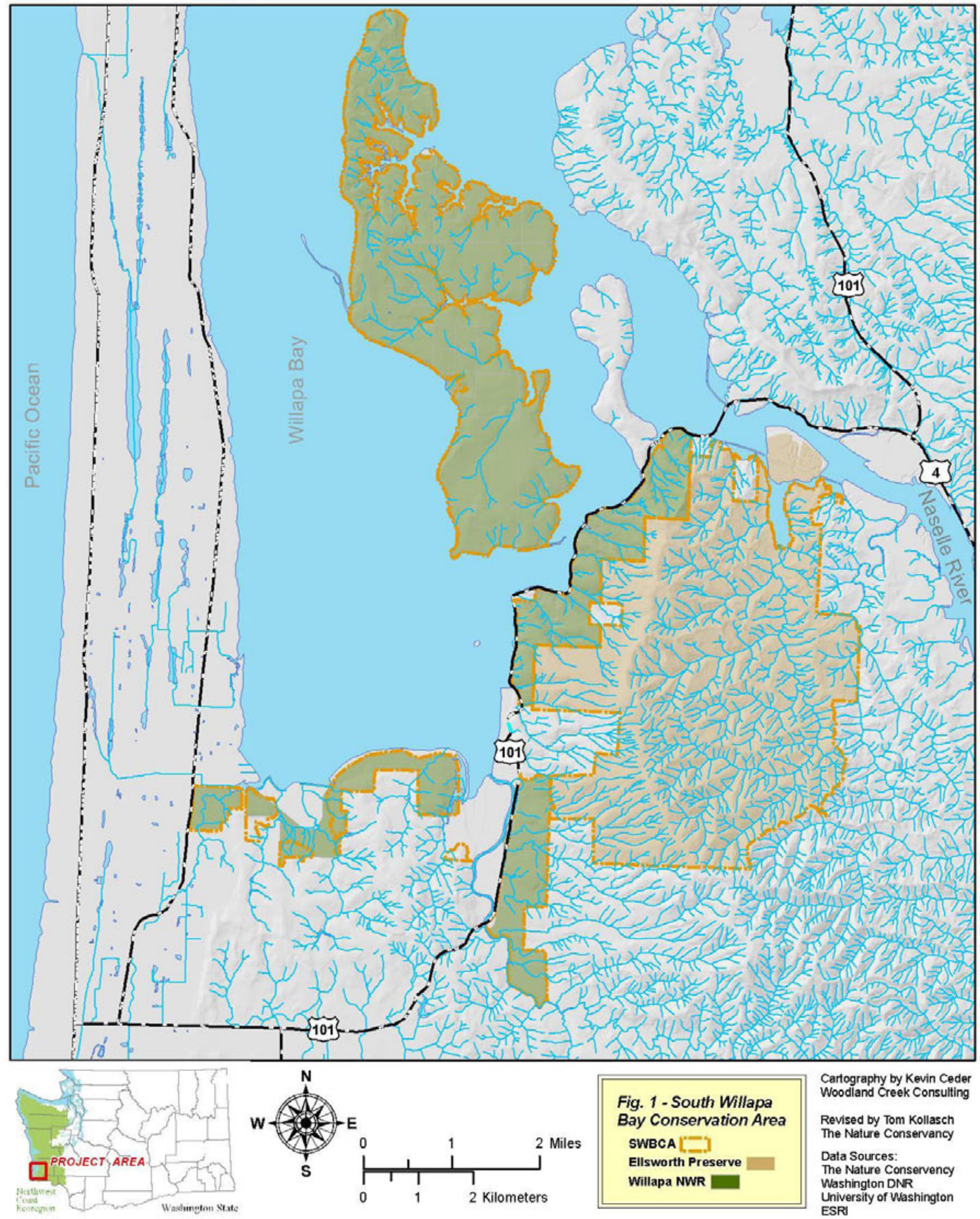
In July of 2003, The Nature Conservancy ("the Conservancy") and U.S. Fish and Wildlife Service signed a Memorandum of Understanding for the purpose of "collaborating to accomplish forest management goals and objectives" on properties managed by both parties in Pacific County, Washington. Thus began a partnership to restore young-managed forestlands at a landscape scale across the Conservancy's Ellsworth Creek Preserve the neighboring Willapa National Wildlife Refuge (the "Refuge"). Financial resources to support this work have been secured, in part, through the U. S. Fish and Wildlife Service's Jobs In The Woods Program (FWS Agreement #134103J007), the Department of Interior's Cooperative Conservation Initiative (Cooperative Agreement 135524J115), Nestucca Oil Spill Revised Restoration Plan (USFWS 2004), and private funds from individuals and foundations. The following management plan was prepared to provide specific goals and management guidance over the next 20 years for this restoration effort within the Refuge and Conservancy's terrestrial ownership, hereafter referred to as the "South Willapa Bay Conservation Area" (SWBCA), (Figure 1 – South Willapa Bay Conservation Area).

Old-growth western redcedar at Teal Slough

Forests within the SWBCA have been managed for timber production over most of the last century. Today, less than 5% of the area remains as unmanaged or old-growth forest habitat. Extensive forest management has profoundly changed ecological conditions within the landscape. The dominant, simplified young-managed forests do not support several species that are dependent on complex old-growth forests including the federally listed marbled murrelet (*Brachyramphus marmoratus*) and Northern spotted owl (*Strix occidentalis caurina*). Streams are altered from high sediment loads and scouring, and extensive forest road systems fragment habitat and modify hydrological processes. Low-elevation coastal old-growth forests in South Willapa Bay, however, provide habitat for an especially diverse array of species while also supporting natural ecological processes that maintain healthy freshwater stream systems and adjacent estuarine habitats. Because of the rarity and biological significance of old-growth forest ecosystems in the Willapa Hills of Washington, the Conservancy and Refuge are working together to restore a forested landscape that is representative of past, unmanaged, landscape conditions.

Restoration actions, or active management, will primarily include (1) carefully designed density management (ie. thinning) within young-managed forest stands (< 90 years old) to promote forest growth and the development of habitat complexity, (2) the removal, or repair of high risk forest roads, and (3) improvement to the existing forest road network to minimize impacts to water quality. This landscape restoration plan outlines the management direction and implementation schedule for specific restoration actions that are anticipated over the following 20 year period. The plan provides detail on management goals, conservation significance, existing natural and cultural resources, desired future conditions, planning considerations, management approach, implementation schedule, and monitoring. While the Conservancy and Refuge recognize that restoration of forest ecosystems within the SWBCA will play out over the next century or longer, we anticipate that the next 10-20 years are critical for altering the ecological trajectory of this important landscape toward a trend that supports the recovery of our mutual conservation values.

South Willapa Bay Conservation Area



2. *Management Philosophy and Goals*

The intent of management within the SWBCA is to restore self sustaining, natural, ecological processes and healthy forest and stream systems, as opposed to engineering or manipulating habitats to meet specific structural or compositional targets. The Conservancy and Refuge propose to do this by abating threats to the landscape and/or sources of habitat degradation. The major identified threats include extensive forest road systems, simplified forest and stream habitats, increased sediment loads in stream systems, and invasive species. Restoration and management practices will be based upon the best science available with the level of active management varying across the landscape. Monitoring and refinement of management practices will occur as a key component of the restoration process.

A core assumption of this landscape restoration project is that young-managed forest landscapes can, over long time periods, develop ecological conditions that are comparable to unmanaged or late-successional forest landscapes found within the same physiographic province. The Conservancy and Refuge recognize that existing unmanaged forest landscapes developed under unique environmental conditions and that those histories cannot be replicated (Spies et al. 2002b). Remaining unmanaged stands represent only a small proportion of the representative habitat diversity that once existed on the landscape. Thus, metrics from the remaining remnant forests will only be used as an initial template for comparison, not as an ultimate target to reach and maintain throughout the landscape. The goal is to restore a dynamic and resilient, naturally functioning forest system, not to artificially hold the landscape in a defined old-growth state (i.e., to balance the affects of continued logging in the surrounding region). The Conservancy and Refuge believe that significant portions of the SWBCA should develop complex forest canopy and understory structures, high levels of standing and downed wood, dynamic and complex stream habitats, diverse species communities, and resilience to natural disturbances that are typical of unmanaged late-successional forest landscapes in the Pacific Northwest (Franklin J.F. and Spies 1991, Naiman et al. 2000).

Specific goals for each partner are outlined below.

The Nature Conservancy

The Conservancy is an international nonprofit conservation organization whose mission is to preserve plants, animals and natural communities that represent the diversity of life on Earth by protecting the lands and waters they need to survive. Since its establishment in 1951, the Conservancy has been responsible for protecting more than 15 million acres in the United States and more than 102 million acres in Latin America, the Caribbean, Asia and the Pacific. The Conservancy works in all 50 states and 28 countries. The Nature Conservancy of Washington was established in 1979 and began acquiring properties as part of the Ellsworth Creek Preserve in 1998. Currently, the Ellsworth Creek Preserve is approximately 7,436 acres in size, encompassing almost the entire Ellsworth Creek watershed, and includes upland forest and estuarine habitats, and freshwater stream systems.

Primary goals for the Ellsworth Creek Preserve include:

1. Restore ecologically functional estuarine, freshwater, and upland forest habitats that support species and ecological processes representative of those found within unmanaged late-successional forest landscapes of the Pacific Northwest coast.
2. Develop and implement restoration strategies that accomplish ecological goals in a cost effective and financially replicable manner.
3. Maximize opportunities for learning how coastal forest landscapes respond to restoration treatments and export those lessons to other forest resource managers.
4. Manage the preserve with exemplary stewardship that earns respect and builds productive relationships within the local community and amongst resource management partners.
5. Attain and maintain Forest Stewardship Council (FSC) certification.
6. Serve as a contributor to positive carbon sequestration.

The Conservancy has been a member of the Forest Stewardship Council (FSC) since 2001 and holds a certificate as a certified forest manager for over 250,000 acres. The Conservancy intends to pursue FSC certification at its Ellsworth Creek Preserve and believes certification is an important forest conservation tool because it can:

- Integrate socio-economic values/concerns into forest management activities;
- Ensure that any active management on Conservancy owned and managed lands is consistent and meets an internationally recognized standard of management;
- Provide independent verification and monitoring of forest management and chain of custody practices that help reduce illegal logging; and,
- Create incentives for sound forest management by providing some landowners with better access to certain markets and price premiums for certified product.

Willapa National Wildlife Refuge

The Refuge was established in 1937 as a refuge and breeding ground for migratory birds and other wildlife in and around Willapa Bay (Executive Order 7541, dated Jan. 22, 1937). The Refuge currently manages approximately 15,000 acres including coastal dunes and beaches, intertidal mudflats, saltwater and freshwater marshes, grasslands and forestlands. The terrestrial portion of the Refuge is approximately 7,726 acres, including 362 acres designated as a Research Natural Area (RNA).

Refuge goals related to forest management include:

1. To preserve and protect unique ecosystems associated with Willapa Bay
2. To manage for the conservation and recovery of threatened and endangered animals in their natural ecosystems.

Under these goals the Refuge has developed specific objectives related to the forest management program.

1. Restore ecological function to Refuge forests by creating a natural distribution of stand structure, composition, and successional stages while promoting old-growth/late successional characteristics to benefit forest dependent wildlife – especially the marbled murrelet.
2. Decommission unnecessary forest roads to reduce/eliminate stream impacts and fragmentation of forest habitat.
3. Adopt forest management practices designed to change fire prone thickets of western hemlock over a period of time to something that structurally resembles old-growth and reduces fuel loads.
4. Protect, and where appropriate, restore associated stream habitat to prevent further declines of anadromous fish stocks and enhance native amphibian populations and other stream dependent wildlife species.
5. Reduce risk from insects and disease where endemics are likely.

Research Natural Areas

The Diamond Point (88 acres) (Dyrness 1972) and Cedar Grove Research Natural Areas (274 acres) (Atkinson 1987)are both located within the SWBCA, on Long Island. Research natural areas are established on federal lands: (1) to preserve examples of all significant natural ecosystems for comparison with those influenced by humans; (2) to provide educational and research areas for ecological and environmental studies; (3) to preserve gene pools of typical and endangered plants and animals (WADNR 2005). Activities on Research Natural Areas are limited to research, study, observation, monitoring, and educational activities that are non-destructive, non-manipulative, and maintain unmodified natural conditions. These areas were designated due to the high quality vegetation communities found at each site and no active management is proposed at either site within this plan.

OVERVIEW OF THE SOUTH WILLAPA BAY CONSERVATION AREA

Late-successional forest at Ellsworth Creek

A. PHYSIOGRAPHIC SETTING

1. *Climate and Climatic Variation*

The SWBCA has a mild, maritime climate. Annual precipitation at nearby Long Beach, WA and Naselle, WA averaged 80" for the period 1967-2005 and 114" for the period 1948-2005, respectively (NOAA 2007). Precipitation is lowest during July and August, however the summer drought is moderated by low clouds and fog (Franklin J. F. and Dyrness 1988). Fog condensation on tree crowns and subsequent fog drip is an additional source of precipitation (Ruth and Harris 1979), which may be of ecological significance during summer months (Dawson 1998). Temperatures are moderate; temperatures at Long Beach, WA range from a mean high of 66.8 F in August and September to a mean low of 36.0 F in January (NOAA 2007).

Climatic conditions are variable at both long (millennial) and short (annual-decadal) time scales. The primary forcing of long-term climate variation in this region is changing patterns of seasonal insolation, which is in turn controlled by variation in the Earth's tilt and orbital pattern (Berger 1991, Heusser C.J., L.E. Heusser, D.M. Peteet. 1985). Long-term climatic variation of this nature has led to substantial changes in the vegetation composition throughout the Pacific Northwest (Whitlock 1992). At the annual and decadal scales, El Nino/Southern Oscillation (ENSO) (Diaz and Markgraf 2000) and Pacific Decadal Oscillation (PDO) (Biondi 2001, Mantua 1997), respectively, and interactions between these two climatic oscillations (Newman 2003) are important sources of climatic variation, influencing both temperature and precipitation. Individual tree growth and forest ecosystem productivity in the PNW respond to annual and decadal climate variation (Peterson David W. and Peterson 2001). Particularly relevant to the SWBCA site management are the recent findings that summer temperature and PDO influence growth in coastal low elevation forests in western Washington (Nakawatase and Peterson 2006). Sitka spruce (*Picea sitchensis*) forests exhibit very high sensitivity to environmental variation, with potential for extreme growth response to climate variation (Holman 2006).

2. *Geology & Soils*

The Ellsworth creek drainage and the lands with the Willapa National Wildlife Refuge are located in the southwestern portion of the Willapa Hills subprovince of the Coast Range physiographic province. All waters drain into Willapa Bay. Ellsworth creek lies within the lower Naselle River watershed, while Conservancy and Refuge lands to the south and west of Bear River Ridge are part of the Bear River watershed unit. Long Island comprises its own watershed unit. Elevation ranges from sea level along Willapa Bay to 1,715 feet along Bear River Ridge. The area covered by this plan can be divided into 2 physiographic zones with distinct geological, topographic, and soil characteristics (Table 1): Coastal hills, and Long Island, alluvial zones and former sand dunes.

Coastal hills

The coastal hills have rounded topography and deep weathering profiles. The landscape is highly dissected, and the drainage network is dendritic. Marine sedimentary rock from the late Eocene through early Miocene (60 to 20 million year old) underlies most of this zone and consists of thin-bedded, laminated tuffaceous siltstones and lesser amounts of sandstone (Wells 1989). Middle Miocene intrusions of basalt also exist and are much more resistant than the surrounding sedimentary rocks. This contrast in rock hardness has resulted in the development of locally steeper slopes and higher relief, as evidenced by Bear River Ridge (Wells, 1989). Due to lack of glaciation during the last 2 million years, soils and exposed bedrock are highly weathered. Thick soils have developed on stable upland surfaces and slopes range from very gentle to over 200%.

Three major geologic formations exist that have corresponding geomorphic features (Map – SWBCA Landforms). The Lincoln Creek formation consists of steep, dissected hill slopes west of the Bear River

Ridge divide and west of Ellsworth Creek (Wegmann 2004) where soils are primarily from the Palix and Narel Series (Map – SWBCA Soils). These deep, well drained soils were generally formed in mixed slope deposits derived from sandstone and siltstone consisting of silt loams and silty clay loams with 10-30% pebble sized rock fragments. Depth to partly consolidated sandstone ranges from 40 to 60 inches. Available water capacity is high and water moves readily through these soils.

The Grand Ronde Basalt formation contains steep escarpments of Bear River Ridge associated with resistant invasive Columbia River basalt flows. Soils are highly weathered basalts from the Vesta series on ridge tops and the Knappton series on side slopes. These deep, well drained soils consist of silt loams and gravelly, silty clay loams with 0-30% pebble sized rock fragments. Depth to weathered, fractured basalt ranges from 40 to 60 inches. Available water capacity is high and water moves readily through these soils.

Figure 2. Landslide risk is generally moderate within the SWBCA although higher risks are associated with roads.

The Shoalwater Bay formation consists of moderately-to-low dissected hill slopes and bluffs west and north of Bear River Ridge that slope gently towards Willapa bay. Soils are weathered sandstones and siltstones from the Palix, Illwaco, Leban, and Treham series, with some intrusions of Knappton soils. The Illwaco and Leban series are similar to the Palix series, while the Treham series is similar to Knappton. Intrusion of basalt and more recent estuarine deposits mixed in and make for complex geology.

All of the soils in coastal hills of the SWBCA are medial, mesic Andic Haplumbrepts (Pringle 1986). These fine textured soils, in combination with the abundant rainfall, give the area high soil productivity. King (1966) 50 year Douglas-fir (*Psuedotsuga menzesii*)site index taken from Cambell Group cruise data ranges from 107-145, and is site class 2 in most places with some site 1 and site 3. Barnes (1962) 50 year western hemlock site index ranges from 90-128 (Map – SWBCA Site Index: 50 year Western Hemlock), and maximum annual volume increment for a fully stocked 50 year old western hemlock (*Tsuga heterophylla*) stand ranges from 214-272 cubic feet per acre per year or 1170 – 1486 board feet per acre per year (Pringle 1986).

The combination of steep slopes, susceptible bedrock types, and significant precipitation makes the area susceptible to landslides. Wegmann (2004) conducted a historical review of landslide activity and an analysis of landslide risk in the lower Naselle watershed. Using data from Powell et al. (2003) he rated overall landslide potential as moderate when compared to other drainage basins in the Olympic and Cascade mountain ranges. He also found that over 90% of past landslides occurred on concave-to-planar slopes of bedrock hollows, inner gorges, and convergent headwalls, especially on slopes greater than 70% in the Grande Ronde Basalt and Lincoln Creek Formations. Based on these factors, mass wasting risk was evaluated for areas within the Ellsworth watershed (Map – Ellsworth Creek Unstable Landforms). The 2000 Washington State DNR slope stability ratings based on the SLPSTAB model (Washington State Department of Natural Resources 2006) are also included in a landslide susceptibility model for both ownerships (Map – SWBCA Slope Stability Hazard).

While most landslides have been shallow rapid slides or debris flows, there have been some deep seated landslides that affect much larger areas and consist of poorly sorted colluvium and bedrock slump blocks. While the risk of further shallow, subsidiary landslides within these previous events is minimal, steep headscarps and over-steepened toes of some of the deep-seated slides are susceptible to increased shallow landslide activity, especially if forest roads are constructed across them. In general, Wegmann's (2004) analysis found that forestry activities have greatly hastened landslide activity and roughly 85% of the 319 landslides since 1958 were related to forestry activities (Wegmann 2004). In a separate analysis of the Ellsworth creek drainage, Powell et. al (2003) found that of the 86 landslides that have occurred since 1946, 52 were road related and 34 were related to clear cut harvests. Approximately 110 acres were affected and 87% of slides resulted in disturbance and or sediment delivery to stream channels.

Long Island, alluvial zones, and former sand dunes

Long Island and other marine terraces bordering Willapa Bay are comprised of estuarine terraces and alluvial deposits that are generally flat to gently sloped (Wells 1989). They consist of unconsolidated to semi-consolidated mud and silt with sand lenses. Terrace surfaces occur up to 260 feet above the modern sea level. Dissection of terrace surfaces increases with increasing elevation above sea level, yet, the overall dissection of these deposits is minimal, likely owing to their relatively young age and minimal topographic gradient (Wegmann 2004).

The marine terraces consist of uplifted and wave cut terraces of highly stratified Willapa Bay esturiane sediments that were laid down over the last 2 million years (Quaternary) as sea levels fluctuated. These terraces occur on Long Island and parts of the mainland shoreline areas and often overlay older, consolidated sandstone that can be seen on Long Island cliffs. Basalt intrusions are also present. Due to rapid weathering, geological history is not well known in many cases. Soils are primarily from the Willapa and Ilwaco series and are deep, moderately drained soils that consist of silt loam in the 8-20 inch surface horizons and mottled, silty clay loams below (Pringle 1986). Available water capacity is high. A small portion of these terraces have Newskaw soils, which are loams in the surface horizons and fine sand below. These soils are medial, mesic Andic Haplumbrepts.

In estuaries, floodplains, and low terraces of the major streams entering Willapa Bay, soils are derived from recent alluvial sediments. Soils from the Ocosta series are the most prevalent (Pringle 1986). This very deep, poorly drained soil occurs in flood plains and deltas of coastal bays ands consists of silty clay loam and silty clay. Other similar, minor soil series include Nuby and Montesa. These soils are mesic Typic Fluvaquents. The Aabab series occurs in terraces along streams and is a silt loam. The small area of the Wildlife Refuge on the Willapa Spit consists of former sand dunes where soils are from the Netarts and Yaquina series.

Soil productivity of marine terrace areas tends to be a little lower than in the coastal hills, but is still quite high on most soil types. Risk of mass wasting is generally low, except on steep slopes along the edge of the Willapa Bay Estuary that have a history of landsliding in response to forest management activities. Both shallow-rapid and small deep-seated failures have occurred here on slopes averaging 34%, indicating a lower slope threshold for landslide risk than in the coastal hills (Wegmann 2004).

Table 1: Proportion of area within each soil series and the corresponding site index.

Soil ID #	Series Name	WNWF % Cover	TNC % Cover	WH Site Index[1]	RA Site Index[2]
111-116	Palix	18%	39%	111	
155-160	Willapa	36%	0%	108	
89	Narel	0%	28%	104	
49-54	Ilwaco	24%	1%	103	
59-61	Knapton	2%	16%	104	
149-150	Vesta	1%	12%	112	
104	Ocosta	10%	0%		94
1	Aabab	0%	3%		100
95-96	Newskah	3%	0%	105	
65-66	Lebam	1%	1%	112	
162	Yaquina	2%	0%		90
102	Nuby	1%	0%		103
79	Montesa	1%	0%		102
144	Traham	1%	0%	92	
108	Orcas	1%	0%		
92	Netarts	1%	0%	107	

[1] Western Hemlock site index is 50yr from Barnes 1962.
[2] Red Alder site index is from Chambers (1974)
Soil Series are from Pringle (1986).

B. CONSERVATION SIGNIFICANCE

From a local to global perspective the SWBCA is an area of particularly high conservation significance. While the large estuarine ecosystem of Willapa Bay is renowned for the ecological and economic value of its marine resources and its shorebird migrations of hemispheric importance (Wolf 1993),populations (Wolf 1993) the forest and freshwater systems also harbor a rich diversity of species and habitats. Low elevation coastal rainforest habitats, such as those found in the conservation area, only occur in a few disparate regions of the world and are typified by high productivity. The forests of the SWBCA provide habitat for diverse assemblages of species, from familiar vertebrate species and abundant salmon to the less know, like fungi, lichens, bryophytes, and many groups of invertebrates such as mollusks and millipedes. These species, and others, all play key roles in functional pathways within the forest, such as decomposition and nutrient cycling. Amphibians are another important group of species within these forests and surveys by the Conservancy have shown the area to have some of the highest species richness in the Pacific Northwest.

Regional conservation assessments for the marbled murrelet and the Pacific Northwest Coast Ecoregional Assessment (The Nature Conservancy et al. 2006) have further substantiated the significance of this conservation area. Over the last several years, the Conservancy has worked with key partners to develop scientifically-rigorous conservation assessments for every North American ecoregion. These comprehensive assessments evaluate the full spectrum of biodiversity within a given ecoregion, identifying areas of biological significance where conservation efforts have the greatest value and potential success. The recently completed Pacific Northwest Coast Ecoregional Assessment(Vander Schaaf et al. 2006) was the product of a partnership initiated in 2001 to identify priority conservation areas in this ecoregion. The Conservancy, the Nature Conservancy of Canada (NCC), and the Washington Department of Fish and Wildlife (WDFW) were the primary partners in this project. The stated goal for the Pacific Northwest Coast Ecoregional Conservation Assessment was to "identify the suite of conservation areas that promote the long-term survival of all native plant and animal species and natural communities in the ecoregion." The SWBCA, and surrounding estuarine and freshwater systems, were all identified in this assessment as sites of high priority for conservation.

1. *Ecological Systems and Natural Communities*

Forests of the SWBCA are located entirely within the Sitka spruce zone of Franklin and Dyrness (1988) while the Natural Heritage Program's classification describes two major ecological systems for this area of the Pacific Coast – the North Pacific hypermaritime Sitka spruce forest, and the North Pacific hypermaritime western redcedar *(Thuja plicata*)-western hemlock (*Tsuga heterophylla*) forest ((http://www.natureserve.org/getData/USecologyData.jsp) (Comer et al. 2003)). Both of these ecological systems are restricted to areas within 40 miles of the coast at low elevation (typically less than 2,000 ft) where the climate is hypermaritime, with cool summers, very wet winters, abundant fog, and without a major winter snowpack. The natural disturbance regime is mostly small-scale windthrow or other gap mortality processes, occasional widespread intense windstorms, and very few fires (a detailed description and analysis of disturbance regimes and forest development pathways in these forest types is provided in Appendix A).

Sitka spruce forests are generally found in more productive micro-sites along valley bottoms or riparian terraces. Stands are typically dominated or codominated by Sitka spruce but often have a mixture of other conifers present, such as western hemlock (often a codominant), and western redcedar. The understory is rich with shade-tolerant shrubs and ferns, including salal (*Gaultheria shallon*), evergreen huckleberry

(*Vaccinium ovatum*), swordfern (*Polystichum munitum*), *Dryopteris* spp., and deer fern (*Blechnum spicant*), as well as a high diversity of mosses and lichens.

Western red cedar- western hemlock forests often contain nearly pure stands of hemlock and thrive in this environment where they are exposed to intense windstorms. The abundance of western red cedar in relation to other conifers is one of the diagnostic characters of this forest system, as is the low abundance of Douglas-fir (*Pseudotsuga menziesii*) and Sitka spruce. A shrub layer of salal, oval-leaf huckleberry (*Vaccinium ovalifolium*), and fool's huckleberry (*Menziesia ferruginea*) is usually well-developed. The prominence of deer fern is typical of hypermaritime conditions. Oregon oxalis (*Oxalis oregano*) is also important in the understory of particularly moist microsites.

Natural plant communities of these two ecological systems are limited to forest stands that have not been harvested or where limited entry has occurred. Specific plant communities identified within the Cedar Grove Research Natural Area include the western redcedar-western hemlock/evergreen huckleberry forest (Atkinson 1987). Forests at Ellsworth Creek and within the adjacent Ellsworth Creek Natural Resource Conservation Area include the Sitka spruce/Oregon oxalis forest, Sitka spruce/salal forest, western hemlock/Oregon oxalis forest, western hemlock/salal/deerfern forest, western hemlock/swordfern forest plant communities (Chappell 1997). Because forests at the Diamond Point Research Natural Area have been harvested they are not considered natural communities by the Washington Natural Heritage Program.

2. ***Rare plants***

Two rare plants are known from the vicinity of the SWBCA (Table 2), although neither is found in upland forest habitats covered by this plan.

Table 2: Rare plants known from the South Willapa Bay Conservation Area.

Scientific Name	Common Name	Ranking	Habitat	Location
Abronia umbellate ssp. a*cutalata**	Pink sandverbena	G4G5T1QSX Species was rediscovered in Washington in 2005	Shifting sands and dunes	Leadbetter Point
Hydrocotyle ranunculoides	Floating water pennywort	GS 5	Freshwater ponds, lakes, and streams.	Ellsworth Cr. estuary

* species is under review to determine whether it is distinctive or a northern population of *Abronia umbellate* ssp. *breviflora*.

3. ***Fish & Wildlife Populations***

The forest, riparian, marsh, and tidal habitats within the SWBCA provide habitat for a large number of species. An estimated 233 species of birds, 51 species of mammals, and 17 species of amphibians and reptiles are known to occur on the Refuge (USFWS 1999). The cool, wet climate of the Willapa area makes it a "hot spot" of amphibian diversity in Washington. Habitats on the Refuge and the Conservancy's lands may support up to 13 of the 24 native amphibians that occur in the state, including several regionally endemic species (USFWS 1999).

Several species of state and federal concern occur within the SWBCA (Table 3), including the marbled murrelet, bald eagle (*Haliaeetus leucocephalus*), and a number of invertebrate (e.g., mollusks and millipedes), lichen, and fungi species. Northern spotted owls (*Strix occidentalis caurina)* were known to inhabit the old-growth forest stands on Long Island in the 1980's, but have been replaced by barred owls (*Strix varia)* (USFWS 1987). Although spotted owl vocalizations were detected in the Ellsworth Creek and Teal Slough areas in the 1990's (USFWS 1999), they are now considered extirpated from the SWBCA. Habitat restoration may improve opportunities for spotted owl recovery in the future.

Table 3: Federal and state species of concern that are known from the Ellsworth Creek Preserve. FT = federal threatened, FCo = federal species of concern, ST = State threatened, SC = State candidate

Common Name	**Scientific Name**	**Federal/State Endangered Species Status**
Marbled Murrelet	*Brachyramphus marmoratus*	FT/ST
Bald eagle	*Haliaeetus leucocephalus*	FT/ST
Aleutian Canada Goose	*Branta canadensis leucopareia*	FCo/ST
River Lamprey	*Lampetra ayresi*	FCo/SC
Columbia torrent salamander	*Rhyacotriton kezeri*	FCo/SC
Cope's giant salamander	*Dicamptodon copei*	None/SM
Red-legged frog	*Rana aurora*	FC/None
Tailed frog	*Ascaphus truei*	FCo/SM
Van Dyke's salamander	*Plethodon vandykei*	FCo/SC
Dunn's salamander	*Plethodon dunni*	None/SC
Pileated woodpecker	*Dryocopus pileatus*	None/SC
Vaux's swift	*Chaetura vauxi*	None/SC
Sea-run Cutthroat trout - Southwest WA/Lower Columbia River ESU	*Oncorhynchus clarki clarki*	FC/None
Coho Salmon - Southwest WA/Lower Columbia River ESU	*Oncorhynchus kisutch*	FC/None

Marbled Murrelet

Marbled murrelets rely on coastal mature and old-growth forests for nesting and their populations have declined along with the loss of habitat to the point where today they are listed as a federally threatened species (USFWS 1997). Existing murrelet habitat and populations in the Willapa Bay area are important to the long-term viability of the species since the area is otherwise largely devoid of nesting habitat and forms a significant distributional gap in the range of the species. The federal recovery plan for the murrelet specifically identifies the protection of existing habitat, and "increasing the amount, quality, and distribution of suitable nesting habitat" in southwest Washington, as important recovery strategies (USFWS 1997). With some of the largest remaining stands of suitable nesting habitat in the Willapa Bay region, and a goal to restore additional, functional, late-successional forest systems, the SWBCA is clearly a crucial landscape for promoting the recovery of this marine bird species.

Significant federal grants have been awarded to both the Conservancy and the Refuge for habitat acquisition specifically aimed at supporting the recovery of marbled murrelet populations. Conservation of occupied murrelet habitat is a critical first step; however, effective restoration will be important in the procurement of the additional habitat necessary to recover the species within reasonable timeframes. Therefore, landscape restoration is a specific focus of this plan. The Conservancy has developed a robust, long-term forest restoration research program at Ellsworth Creek designed to provide guidance for restoring forest complexity in formerly managed coastal forests. Lessons learned through this research will be applied more broadly within the Preserve, on the Refuge, and hopefully on other federal and private lands in the coastal region. Recognizing this significant contribution to murrelet recovery, the U.S. Fish and Wildlife Service (USFWS) has proposed excluding both ownerships from designation as critical habitat for the marbled murrelet under section 4(b)(2) of the Federal Endangered Species Act (USFWS 2006). Justification for this exclusion is based on documentation that provides:

1. A management plan that is complete and demonstrates a conservation benefit to the species.
2. Reasonable assurances that the conservation management strategies and actions will be implemented.
3. Reasonable assurances that the conservation strategies and measures will be effective.

The USFWS is expected to review this restoration and management plan to ensure that these conditions are met. Elements of our approach to marbled murrelet conservation and habitat restoration/development are described throughout the management plan. Sections of particular note include …….

Portions of stands that are known to be occupied by nesting murrelets will not be targeted for biomass removal treatments. Young-managed forest stands of unsuitable habitat with simplified forest structures and dense stocking may, however, be actively managed, following the criteria and restrictions outlined in this plan, so they develop older forest structures more quickly that are suitable for meeting suitable murrelet nesting habitat.

Salmonids

Ellsworth creek contains one of the highest spawning densities of chum salmon (*Oncorhynchus keta*) in the Willapa Bay watershed with close to 8,000 fish reported over a 0.8 mile index reach in 2002 (Washington Department of Fish and Wildlife data). Although abundant populations of coho salmon (*Oncorhynchus kisutch*) and coastal cutthroat trout (*Oncorhynchus clarki*) are reported in the Ellsworth Creek drainage, systematic inventories of most fish species have not been conductedcompleted (scheduled for summer 2007). Stream surveys conducted on the Refuge (Barndt et al. 2000, Yoshinaka and Stone 2004) have observed coho and chum salmon, cutthroat trout, riffle sculpin (*Cottus gulosus),* and threespined stickleback (*Gasterosteus aculeatus)* in varying levels in different streams and note that spawning populations are likely. Therefore, theseEach of the Refuge streams and Ellsworth Creek are classified as being strongly heterotrophic (require complex organic chemicals for metabolic synthesis). Management actions proposed in this plan are expected to improve habitat for salmonids and other anadromous fish over time; however, short term effects of active forest restoration and road removal are unknown.

Amphibians

The SWBCA is known to have some of the highest diversity of amphibian species is Washington state. In particular, surveys have found abundant populations of stream-associated amphibians in headwater tributary habitats. Species found here include Cope's giant salamander (*Dicamptodon copei*), Columbia torrent salamander (*Rhyacotriton kezeri*), Dunn's salamander (*Plethodon dunni*), Van Dyke's salamander (*Plethodon vandykei*), and the tailed frog (*Ascaphus truei*). Populations of these species have been in decline with research suggesting a relationship between intensive timber management practices and the degradation of habitat (Corn and Bury 1989). The distribution and population levels of these species are not fully known within the SWBCA. Recently initiated monitoring surveys within the Ellsworth Creek watershed should lead to a better understanding of population densities for this group of species.

Figure 3: Amphibian diversity is extremely high within the SWBCA. Here a Van Dyke's salamander is followed by a Dunn's salamander with a western red-backed salamander in the background.salamanders.

Management actions proposed in this plan are expected to improve amphibian habitat over time; however, short term effects of active forest restoration and road removal are unknown.

4. ***Potential Threats to Conservation Value***

Throughout the SWBCA lingering threats to biological diversity remain from decades of logging activity, including habitat fragmentation, invasive species, sedimentation and altered hydrology related to extensive forest road systems. Climate change may also cause significant future changes in forest community composition.

When placed in the context of surrounding industrial ownerships, where intensive forest management with short rotations continues to prevail, the Conservancy and Refuge ownerships will provide an increasingly important refugia of mature and old forest habitat for fish and wildlife species within the coastal region of northern Oregon and southern Washington.

High Risk Invasive Species

Invasive species are considered by many to be one of the top two threats to the decline of biological diversity, together with habitat loss. While invasive species are thought to be uncommon within the SWBCA quantitative information on the distribution of most species is lacking. For this plan the focus is on invasive species that are found in upland forest, riparian forest and freshwater habitats. Exotic invasive species are spreading through forest and freshwater ecosystems in the Pacific Northwest at rates that are alarming ecologists. Species such as English ivy (*Hedera helix*), holly (*Illex aquifolium*), and Japanese knotweed (*Polygonum cuspidatum*) have become well established in some areas of Pacific County and are being targeted for eradication. Others like West-nile virus, sudden oak death (*Phytophthora ramorum*), and citrus long-horned beetle *(Anoplophera chinensis*) pose an enormous future threat to the region as they spread in nearby areas and are being closely monitored. The spread of these and other exotic species and even native pathogens have benefited from climatic changes and human manipulations of habitat. Interstate and international commerce, extensive road systems that fragment habitat, and the modification of natural ecological processes such as fire have all contributed to the globalization of ecosystems (Duncan 2001). For example, it is thought that the impacts of Swiss needle cast (*Phaeocryptopus gaeumannii*), a native foliage pathogen that affects Douglas-fir in coastal areas, has intensified with the large-scale adoption of uniform silvicultural practices favoring Douglas-fir production across the ecoregion (Thies and Goheen 2002). Given current patterns and conditions, we can only expect the list of exotic species and their breadth of distribution to increase over time.

Invasive species have the potential to alter the structure, composition, and function of ecological communities and are known to directly eliminate species from an ecosystem. Although the long-term ecological impact of many invasive species is unknown, there is growing concern with the increased number and distribution of species in this region. Moreover, the SWBCA is close to several ports of entry for these invasive species, which increases the likelihood of further introductions and infestations in the future. While non-native invasive species are relatively uncommon in the forested areas, they are slowly increasing in abundance, especially in proximity to roads. Species of particular concern in the SWBCA include English ivy (spreading along highway US 101) and English holly (which is seen scattered throughout the forest in low to moderate abundamce). While not specifically addressed in this plan, managers within the SWBCA should develop weed management plans in the near future to limit the spread of these and other habitat altering species.

Table 4: Major invasive weeds found within the South Willapa Bay Conservation Area and general ranking of abundance and distibution.

Common Name	Scientific Name	Abundance	Distribution	Potential Impact[1]
bull thistle	*Cirsium vulgare*	Low	Local	Low
common gorse	*Ulex europaeus*	Low	Local	Low
cutleaf blackberry	*Rubus laciniatus*	Moderate	Wide	Moderate
English ivy	*Hedera helix*	Low	Local	High
English (cherry) laurel	*Prunus laurocerasus*	Low	Local	Moderate
English holly	*Ilex aquifolium*	Moderate	Wide	High
hairy catsear	*Hypochaeris radicata*	High	Wide	Low
Himalayan blackberry	*Rubus discolor*	High	Wide	Moderate
giant knotweed	*Polygonum sachalinense*	Absent[2]	Absent	High
Japanese knotweed	*Polygonum cuspidatum*	Absent[2]	Absent	High
old-man-in-the-Spring	*Senecio vulgaris*	Moderate	Wide	Low
reed canarygrass	*Phalaris arundinacea*	Moderate	Local	Moderate
Scotchbroom	*Cytisus scoparius*	Moderate	Wide	Moderate
stinking willie	*Senecio jacobaea*	High	Wide	Low

1 Species with high impact could significantly alter forest habitat composition and structure - those with low potential are common in open or disturbed areas, but are not expected to persist as forest canopies develop.

2 Both knotweed species are not currently known from the SWBCA, however they are found nearby in the Naselle River drainage and have a high potential impact if populations are discovered in the future.

C. Site History and Management

1. *Pre-settlement Forest Composition*

Holocene Vegetation

Vegetation assemblages in the maritime PNW have changed in response to climatic variation during the Holocene (10,000 yrs Before Present [BP] to current time). In the early Holocene, forest vegetation on the western Olympic Peninsula—which we assume to be representative of the planning area—transitioned from a pine-spruce-mountain hemlock-fir (*Pinus-Picea-Tsuga mertensiana-Abies*) community to an alder-Douglas-fir-bracken fern (*Alnus-Pseudotsuga-Pteridium*) community (Heusser C.J. 1977). This shift in species composition was apparently brought about by increasing temperatures coupled with a relatively droughty precipitation regime. Warming continued, apparently reaching a maximum during the Hypsithermal at approximately 7,000-8,000 BP (Heusser C.J. 1977). Modern vegetation assemblages developed about 5,000-6,000 years BP, concurrent with decreasing temperatures and increasing precipitation. Perhaps the most noticeable change in vegetation composition is the arrival and proliferation of western redcedar. In western Washington western hemlock and Sitka spruce increased in abundance simultaneous with the arrival of western redcedar (Whitlock 1992).

Sediment cores taken from a small lake in northern coastal Oregon just south of the mouth of the Columbia River provide a proxy record of fire and vegetation history for the planning area (Long C.J. and Whitlock 2002). Throughout the 4,600 year record the pollen (and spore) assemblage is dominated by red alder (*Alnus rubra*), western hemlock, Sitka spruce, western redcedar and sword fern —the characteristic modern flora of the locale. Charcoal and magnetic susceptibility data indicate that fire episodes occurred during the period 4,600-2,700 years B.P. more frequently (140 +/- 30 years) than the period 2,700 B.P. to present (240 +/- 30 years). The earlier of these two periods is characterized by a relatively greater abundance of alder and sword fern pollen, indicating that burned areas may have been occupied by a seral community analogous to the red alder/sword fern formation—a closed canopy community—described by Bailey and Poulton (1968) on the Tillamook Burn. Overall, fire appears to have been a significant disturbance agent over the last 4,600 years in these coastal forests.

Forests of the Early 20th Century

Powell et al. (2003) examined bearing tree records from section corners of the 1908 public lands survey, and estimated composition of the forests in the Ellsworth creek watershed at that time. While this method does not provide a complete picture of forest composition, it has been used by a number of authors to get an idea of pre-settlement conditions in other areas in Washington (Collins et al. 2002). Western hemlock was the dominant species in terms of total volume in almost every plot. From Powell's data, the maps were produced displaying the location and abundance of Sitka spruce, western redcedar, and Douglas-fir (Figure 4 – Historical Forest Composition). Sitka spruce appeared along the mainstem of Ellsworth Creek and in valley bottoms, while western redcedar was very abundant overall and generally missing where spruce is prevalent. Douglas-fir was present in minor amounts and red alder seemed to be very uncommon (Powell et al. 2003). Because close to 98 % of the watershed was identified as being in an old-growth structural condition (Powell et al. 2003), one can infer that stand replacing disturbance at stand to landscape scales were infrequent.

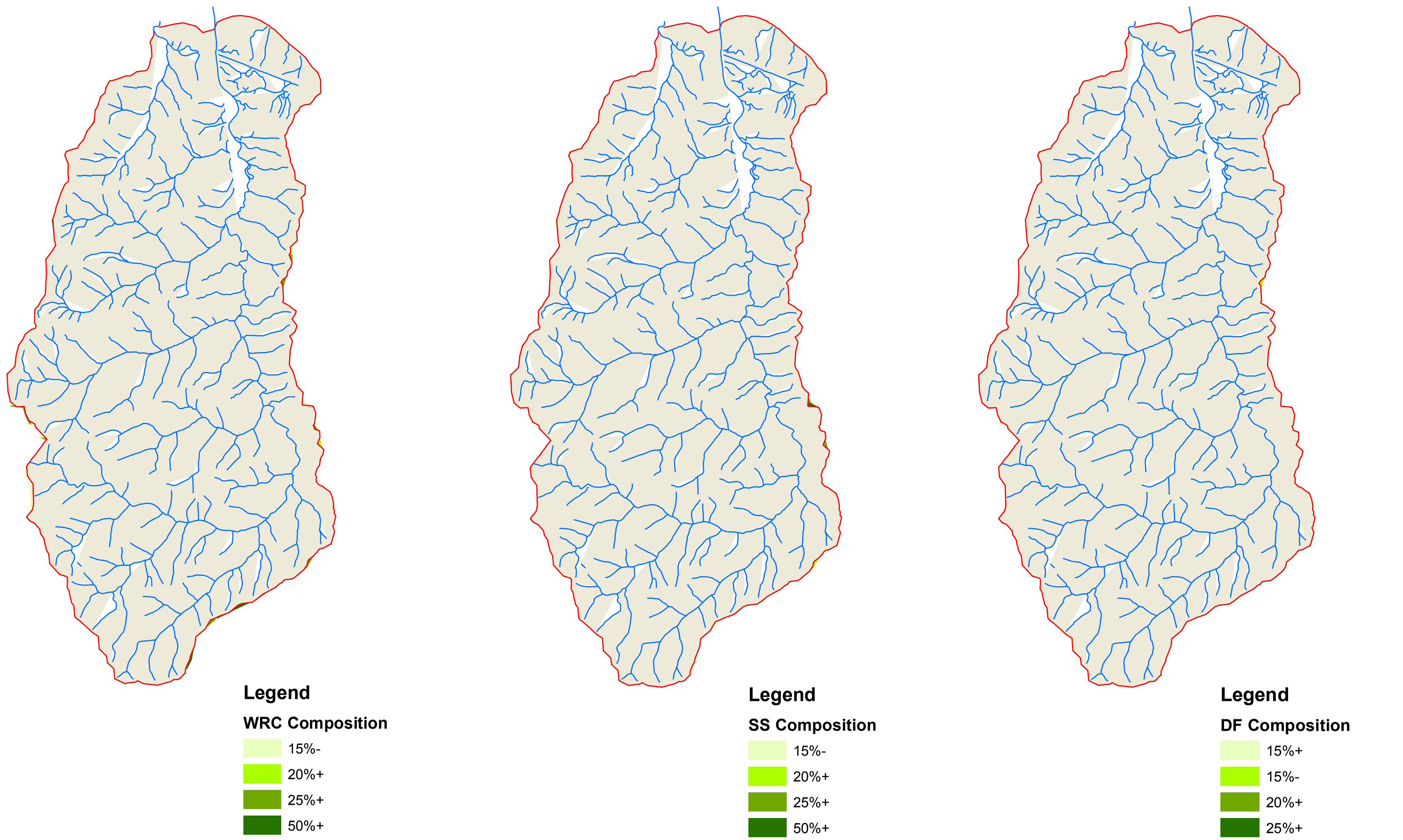


Figure 4: Historical Forest Composition - Sitka spruce, western redcedar, and Douglas-fir abundance in 1908 in Ellsworth Creek as percent of total plot volume (data from Powell et al. 2003)

2. ***Human Use***

Native American History and Use

Prior to western settlement, the Willapa Bay region was inhabited by Native Americans for thousands, perhaps tens of thousands of years. The Chinook people were a widespread group of linguistically similar people who lived along the Columbia river upriver to present day The Dalles, OR and twenty miles up and down the Pacific coast from the Columbia's mouth. The Shoalwater tribe of the Chinook spent summers along the mouth of the Columbia River and lived along the protected shores of Willapa Bay, formerly called Shoalwater Bay, primarily during the winter. There are several known archaeological sites on Long Island which are remains of Indian Villages and middens (USFWS 1979).

The Chinook fished for salmon, sturgeon and eulachon (smelt), and gathered clams, oysters, seaweeds and other inter-tidal foods. They also harvested cranberries, wapato and other plants from local wetlands. The Chinook were prolific traders; occupying a strategic location at the mouth of the Columbia where they controlled trade of a wide variety of goods and staples between inland tribes and tribes up and down the Pacific coast (USFWS 1979).

Chinook use of the forested uplands appears to have been minimal and infrequent, and there is little information about how the Athabascan tribes may have used the inland forest areas. Western redcedar was highly valued by the Chinook. They used cedar bark to make clothing, baskets and other woven goods. Certain cedar trees or stands are known to have been favored for bark gathering by the Chinook, but no such sites have been documented within the planning area. Cedar was relatively easy to split into planks for use in building their rectangular longhouses for communal living and storage. The Chinook were renowned for their craftsmanship in building cedar dugout canoes and for their skill in open water navigation, but the cedar they used for canoe building came from the forest margins or beaches in the form of driftwood. The Shoalwater people used large canoes for fishing and transporting trade goods and small canoes on local streams to facilitate portage between the Columbia River and Willapa Bay until ship-based trading began with the Chinook after Captain Robert Gray first navigated the Columbia River in 1792.

Settlement History

Anglo American settlement of the region began shortly after the historic journey of Lewis and Clark to the lower Columbia during the winter of 1805-1806. The first permanent settlements in the area were established as outposts for fur trading companies such as the Hudson's Bay Company and the Pacific Fur Company. The settlements that followed focused on salmon harvest with logging increasing from local procurement to volume production over time.

The Naselle River valley was first settled, predominantly by Finnish immigrants, in the 1850's. The growing community coalesced around agriculture, especially dairying, with fishing and timber production also providing significant employment. Other settlements in the area fared less well in the long run. Diamond City was established in 1867 at the north end of Long Island, primarily to harvest and sell the area's oysters. By 1878, the area's oysters were depleted and the town was abandoned. Speculative development led to the platting of a town on the eastern margin of Ellsworth creek. As discussed in a report by Bryan Penttila (2002), a hotel was built during the early history of the Ellsworth Creek area which was used by passing boating traffic. The town however never became a reality.

3. ***Forest Management History***

Like much of coastal Washington, forest management began slowly in the beginning of the 20th century. As recently as 1942, nearly 87% of Ellsworth Creek's forestlands remained as unmanaged old-growth (Powell et. al. 2003). Aside from some minor logging at the mouth of Ellsworth Creek by the Ellsworth family, logging in the watershed began during World War I. The United State Spruce Production Division set up camp in 1918 and built several kilometers of narrow-gauge railway into the watershed (Penttila 2002).

Although this effort only lasted 6 months, a surprising number of large Sitka spruce were selectively logged, mainly in the middle portion of the main stem of Ellsworth Creek. With the advent of chainsaws and the Caterpillar bulldozer, the Brix Logging Company began extensive road building and timber harvesting in the watershed in 1943 (Penttila 2002). By 1950, Brix had relocated and in 1960 the Weyerhaeuser Timber Company took control of the forests and began logging operations. Weyerhaeuser rapidly expanded the road network and introduced high yield, even-aged silvicultural systems (clearcutting) throughout the basin. In the 1980's, John Hancock Insurance Company and the Campbell Group purchased Ellsworth and continued to log extensively. By 2001, when the Conservancy acquired the basin, only 7%, or approx. 350 acres, of the original old-growth forests remained (Figure 5 – Historical Forest Age Class Distribution). Over 16% of the basin has been cut twice and is now in its third rotation (Powell et. al. 2003). Although historical information for the Conservancy or mainland Refuge forests outside of the Ellsworth Creek basin is not known, the logging history is presumed to be similar to what is known from Ellsworth Creek.

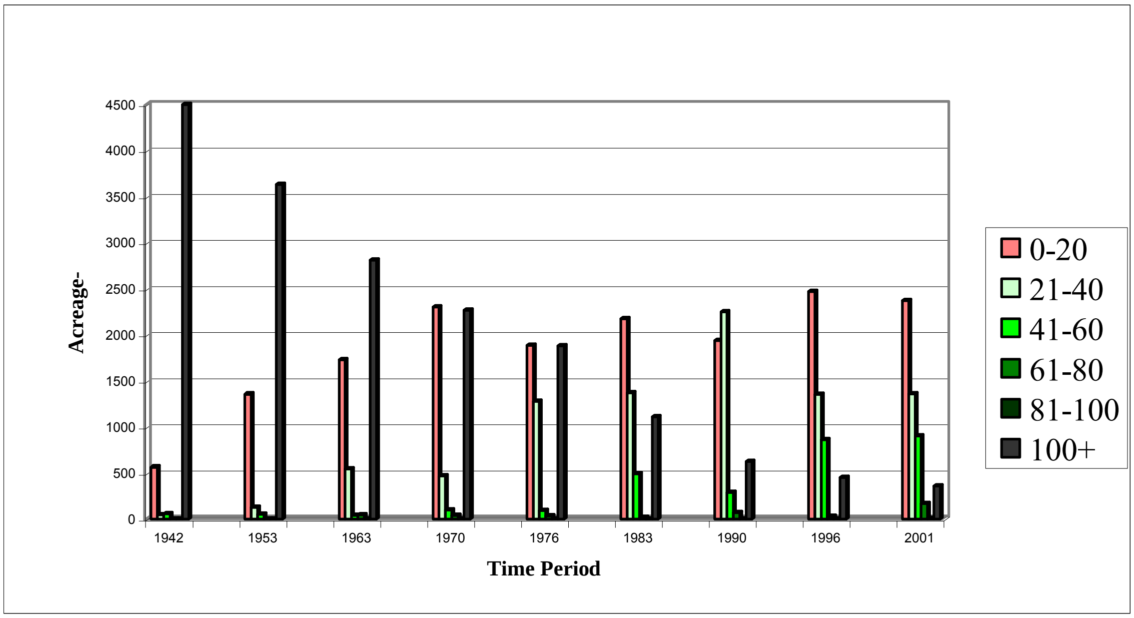


Figure 5: Historical changes in forest age class distribution from harvest activities in the Ellsworth creek basin (From Powell et. al. 2003)

Logging on Long Island began in the late 1800's and most of the island was logged by private timber companies with a focus on old-growth western red cedar and Sitka spruce – as western hemlock was then considered unmarketable. Regeneration was mostly natural and little thinning was done over the years. The Refuge began acquiring land on the island from the Weyerhaeuser Company in 1940 and consolidated its holding with two Land for Timber Exchange Agreements in the 1950's.

In the early 1950's, an outbreak of the Hemlock Looper occurred in Northwest Oregon, from the Astoria Area to the Tillamook Burn Area within the Spruce/Hemlock Zone. Stands of old hemlock (>200 years old) were defoliated. Extensive salvage operations took place by industrial timber land owners, to capture the mortality. Natural regeneration of dense hemlock followed. It was also reported by a local resident, that the South Willapa Bay Area (including Long Island) was aerial sprayed with DDT to prevent the potential threat to the older hemlock stands in the area.

Between 1960 and 1968 the Refuge harvested timber on its own lands following a plan developed in 1960. Following a large windstorm in 1962, both the Refuge and Weyerhaeuser Company increased harvest around salvage operations. A review of the Refuge's harvest practices in 1968, however, resulted in a halt of logging operations until 1975 when the Refuge entered into a memorandum of understanding with the

Weyerhaeuser Company to acquire the remainder of the companies lands (at that time 1,622 acres) on the island. The agreement stated that both parties would develop a cooperative resource management plan for the island. As part of the plan Weyerhaeuser agreed to exchange its lands to the Refuge for the value of the timber on the island. At the time it was felt that harvesting of this timber resource was consistent with the Refuge's goals for wildlife management (USFWS 1979). Most of the harvestable forest stands were even-aged stands dominated by western hemlock and less than 100 years old, having regenerated after logging and wildfire before the turn of the century. Weyerhaeuser proceeded to harvest 1,009 acres in total (USFWS 689 acres, Weyerhaeuser 320 acres) and transfer its entire ownership to the Refuge until the program was completed in 1987.

4. ***Current Land Use and Surrounding Ownership***

Naselle is currently an unincorporated town of approximately 400 residents and perhaps 1400 people living within the school district. Primary economic activity centers on timber production and commercial fishing and decreasingly on farming. Following the completion of the Megler Bridge across the Columbia River in 1966, tourist traffic through the area has increased as has development

Land use patterns in this largely rural county (Pacific) are dominated by private forest land dedicated to commercial timber production. Large lot residences are scattered along major highways and secondary county roads. This pattern is consistent within the immediate vicinity of the SWBCA. That is, neighboring lands are, by and large, commercial timber holdings with limited numbers of home sites adjacent to county roads. The commercial timberlands directly adjacent to the SWBCA are largely owned by investment groups and managed by timber investment management organizations (TIMO's). Two TIMO's, Campbell Group and Hancock Investments, manage adjacent forestland for investment return purposes.

5. ***Recreation and Public Access***

The Ellsworth Creek Preserve is open to public access though vehicle traffic is restricted behind locked gates. Walk in access is permitted inside gated areas; however, no formal trails are maintained for public use. Hunting and fishing activities are allowed within the preserve as permitted by state regulations. Fires and camping are not allowed.

The Refuge offers a variety of public access and recreational activities. Campgrounds, hiking trails, hunting, boating and wildlife viewing are all provided at various locations around the Refuge. The Refuge has an active public recreation program that maintains and develops appropriate public infrastructure and interpretation.

Long Island is a main focus of boating and hiking activities, and the only area on the Refuge where camping is permitted. Access to the Island is strictly by boat. The Refuge provides a public boat launch at the headquarters location. There is a boat ramp on Long Island just south of there. Five campgrounds, all accessible from the water, are spread across Long Island. Former logging roads or trails currently link all but one campground to the main road system. Another trail loops through the "cedar grove", a stand of ancient western redcedar located at the center of the south end of the island. Modern firearm hunting is not permitted on the island, however, archery hunting is allowed.

6. ***Bonneville Powerlines***

Two electrical transmission lines, owned and managed by the Bonneville Power Administration, traverse the Ellsworth Preserve and Refuge property. This line emanates from the power substation located in

Naselle and supplies power to local public utility districts in the Ilwaco and Long Beach Area. It is a 6-line system, generally contained on one large transmission structure but sometimes splits into two 3-line transmission structures. It runs westerly along the south side of the Naselle River estuary and continues inland along the north boundary of the DNR's Ellsworth NRCA. The line then heads north along Pellervo ridge before turning southwest and crossing the Ellsworth estuary. It then continues westerly and southerly through the Ellsworth Preserve for several miles, then continues in a southerly manner for several miles through the Ellsworth Preserve, then leaves the Willapa Forest continuing westerly across Highway 101 near Greenhead Slough, and finally splitting into two lines—one continuing westerly across the South Willapa Bay Estuary and one continuing southerly through the Refuge's North Bear river unit towards Seaview.

The BPA transmission line right-of-ways run for 3.6 miles through TNC property and 1.9 miles through Refuge property. In addition, a number of roads are associated with maintaining the transmission lines and rights-of-way. Many are rudimentary (narrow and unrocked) roads. These access roads can be a source of erosion, sedimentation, and water quality degradation particularly on the Ellsworth Preserve.

The areas underneath the transmission lines are maintained in a manner that precludes trees from growing taller than 10 feet. Thus, the transmission line right-of-ways significantly influence and impact operational activities and landscape level forest restoration goals. These barriers are an operational and restoration challenge and will have to be factored in to annual operation plans.

Landscape Resource Assessment

Long Island and Willapa Bay looking northwest from Bear River Ridge

A. Forest Vegetation

1. *Forest Inventory and Key Structural Metrics*

Stand structure and species composition varies considerably in particular stands due to differences in age and management history. To gain a thorough picture of existing conditions, a detailed forest inventory was conducted by Integrated Resource Management (IRM) on both the Conservancy and Refuge ownerships in 2004 (Stringer 2005). Over half of the total acreage and a representative sample of age classes were inventoried (Table 5). The inventory was based on field protocols developed under the Oregon Department of Forestry's Stand Level Inventory Protocol (ODF 2002). Basic forest structure attributes were sampled along with understory plant cover, downed wood, snags, and forest health concerns. An average of 15 plots were installed within each stand. While not complete for the entire ownerships, the information is sufficient for long term planning efforts. Additional inventory work will be conducted during management activities in specific stands and through an ongoing effort to re-sample approximately 10% of the forest stands within the SWBCA each year.

Table 5: Distribution of stand types and acres inventoried in 2002-2004 by IRM and un-inventoried stands (includes additional data from the 2006 Rogers addition to the Ellsworth Creek Preserve).

Stand Type	TNC		WNWR		All
	Inventoried acres & (stands)	*Un-invent. acres & (stands)*	*Inventoried acres & (stands)*	*Un-invent. acres & (stands)*	*Total Number of acres & (stands)*
WH-SS-RC-1 (0-15yr)	614 (12)	256 (5)	13 (1)	837 (15)	1,719 (33)
WH-SS-RC-2 (15-30)	1,171 (14)	521 (15)	77 (1)	50 (4)	1,818 (34)
WH-SS-RC-3 (30-60)	1,388 (15)	124 (7)	2,194 (19)	303 (11)	4,009 (52)
WH-SS-RC-4 (60-100)	292 (9)	128 (8)	1,063 (16)	564 (18)	2,048 (51)
WH-SS-RC-5 (100+)	269 (2)	23 (3)	500 (5)	34 (3)	826 (13)
Douglas-fir-1 (0-15yr)	60 (2)	388 (8)	35 (1)	80 (1)	564 (12)
Douglas-fir-2 (15-30)	607 (4)	821 (14)	103 (1)	351 (2)	1,882 (21)
Red Alder-1 (0-15yr)	73 (4)	0 (0)	0 (0)	77 (1)	150 (5)
Red Alder-2 (15-30)	0 (0)	2 (1)	0 (0)	221 (5)	222 (6)
Red Alder-3 (30-60)	12 (1)	106 (7)	103 (3)	33 (5)	253 (16)
Red Alder-4 (60-100)	0 (0)	0 (0)	200 (3)	20 (3)	220 (6)
Non-forest	0 (0)	76 (4)	0 (0)	382 (7)	458 (11)
Totals	4,486 (63)	2,444 (72)	4,288 (50)	2,952 (75)	14,170 (260)

This baseline inventory information was used to calculate common structural metrics for each inventoried stand (Appendix B). Inventory data was also input into the Landscape Management System (LMS) (McCarter et al. 1998) to facilitate many types of stand and landscape level analyses. To quantify stand structure, guide management decisions and gauge progress towards desired future conditions, two key metrics were chosen - Stand Density Index (Long J.N. 1985, Reineke 1933) and Weighted Old-growth Index.

The Stand Density Index (SDI) was selected to measure degree of site occupancy and level of tree competition, or relative density. While Curtis' Relative Density (Curtis 1982) is commonly used for Douglas-fir and Relative Density Index (Drew and Flewelling 1979) can be used for both Douglas-fir and western hemlock stands, SDI is the most broadly used across different species (Woodall et al. 2006) and is the only metric that has been used by numerous researchers in multi-species and multi-cohort stands (Amoroso 2004, Long J.N. 1996, O'Hara 1996, Puettmann et al. 1993, Woodall et al. 2005). This is done by calculating SDI for each species, cohort, or diameter class and then adding them together (Long J.N. 1995, Shaw 2000). As SDI was designed for use with single cohort and single species plantations, there are significant challenges to using it in complex stands (O'Hara and Gersonde 2004, Woodall et al. 2005). Yet it is the most versatile density metric that is still practical for management applications.

The Weighted Old-growth Index was developed by Franklin et al. (2005) to assess old growth structure on Washington State DNR lands across western Washington. For the SWBCA landscape, a Modified Old-growth Index (MOGI) was used that does not include stand age (Franklin J.F. et al. 2005). The MOGI is based on for structural variables associated with old-growth forests:

1. Large trees (number per acre > 100 cm dbh [40 inches])
2. Large snags (number per hectare > 50 cm dbh and > 15 m tall [20 inches dbh; 49 feet tall])
3. Volume of down woody debris (cubic meters per hectare)
4. Tree size diversity: (# of trees in the following 4 diameter classes: 2-9.9", 10-19.9", 20-39.9", 40"+)

The MOGI ranks old-growth structure for each stand on a scale of 0-100, with 75 representing the median of the old-growth dataset used by Franklin et al. (2005). The four structural variables can be weighted to increase or decrease the importance of a particular structural variable; variables were equally weighted in the analysis of SWBCA stands. MOGI has been successfully used to identify old-growth stands from inventory data in coastal spruce-hemlock-cedar forests (Franklin et al. 2005). However, old-growth stands will not necessarily attain perfect scores (i.e. 100). In general, MOGI scores increase with stand age (Map – SWBCA Modified Old-Growth Index). Old-growth SWBCA stands averaged 62 with a 90% confidence interval of 22-72. The highest MOGI scored was the main cedar grove stand on Long Island with a score of 73 (stand #30026).

2. ***Forest Stand Types***

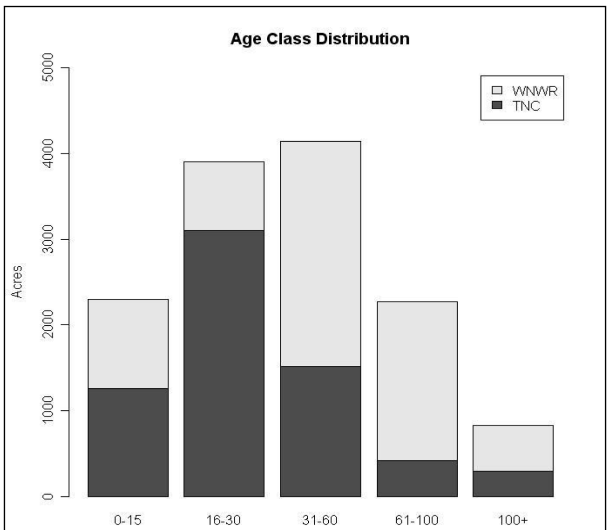


Figure 6: Age class distribution of forests in the Refuge and Conservancy ownerships in 2006.

The IRM inventory information was used to classify stands into stand types (Map – SWBCA Stand Types). For un-inventoried stands, inventory data from past owners, aerial photos, and field verification was used. In order to make this classification simple and practical for management purposes, typing was based on dominant species (over 50% of basal area) and age class using age at breast height. When needed for landscape level analysis, stands can be further classified according to attributes such as developmental stage, SDI, MOGI, presence of residual old-growth legacy features, or relative species composition. Averages for each stand type of these attributes, along with other forest structural variables, are presented in Table 6.

Overall, both ownerships are dominated by structurally simple managed forests younger than 60 years of age since harvest (Figure 6 – Age Class Distribution) . The old-growth index values also proved to be fairly well correlated with age class with scores being relatively low for most of the inventoried stands as would be expected given the SWBCA's management history.

Table 6: Average stand metrics and 90% confidence limits *(Italics)* for stands inventoried by IRM. NF = attribute not found. *NA* = insufficient data for confidence interval.

		Live Trees									Snags and Downed Logs				
Stand Type	**N**	**BA**	**TPA**	**TPA > 10**	**TPA > 18**	**TPA > 30**	**AVG DBH**	**QMD**	**RD**	**TREE VOL**	**SPA**	**AVG DBH**	**LPA**	**LOG VOL**	**MOGI**
DF-1	3	11 *(5)*	1910 *(2975)*	1 *(NA)*	NF *(NA)*	NF *(NA)*	1 *(1)*	1 *(1)*	11 *(7)*	0 *(0)*	1 *(NA)*	11 *(NA)*	326 *(366)*	97 *(20)*	15 *(8)*
DF-2	6	164 *(25)*	597 *(224)*	60 *(51)*	3 *(2)*	NF *(NA)*	6 *(1)*	7 *(1)*	61 *(8)*	20 *(5)*	60 *(51)*	12 *(1)*	241 *(135)*	92 *(40)*	32 *(7)*
RA-1	4	104 *(214)*	694 *(996)*	96 *(59)*	21 *(22)*	4 *(NA)*	4 *(8)*	5 *(10)*	33 *(69)*	18 *(38)*	96 *(59)*	17 *(2)*	291 *(513)*	90 *(100)*	25 *(14)*
RA-3	2	118 *(21)*	642 *(4117)*	56 *(106)*	3 *(21)*	NF *(NA)*	5 *(24)*	6 *(22)*	48 *(90)*	13 *(5)*	56 *(106)*	13 *(2)*	194 *(2347)*	84 *(858)*	28 *(101)*
RA-4	2	233 *(1183)*	720 *(1375)*	135 *(800)*	24 *(132)*	2 *(9)*	5 *(32)*	8 *(27)*	81 *(282)*	39 *(171)*	135 *(800)*	16 *(8)*	127 *(567)*	60 *(6)*	32 *(183)*
WH/SS/RC-1	9	63 *(66)*	2026 *(897)*	24 *(33)*	21 *(23)*	6 *(6)*	2 *(2)*	3 *(3)*	30 *(20)*	8 *(16)*	24 *(33)*	17 *(4)*	277 *(89)*	107 *(31)*	25 *(11)*
WH/SS/RC-2	17	160 *(23)*	874 *(233)*	64 *(25)*	6 *(5)*	3 *(2)*	5 *(1)*	6 *(1)*	64 *(7)*	17 *(5)*	64 *(25)*	13 *(1)*	243 *(62)*	103 *(30)*	31 *(6)*
WH/SS/RC-3	41	253 *(24)*	760 *(146)*	150 *(18)*	18 *(5)*	2 *(1)*	6 *(1)*	8 *(1)*	87 *(8)*	43 *(6)*	150 *(18)*	15 *(0)*	283 *(51)*	104 *(18)*	38 *(3)*
WH/SS/RC-4	27	277 *(27)*	822 *(242)*	113 *(16)*	30 *(6)*	7 *(2)*	6 *(1)*	9 *(1)*	94 *(8)*	60 *(8)*	113 *(16)*	18 *(1)*	179 *(42)*	94 *(20)*	48 *(4)*
WH/SS/RC-5	5	313 *(70)*	469 *(353)*	72 *(23)*	45 *(9)*	16 *(3)*	7 *(6)*	13 *(6)*	91 *(26)*	91 *(19)*	72 *(23)*	24 *(2)*	105 *(57)*	123 *(72)*	62 *(10)*

Definitions
Species: DF = Douglas-fir, RA = red alder, WH/SS/RC = western hemlock, Sitka spruce or western redcedar
Age class (yrs): 1 = < 15, 2 = 15 – 30, 3 = 30 – 60, 4 = 60 – 100, 5 = > 100
N: Number of stands within each Stand Type inventoried in 2004 by IRM.
Live Tree Metrics: BA: Total basal area in square feet. TPA: Total trees per acre. TPA > 10: Trees per acre with DBH > 10". TPA > 18: Trees per acre with DBH > 18". AVG DBH: Arithmetic average DBH in inches. QMD: Quadratic Mean Diameter in inches. RD: Curtis's Relative Density. TREE VOL: Scribner board-feet volume per acre in thousands of board-feet per acre.
Snags and Logs: SPA: Total number of snags per acre. AVG DBH: Average DBH of snags in inches. LPA: Total number of logs per acre. LOG VOL: Total cubic foot volume of logs in thousand cubic feet.
MOGI: Modified Old-Growth Index

Western hemlock/Sitka Spruce/Western Redcedar types

This is by far the most prevalent type on both ownerships and was dominant throughout most of the landscape in the pre-settlement times. While western hemlock typically dominates these stands in terms of trees per acre and basal area, Sitka spruce and western redcedar make up significant portions of these stands and in a few cases are the dominant species. Red alder is abundant in riparian areas and along roads and landings, and a minor to moderate component in upland areas. Douglas-fir is relatively rare, but present in varying degrees due to management history. Images generated by the Stand Visualization System (SVS) using inventory information from specific stands are provided for each age class in (Figure 7 – SVS stand types).

The 100 yr+ age class is either unmanaged old growth or stands that were selectively logged by the U.S. Spruce Production Division or early settlers. While this partial harvesting altered some of these current old growth stands, it is not clear to what extent and what the impact on current stand structure is. Approximately 825 acres of this age class exist across the SWBCA. Three major types of remnant old-growth stands exist in the SWBCA landscape – spruce-hemlock, cedar-hemlock, and pure hemlock.

Spruce-hemlock stands typify the old-growth remnants in along the lower reaches of Ellsworth Creek. This stand type is analogous to the Sitka Spruce-Western Hemlock Plant Association Group (PAG) of Franklin et al. (2005) and the Sitka spruce Zone of Franklin and Dryness (1988). Large diameter spruce are the dominant feature in these stands while hemlock dominate the understory and midstory. Spruce is moderately shade tolerant and long-term coexistence with hemlock is thought to be mediated by canopy gap formation (Taylor A.H. 1990). Spruce-hemlock stands were historically distributed along the lower reaches of the Ellsworth Creek and major tributaries.

Cedar-hemlock stands historically dominated the uplands of the Ellsworth Creek watershed and most of Long Island. These stands most closely resemble the Western Redcedar Coastal Plain PAG of Franklin et al. (2005). They do not seem to be an exact match however; the regeneration difficulties typical of the Western Redcedar Coastal Plain PAG are not apparent anywhere in the SWBCA landscape. Very large cedars are the dominant feature in these stands; individuals up to 15' dbh can be found in the SWBCA landscape. Woody debris loads can be extremely large due to the decay resistance of cedar wood. These forests appear to be maintained by chronic, low to moderate severity wind disturbance which primarily affects hemlock and not the decay and wind resistant cedar. Understory vegetation is dominated by dense thickets of salal, fool's huckleberry and evergreen huckleberry.

A few residual old-growth stands, particularly in the Ellsworth Creek Watershed, appear to be a mixture of the two former types. All three major species, spruce, hemlock and cedar can occur in relatively even mixture. This mixed type was most likely more common in historical conditions than is suggested by the composition of present day remnant old-growth stands.

Pure or nearly pure hemlock stands comprise the third old-growth forest type. Classical old-growth structures—large diameter trees, snags and logs—are relatively scarce in these stands due to the relatively short lifespan of hemlock. Understories can be poorly developed, particularly when the overstory is intact. The origin and developmental history of these stands is not clear. The most likely explanation is that they established as high density hemlock stands following periodic disease/insect outbreaks, high severity wind disturbances, and prolific stress seed production. Throughout remnant old-growth stands on the mainland, and less so on Long Island, occasional Douglas-fir individuals add structural and compositional diversity.

The 30-60 and 60-100 year age classes are mostly a result of the Brix company operations and early Weyerhaeuser logging that was focused on removing high value trees. Natural regeneration was relied on, and abundant legacies such as decadent old-growth hemlock, mid and understory trees, non-merchantable downed logs, and snags were typically left following harvest. These stands tend to have higher levels of structural complexity and are mostly naturally regenerated hemlock, some Sitka spruce, and little western redcedar. Some of these stands appear to have been pre-commercially thinned to densenarrow spacing (e.g., 8 x 8' to 10x10'), in anticipation of future clearcut harvesting at around age 45-50 years old8 feet to 10x10 feet). In general, these stands are very dense, have little understory development, and are in the competitive exclusion stage. Some older stands in the 60-100 year age class are more complex, however, and are in an understory re-initiation stage of development.

The 15-30 year age class is marked by changes in management practices. In 1967, Weyerhaeuser introduced High Yield Forestry and began planting Douglas-fir seedlings immediately following timber harvest (Pentilla 2002). However, natural western hemlock regeneration often overtook planted seedlings. In addition, it was a routine practice to aerial spray the young conifer plantations to eliminate competing hardwood trees and shrubs. A shift toward much more intensive site prep began that included snag felling, slash removal, and broadcast burning. By the mid 1970s thorough site prep and planting were standard practice and pre-commercial thinning became common. While a portion of this age class has been pre-commercially thinned and has densities of approximately 350 trees per acre (TPA), many stands have not and are extremely dense. Few, if any, legacies exist, and stands are simplified conifer plantations in the canopy closure or early competitive exclusion stage. They have varying degrees of species diversity, and a few stands dominated by Sitka spruce exist. Where western redcedar is found, it is generally in the lower crown classes due its slower early height growth (Oliver and Larson 1996, Ruth and Harris 1979) and is commonly dying out from competition induced mortality.

The 0-15 year age class is comprised of recent clear-cuts, usually of second-growth stands. Broadcast burning fell out of favor in the late 1980's and 1990's and site prep and control of competing vegetation was typically not as thorough in these stands. Small numbers of snags, live trees, and 25-50' riparian buffer strips were left due to changes in forest practice regulations, although a few stands contain large number of legacy old growth snags. Western hemlock and Sitka spruce were either planted or have outgrown Douglas-fir affected by Swiss Needle Cast. Red alder and western redcedar are moderately abundant. These stands are in the cohort establishment or canopy closure stage, and typically have higher levels of tree species diversity, shrubs and forbs, and patchiness than the 15-30 year age class. They are still structurally simple plantation stands, however, and competitive exclusion will eliminate much of the diversity and complexity in the next 10-30 years if left alone.

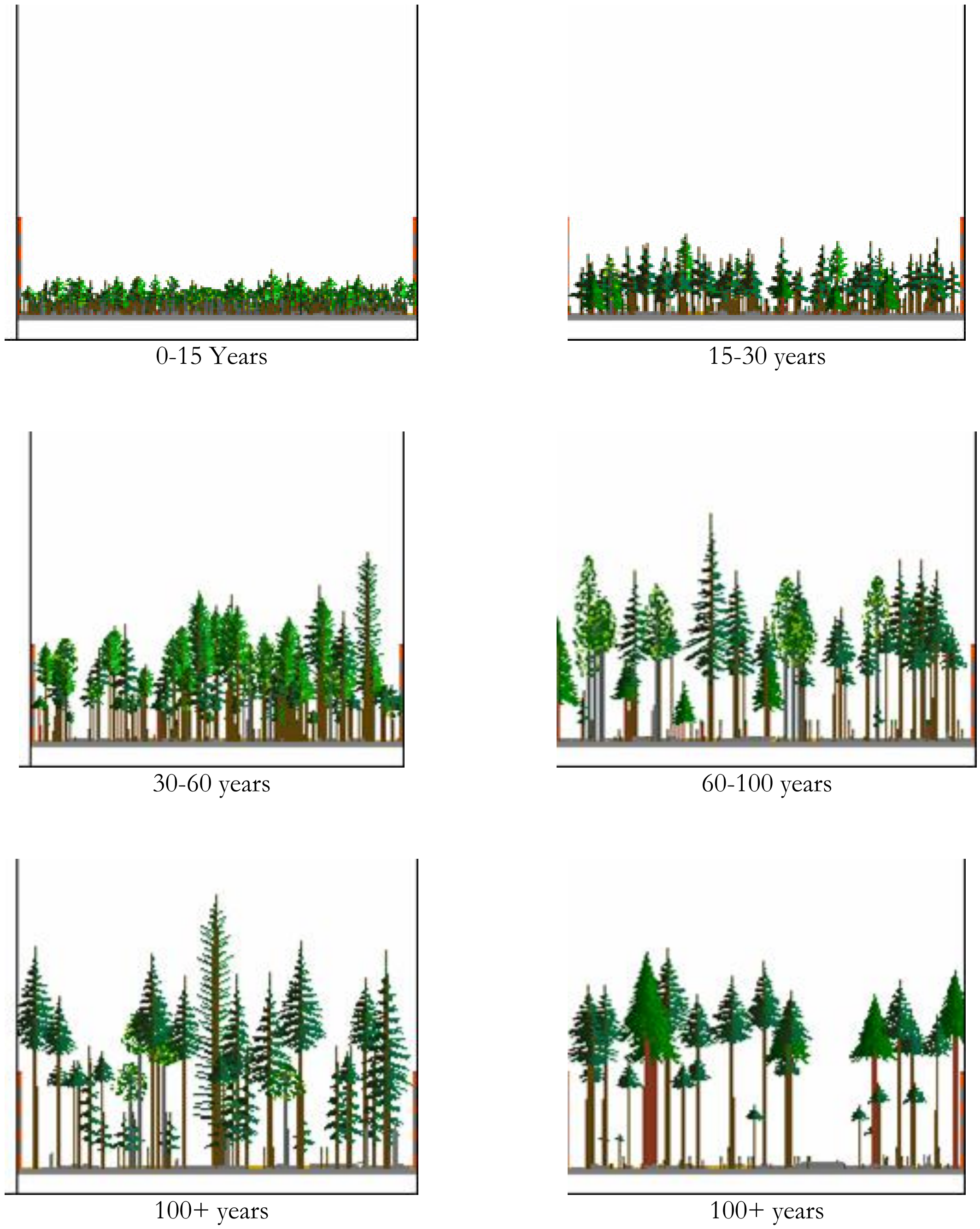


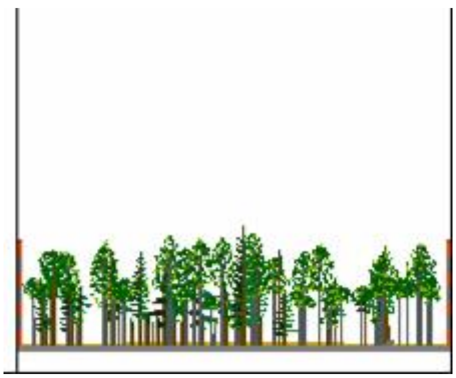
Figure 7: SVS images of different age classes of western hemlock, Sitka spruce, western redcedar stand type. Two 100 year + stands are provided to demonstrate differences in old-growth structure.

Douglas-fir types

The two age classes of Douglas-fir, 0-15 and 15-30 years, resulted from planting Douglas-fir after intensive site prep and control of competing vegetation. The oldest stands are approximately 30 years old. Establishing Douglas-fir in this region proved to be a challenging task and often failed (Tappeiner et al. 2002). Except for stands that were pre-commercially thinned to heavily favor Douglas-fir, stands have significant amounts of other trees species. While the Douglas-fir appears to be growing well in most places, Swiss Needle Cast is prevalent and has reduced foliage density in many stands. Except for the dominance of Douglas-fir, these stands are similar in structure to corresponding age classes in the western hemlock type as described above.

Red alder types

Red alder stands established in areas where naturally regenerated red alder was not controlled and was able to outgrow planted or naturally regenerated conifers. While alder is the dominant species, these are typically mixed stands with significant amounts of conifers in both the overstory and understory (Figure 8 – SVS alder stand types). In the younger age classes, 0-15 and 15-30 years, density tends to be high and crown competition between alders and conifers is intense. The older age classes, 30-60 and 60-100 years, are relatively complex with lush, well developed understories, mid-story conifers, and large spruce, hemlock, or cedar emergents that rise above the alder canopy. Alder snags are becoming abundant in the older stands. Patches of pure alder do exist within stands, but they are relatively uncommon. Evidence of browse from deer and elk is quite common in these stands.



30-60 years

60-100 years

Figure 8: SVS images of different age classes within the red alder stand type.

Riparian Forests

Riparian forests are typically the most floristically diverse and structurally complex parts of forested landscapes in the Pacific Northwest (Pollock 1998). While this is the case in much of the SWBCA, harvesting and increases in mass wasting events related to forest management have simplified many riparian stands and shifted species composition towards red alder. Rentmeester's (2004) assessment of forests within 160 feet (50 meters) of the fish bearing segments of Ellsworth Creek creates a foundation for our understanding of this forest type within the SWBCA (Figure 9 – Riparian Forests).

Similar to upland stands, management history plays a significant role in determining age and composition in riparian forests. The old growth riparian stands in Ellsworth creek tend to be dominated by 2-4' diameter western hemlock with a significant component of larger Sitka spruce. A surprising number of spruce stumps are present from the World War I era Spruce Division (Rentmeester 2004), and corroborate the public land survey data from 1908 showing that that spruce was abundant along much of the mainstem (Figure 4 – Historical Composition). Sitka spruce also dominate the old-growth riparian stands along the small creeks on the mainland portion of the Refuge (USFWS 1999). The large western redcedar that characterize other old-growth stands in the mainland portions of the SWBCA are relatively rare, possibly due to the productive soils and lower frequency of blow down events in the protected valley bottoms, which both favor hemlock dominance. In contrast, the old growth riparian areas on Long Island have a much high component of western redcedar.

In 25-50 year old riparian forest stands, Rentmeester (2004) found that: "while structural aspects (basal area, density, and QMD) were not significantly different between stands of the same age, stand composition was notably different between confined and unconfined reaches". Riparian forests located along unconfined stream reaches have wide valleys and tend to be located entirely on floodplain and terrace landforms. Mixed conifer/hardwood stands are prevalent and tend to have a gradual transition from red alder dominance in the inner riparian zone to conifer dominance on outer zone and side slopes. These areas are similar to the red alder stand types described above, although conifer abundance is often lower and generally consists of understory and midstory western hemlock and Sitka spruce. Black cottonwood (*Populus tricocarpa*) is also present in some areas. In narrower, confined channels, a much sharper transition exists between alder dominance along the stream channel and terraces, and conifer dominance on the steep side slopes. This sharp transition is very clear in low order, non-fish bearing streams throughout the Ellsworth Creek basin. Conifer dominance is especially prevalent in plantation stands 20-40 years old that have been intensively managed. Stands less than 20 years old typically have narrow buffer strips of older, mixed forest in the inner riparian area that were left due to the implementation of riparian buffers under the Washington Forest Practice Rules.

Rentmeester (2004) also found typical patterns of plantation stand development in terms of forest structure. Basal area increased with stand age, and ranged from 107 ft^2/acre in 15 year-old stands to 305 ft^2/acre in stands more than 200 years old. Quadratic mean diameter also increased from an average of 5.7 inches in 15 year old stands to 17.3 inches in 200 plus years old areas. Average trees per acre decreased, and ranged from 283 to 2004 tpa in young transects and from 57-405 tpa in older stands. Snag abundance decreased with age, with 38 stems/acre at age 25, 32 stems/acre at age 50, and 28 stems/acre at age 200. Mean diameter of snags, however, increased from 6 inches at age 25 to approximately 16 inches at age 200. Decay class was generally higher in younger stands, reflecting the process of competition induced mortality early in stand development. In 25 year old age classes, 68% of snags were conifers. The portion of hardwood snags gradually increased to age 75, where 83% of snags were hardwoods. In the 200 plus age class, only 10% of snags were hardwood.

In the smaller watersheds outside of the Ellsworth Creek watershed - that drain west and north of Bear River Ridge on both the Conservancy and Refuge ownerships - studies on stream conditions (Barndt et al. 2000, Wright W. and Callaghan 2002, Yoshinaka and Stone 2004) and field reconnaissance indicate that the pattern of hardwood dominance in the inner riparian zone and greater conifer abundance in the outer zone is generally the same as described above. A notable difference is the presence of big leaf maple (*Acer macrophyllum*), which is not found within the Ellsworth Creek Preserve. On Long Island, the short, low gradient streams tend to be dominated by red alder in managed areas, while the older unmanaged riparian stands are mostly composed of conifers.

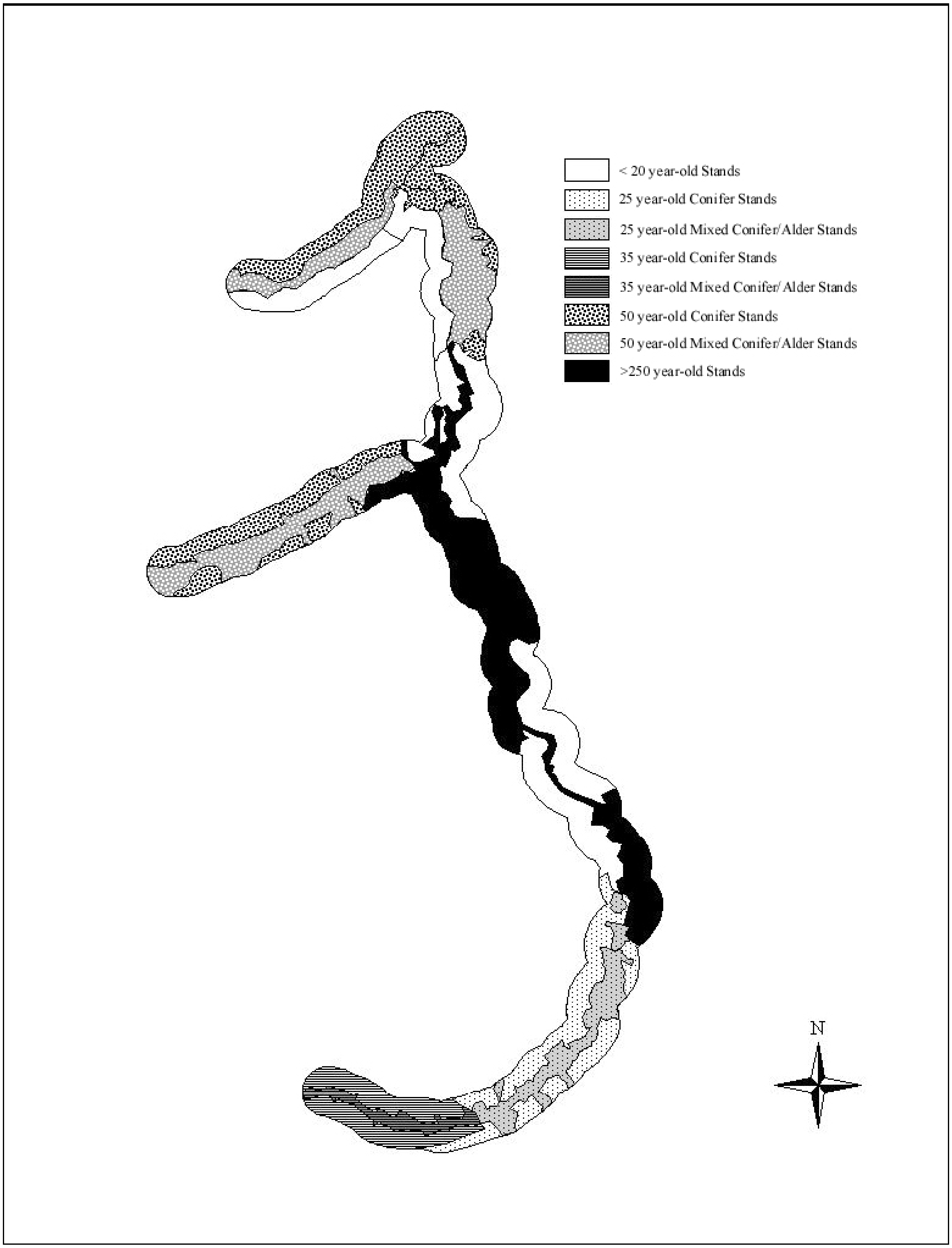


Figure 9: Riparian forest types along fish bearing channels of Ellsworth Creek (Rentmeester 2004)

3. ***Forest Health***

The interactions between fungi, insects, animals, and abiotic disturbance agents play critical roles in shaping forest structure and creating complex, diverse ecosystems (Edmonds et al. 2000). In order to achieve the given management objectives within the SWBCA, it is essential to understand these agents and work with them, as opposed to viewing them as threats. While these agents result in significant losses to timber value in spruce/hemlock forests (Ruth and Harris 1979), their patterns and influences do not appear to have been dramatically altered by forest management within the SWBCA in most cases. Insects and diseases are not likely to dramatically affect forest management over the next few decades (Hildebrand and Hostetler 2003) although climate change may lead to major shifts in their dynamics.

Swiss needle cast, caused by the fungus *Phaeocrytopus gaeumannii*, is native to Pacific Coast forests and while long considered innocuous, it has become a major concern in Douglas-fir plantations within approximately 18 miles of the coast in Oregon and Washington in the last few decades (Thies and Goheen 2002). During wet springs when adequate moisture is present, the fungus germinates, infects needles on Douglas-fir trees, and causes them to yellow and drop prematurely. Although it rarely kills trees outright, Swiss needle cast can reduce growth rates by up to 35% and make trees more susceptible to other agents of mortality (Holmberg et. al. 2006). While the causes of the recent increase are not fully known, the large-scale replacement of spruce-hemlock forests with pure Douglas-fir plantations is thought to be a chief factor (Thies and Goheen 2002). The 5-30 year old, Douglas-fir dominated stands on the Conservancy ownership have moderate to high levels of infection that appears more pronounced on upper ridges and west aspects (IRM 2005). In young plantations with more western hemlock, infection levels are generally lower and tend to vary more from tree to tree. On the Refuge, 10 infected stands totaling 1,041 acres were identified, with infection levels again highest in Douglas-fir dominated stands (IRM 2005). While crowns often appear sparse, height and diameter growth on dominant and co-dominant trees in most stands appears to be within expected ranges of site class. Its long terms effects are uncertain, however.

Gap development is often influenced by the action of forest pathogens.

Annosus root rot, caused by the fungus *Heterobasidion annosum,* is a common pathogen in western hemlock and Sitka spruce. It produces a dark brown conk and brown-heart rot that weakens the bole of trees and typically leads to stem breakage or mortality from bark beetles or other agents. It spreads through root graft and pervasive aerial spores that germinate readily on live bare wood, such as fresh stump surfaces, bole exposure from logging damage, or top or major branch breakage. It grows slowly, however, and effects are usually not noticeable until trees reach at least 120 years old (Thies and Goheen 2002). Combined with wind, it is probably the largest cause of tree mortality and snag recruitment for mature western hemlock in this forest type and a major limiting factor on the development of large, old hemlocks and to a lesser extent Sitka Spruce. Thinning has been shown to significantly increase infection levels as spores germinate on cut stumps and spread through root grafts to live trees (Edmonds et al. 2000). This has not proven to be a serious concern in plantations that are harvested well before age 120 (Edmonds et. al. 2000). As none of the managed stands on the Conservancy and Refuge ownerships are over 100 years old, mortality from annosus appears to be confined to the old growth stands and legacy hemlocks in younger stands (Hildebrand & Hostetler 2003). However, it is likely that the fungus is present in many trees and that thinning will increase infection levels. In stands heavily dominated by hemlock, this poses a challenge to the long-term goal of developing old growth structure (Thies and Goheen 2002).

Hemlock dwarf mistletoe (*Arceuthobium tsugense*) is a vascular, parasitic plant that affects western hemlock, and occasionally Sitka Spruce and Douglas-fir, in this forest type. Mature female plants forcibly discharge seeds an average of 15 feet, and the sticky seeds adhere to branches and stems of new hosts. The flowers, fruits, and seeds are a source of food for several invertebrates and bird species, and birds can spread the seeds. Seeds then germinate and the roots mechanically enter host tissues to extract water, nutrients, and sugars. Host branches usually respond with swelling and by producing a "witches broom" that may grow to weigh several hundred pounds in older trees and provide preferred nesting platforms for marbled murrelets and other species (Thies & Goheen 2002). Young western hemlock trees that are lightly infected (less than 1/3 of branches infected), and that are free to grow in the open, can outgrow dwarf mistletoe infection and leave the dwarf mistletoe in the lower crown. Severe infestations cause growth loss, reduction in wood quality, and an increase in mortality. Damage is more serious in stands over 100 years of age than in younger stands. Dwarf mistletoe is prevalent in the old growth stands and on legacy hemlocks in younger stands across the SWBCA. Forty to sixty year old trees that are adjacent to infected legacy trees are beginning to show signs of infection in many stands.

Sitka spruce is susceptible to the white pine weevil (previously known as the Sitka spruce weevil *Pissodes strobi)*. The weevil lays its eggs on the terminal shoot, and larvae then mine the phloem and girdle the leader, causing it to die and curl. Damaged trees are often overtopped and suppressed by other species. Surviving spruce may have forked and crooked tops and a bushy appearance. Weevil infection is highest in warmer, drier areas, while areas immediately adjacent to the coast are low hazard due to cool climate (Holmberg et al. 2006). Weevil populations and attack rates typically stabilize and begin to decline as trees reach heights of 30 feet. Incidence of spruce weevil appears to be low within the SWBCA, although it does contribute to overtopping of spruce by other species in many stands. It should not be much of a long-term concern, however, as trees will be greater than 30 feet relatively soon in most stands.

Laminated root rot pockets, caused by the fungus *Phellinus weirii,* were noted in several stands on the Conservancy's ownership during the IRM inventory. Although western hemlock is susceptible, this fungus is typically rare in spruce-hemlock forests and commonly found in natural and planted Douglas-fir stands (Thies and Sturrock 1995). It spreads through ectotrophic mycelium in roots and root grafts and moves outwards from infections centers at a rate of approximately 30cm per year, slowly creating an expanding pocket of mortality. Spread by spores is thought to be unimportant compared to vegetative spread, but little is known about how new infection centers get started in stands without previous history of the fungus (Thies and Sturrock 1995). While its effects are currently small in the SWBCA, it could become a larger factor in Douglas-fir plantations in the future.

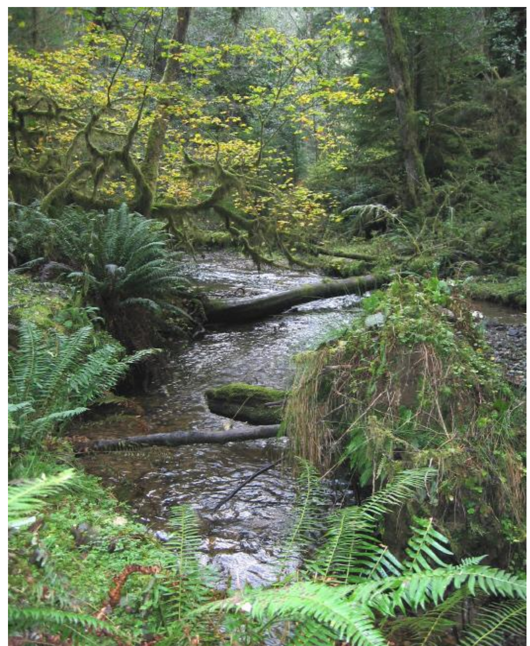
Mature western hemlock stands are susceptible to epidemics of the hemlock looper (*Lambdina fiscellaria lugubrosa*), a defoliating caterpillar. Outbreaks typically occur in old hemlock stands, but recently have occurred in 60 year old second growth (Holmberg et al. 2006). Outbreaks last 3-4 years and can kill large areas of stands dominated by western hemlock (Edmonds et al. 2002). Other conifers within these stands are also heavily fed upon and can die as well. Recent anecdotal observations indicate that stands whose vigor has been enhanced by thinning are relatively resistant to surrounding epidemics (Holmberg et al. 2006). Pentilla (2002) states, "a section of timber was decimated by a hemlock looper infestation in 1931", according to Pentilla (2002). Also, it has been reported that a large scale looper infestation occurred in Northwest Oregon, stretching from Astoria south to the Tillamook Burn Area. In addition, a conversation with a local resident revealed that vicinity of the forested stands on Long Island were sprayed with DDT around the same time period, to address a hemlock looper infestation. SWBCA. As mature hemlock stands in this region have been almost entirely been converted to younger plantations and are likely to be managed under short rotations for the foreseeable future, it is unlikely that major outbreaks will reach the SWBCA. However, as the hemlock dominated forests mature, an outbreak is possible and could result in large-scale mortality. It is also unknown what the effects of climate change will be on the lifecycle dynamics of the looper and other invertebrates that cause tree mortality.

Bear damage largely occurs in the spring when the sap is running and other food sources are scarce.

Animal damage to trees from black bears, porcupines, mountain beavers, beavers, and rubbing from ungulates appears to be a persistent, but low-level source of tree wounding and mortality. Bear damage to western redcedar has been noted throughout the SWBCA. It is not a concern it terms of affecting the long-term goal of developing late seral structure, however, unless bear populations increased significantly from present levels. The only exception is the significant effect of elk and deer browse on conifer regeneration, especially in riparian corridors. Efforts to underplant western redcedar will need to address this fact or risk failure.

B. Freshwater Stream Systems

Based on the Washington State DNR hydrography GIS layers the SWBCA contains approximately 46 miles of fish bearing streams and 115 miles of non-fish bearing perennial and seasonal streams. The streams have been classified according to the Washington State DNR stream classification system (WADNR WAC 222-16-031) and are shown in Map – SWBCA WADNR Stream Types. Stream types include fish bearing (F), shoreline (S), non-fish bearing (N), and (U) for unknown. These coastal streams are all rain fed, have their highest flows during the winter months, and flow regimes that are highly sensitive to rain storms. Most of these streams have been surveyed and overall stream condition in terms of salmonid fish habitat and biotic integrity ranges from fair to good (Table 7). However, road building, forest harvesting, diversion dams, and diking have increased sediment inputs, blocked fish passage, decreased abundance and recruitment of large woody debris, and exacerbated peak flows due to the expansion of the stream network.


Ellsworth Creek

Ellsworth Creek is by far the largest watershed and drains approximately 5,000 acres. Rentmeester (2004) conducted a thorough inventory of large wood debris (LWD) loading and stream geomorphology. He divided the watershed into headwater channels that drain less than 500 acres, and mainstem channels that drain more than 500acres and have an average slope of less than 3%. Headwater channels matched or exceeded LWD loading levels found in unmanaged streams in western Washington (Fox 2001), while mainstem channels were generally deficient in total volume and especially in large, key pieces. He attributed this to the fact that headwater channels receive the majority of their LWD inputs from debris flows (Bilby R. E. and Bisson 1998a) which have increased due to forest management (Powell et al. 2003). Mainstem channels, on the other hand, depend on bank erosion, stand mortality, and transport from upstream. Harvesting has thus depleted recruitment rates and piece size. Without the large, key pieces that form pools and debris jams smaller wood that is transported from upstream tends to get flushed out much faster. Increased recruitment of large pieces in mainstem channels will take many decades, if not centuries, as most inner riparian zones along mainstem channels are dominated by red alder, which breaks easily and does not persist nearly as long as large conifer logs (Cederholm et al. 1997).

The Washington Department of Ecology selected Ellsworth Creek as 1 of 10 statewide core reference sites for their stream biological monitoring program (WA DOE 2004). Using the River Invertebrate Prediction and Classification System (Plotnikoff and Wiseman 2001), biotic integrity was found to be very high (Table 7).

Table 7: Stream conditions for the SWBCA. Streams type classifications are displayed on Map – SWBCA WADNR Stream Types.

Stream Name	Drainage Area:km²	B-IBI [a] RIVPAC [b]	LWD Rating	Channel Complexity[c]	Substrate Suitability[d]
Ellsworth[e]	20	1.03[2]	Good: headwater Poor: Mainstem		
Headquarters[f]	0.7	42	Adequate: above dam Poor : below dam	Poor: above dam Moderate: below dam	Moderate
Long Island Cedar Grove[f]	1.9	40	Adequate	Moderate	Good
WDFW #0674[g]	2		Adequate	Good	Good
WDFW #0675[g]	1.3		Poor	Poor	Poor
WDFW #0677[g]	2.6		Adequate	Moderate	Moderate
North Creek[h]	1.9	46	Poor	Moderate-good	Good – moderate
Middle Creek[h]	2.6	42	Poor	Moderate-poor	Good – moderate
South Creek[h]	2.1	38	Poor	Moderate	Poor
Lewis 1[f]	2.5	36	Poor - adequate	Moderate - high	Good
Porter[f]	1.7		Poor - adequate	Poor	Poor
Riekkola[f]	3.0				None: above dam

Notes:
a: River Invertebrate Prediction and Classification System (RIVPACS) score. A score of 1 means that 100% of expected invertebrates were present (Plotnikoff & Wiseman 2001).
b: Benthic Index of Biotic Integrity (Kerans & Karr 1994). A composite measure of invertebrate community composition. A score of 50 is the highest score
c: Channel complexity is a general evaluation of the ratio, quality, and quantity of pools, riffles, and off channel habitats.
d: Rating of suitability of substrate for spawning of salmonids.
e. Source: Rentemeester 2004, WA DOE 2004
f. Source: Barndt et. al. 2000
g. Source: Wright & Callaghan 2002
h. Source: Yoshinaka & Stone 2004, Conklin (2003)

A series of much smaller creeks drain the watersheds on the north and west sides of Bear River ridge and to the west of Bear River (Table 7). They flow directly into Willapa Bay or into Bear River. The headwaters of some of these creeks are owned by the Conservancy while others are owned and managed by the Washington Department of Natural Resources or other private landowners for most of these creeks. Long Island also supports a number of small creeks. Most of these creeks have adequate levels of overall LWD, although a few are noticeably deficient. Similar to Ellsworth, large pieces are much less common, and future recruitment is limited by the dominance of red alder along inner riparian zones as well as the young age of many of the conifers in riparian areas. Macro-invertebrate communities have been sampled in many of these creeks, and B-IBI scores (Benthic Index of Biological Integrity; Karr et al 1986) range from fair to good or 32-42 out of 50 (Yoshinaka & Stone 2004, Conklin 2003). Channel complexity, including pool ratios and volume, riffles, and off channel habitats, are variable between streams, as is substrate suitability for spawning by salmonids. Beaver ponds were observed in many of these streams as well as log jams that form potential fish barriers. Human created barriers such as high gradient or disconnected culverts and dams are also present on several creeks. In general, stream surveys (see references in Table 7) found that habitat quality for salmonids varied from poor to good, with most of the streams rated moderate to good. There are also two small artificial ponds on Long Island, but neither have suitable fish habitat.

C. Forest Roads and Other Infrastructure

1. *Forest Roads*

Assessments of forest road conditions were completed for the Ellsworth Creek Preserve in 2001 (CWC 2001) and the Refuge in 2005 (Stringer 2005) following consistent methods and field protocols. The Ellsworth Creek inventory describes conditions, at the time, for 72 miles of forest road across 7,900 contiguous acres. Some of this land has since been transferred to the Refuge and additional lands have been acquired. However, the general conclusions and site specific assessments remain valid regardless of current ownership. The Refuge inventory describes conditions for 28 miles of forest road across 7,800 noncontiguous acres (Stringer 2005).

Although the road systems for the Refuge and Ellsworth Creek Preserve are often contiguous, they nonetheless differ in the density of roads present (6.3 mi/mi^2 on Ellsworth vs. 2.3 mi/mi^2 on Refuge) and in the general condition of those roads (poor condition at Ellsworth vs. fair condition at Refuge). These differences can often be attributed to differing topography and geology, but also to road age, and previous ownership patterns. Ellsworth Creek Preserve lands are typically steep and deeply dissected whereas Refuge lands are generally less steep. Roads at Ellsworth Creek were frequently built across steep landslide prone terrain that is less common on Refuge lands. However, roads on both properties have not been well maintained in recent years, due to changing ownership and the relative remoteness of sections of the road system (e.g., Long Island). This has led to a general reduction in the condition of forest roads throughout the planning area.

A variety of mass wasting hazards exist on road systems across the SWBCA. An analysis of forest history chronology that maps road building, logging and landslides was conducted and found a strong correlation between road building and the incidence of landslides (CWC 2003). Fill slope failures have resulted from overloading of fill slopes with sidecast material, especially on roads cut into steep mid-slope terrain. This type of road is quite common on Ellsworth Creek though less so on the Refuge; thus significant failure risks remain. Secondly, stream crossings are susceptible to mass failure when poorly constructed (i.e., some at Ellsworth Creek that were built without culverts) or poorly maintained. Risks can increase with age as old galvanized culverts rust through. These conditions have been exacerbated or triggered by insufficient or poorly designed drainage from the road surface and ditches.

Running surface erosion caused by poorly designed or maintained road surface drainage has resulted in degradation of road conditions, particularly in areas where grades are steep and roads are graded flat. Also, improperly placed cross drain culverts have caused major erosion of the outboard slope in places.

Some roads within the planning area are shared through easement with other neighboring landowners. These easements may affect the nature and timing of maintenance actions on these roads. Easement holders have specific access rights and maintenance responsibilities that are described in the legal title documents for those properties. Similarly, access to some areas can only be gained through neighboring land and roads (e.g., the new Rodgers addition to the Ellsworth Creek Preserve). A Bonneville Power Administration (BPA) high voltage power line runs through the Ellsworth Preserve and portions of the refuge. BPA has broad authority to access the power infrastructure through both properties by roads that roughly parallel the power corridor.

2. ***Rock Pits***

Eleven rock pits exist within the Ellsworth Creek Preserve. None are known inside the Refuge. These rock pits were quarried to build and maintain the existing road system. The pits vary in size and condition from approximately 2,500 ft^2 to perhaps 25,000 ft^2 and from overgrown to open and functional. Rock quality has been informally assessed at the sites that are strategically located and likely to produce good quality road rock. Hard crushed rock is also available for purchased from Weyerhaeuser's Templin pit which is enclosed by Preserve and Refuge lands. The Refuge will continue to procure rock materials from commercial sources such as this.

The Conservancy will develop rock from its own pits for use on roads within the Preserve, or where road easements exist outside the Preserve, to upgrade and maintain the road system with the goal of reducing road related impacts to aquatic habitat. Development of rock resources will occur following the guidelines and commitments discussed below in the Management Approach section.

3. ***Building Infrastructure and Other Resources***

A number of structures exist at various locations across the Refuge for administrative and maintenance purposes. The Refuge headquarters is located along US Hwy 101 across from the south end of Long Island. Administrative functions for the Willapa refuge complex are located in a remodeled residence with two neighboring shop buildings, fuel storage and equipment parking. Public parking, interpretive signage, a pit toilet and a boat ramp are located along the highway at the headquarters. The Refuge manager quarters are located near the south end of the north Bear River unit. A small shop is located on the south end of Long Island, near the boat ramp access. The Refuge's main heavy equipment storage and maintenance shop is located at the Reikkola unit at the south end of Willapa Bay. Access is from the west off Sandridge Road.

One structure, a small cabin acquired in 2008 on the Larwick property, exists within the Ellsworth Creek Preserve. Although it generally removes structures from the lands it acquires, the Conservancy chose to retain this structure for the potential utility it provides. The Conservancy intends to chiefly use the cabin as lodging for out of area researchers, volunteers or other work crews directly engaged in stewardship activities on the Preserve. Occasional small events, meetings or retreats may also occur.

The cabin is constructed almost entirely of Sitka spruce lumber milled from the surrounding property. It has full kitchen and bathroom facilities, two small bedrooms and a loft. Water is supplied via rain collection from the metal roof. Sewage is treated in a septic drain field. Power consists of a 12 volt battery system, recharged by a small solar panel, which supplies a few lights.

The Conservancy recognizes the long term potential for human disturbance this type of development presents, especially in the context of marbled murrelet recovery. Currently, the cabin is located within a young forest stand, less than 20 years old. The nearest suitable murrelet nesting habitat is about ¾ miles away. Although this is too far to cause concern, the potential for disturbance will increase in the future as stands near the cabin mature. Therefore, the Conservancy commits to removing the cabin and reforesting the site in 2038, 30 years from its date of purchase. In the interim, the Conservancy will conduct necessary repairs to maintain the cabin in usable condition. Should the cabin fall into disuse or disrepair and become unusable the Conservancy will remove it at that time.

MANAGEMENT CONSIDERATIONS

Old-growth western red cedar at Teal Slough

A. Desired Future Conditions

On 23 June 2006 a joint workshop between the Conservancy and the Refuge and facilitated by Stewardship Forestry Alternatives was held to identify the desired future ecological conditions for the SWBCA. Several themes for desired future conditions emerged from the discussion during the workshop, some of which are already captured by the goals listed in the introduction to this plan. In this section we describe the major elements of the desired future conditions for the SWBCA: ecosystem resistance to environmental perturbation at multiple scales, spatial and temporal heterogeneity, functional landscape linkages, and provision of habitat for late-successional species and species of concern.

1. *Ecosystem Resistance and Resilience to Perturbation at Multiple Scales*

Ecosystem resistance and resilience to perturbation—disturbances and environmental change—emerged as a major component of the DFC for the SWBCA landscape. Resistance is the capacity of an ecosystem to withstand perturbation, while resilience is defined as the degree to which an ecosystem is able to return to initial conditions following perturbation (Halpern 1988). We define perturbation here to include both punctuated events such as windstorms, fires and floods, as well as the protracted process of large-scale climate change. Perturbations are a critical and unavoidable component of any ecosystem.

Wind Disturbance

Managed landscapes, such as the SWBCA, have been altered such that the response to typical perturbations is different from that of unmanaged landscapes. For example, past harvest has created forest stands with hard edges, decreasing forest ecosystem resistance to wind disturbance (Ruth and Harris 1979). Across the SWBCA landscape, stands historically contained relatively high densities of large, old, wind firm western redcedar, indicating the prevalence of a chronic, low severity disturbance regime and not a high severity, catastrophic regime. Past harvesting, regeneration, and thinning practices have dramatically reduced both large and young western redcedar in most of the SWBCA landscape. Dense, even-aged western hemlock and Douglas fir dominated stands are now the dominant stand type and are much more susceptible to catastrophic blow down (Beese 2001). The high stand density causes trees to have high height:diameter ratios, with stand stability reaching a minimum in the mature (*sensu* Franklin et al. 2002) stage. During early maturity, where natural single cohort stands are just beginning to transition into multi-cohort structure and composition, the likelihood of high severity wind disturbance is greatest (Acker et al. 2000, Greene 1992, Harcombe P.A. et al. 2004, Harcombe P.A., Harmon, M.E., Greene, S.E. 1990, Harris 1989, Jane 1986, Rebertus et al. 1997, Wimberly and Spies 2001). A likely outcome for these single cohort western hemlock dominated stands originating from catastrophic disturbance (timber harvest) is to move into a high-severity wind disturbance regime, in contrast to the historical low severity wind disturbance regime that maintained the landscape in a high proportion of old-growth (Figure 10 – Stand Structure-Mediated Wind Disturbance). High severity disturbance is undesirable in this scenario because the affected area is returned to the early stages of stand structural development, which is at odds with another DFC for the SWBCA landscape (see *Provision of Habitat for Late-successional Dependent Species* below). Consequently, a major DFC for the SWBCA landscape is to return the system to a state where wind and other disturbance results in low to moderate severity tree mortality or breakage and further development of old-growth forest structure, and away from a state that is susceptible to catastrophic, high severity events that restart forest development.

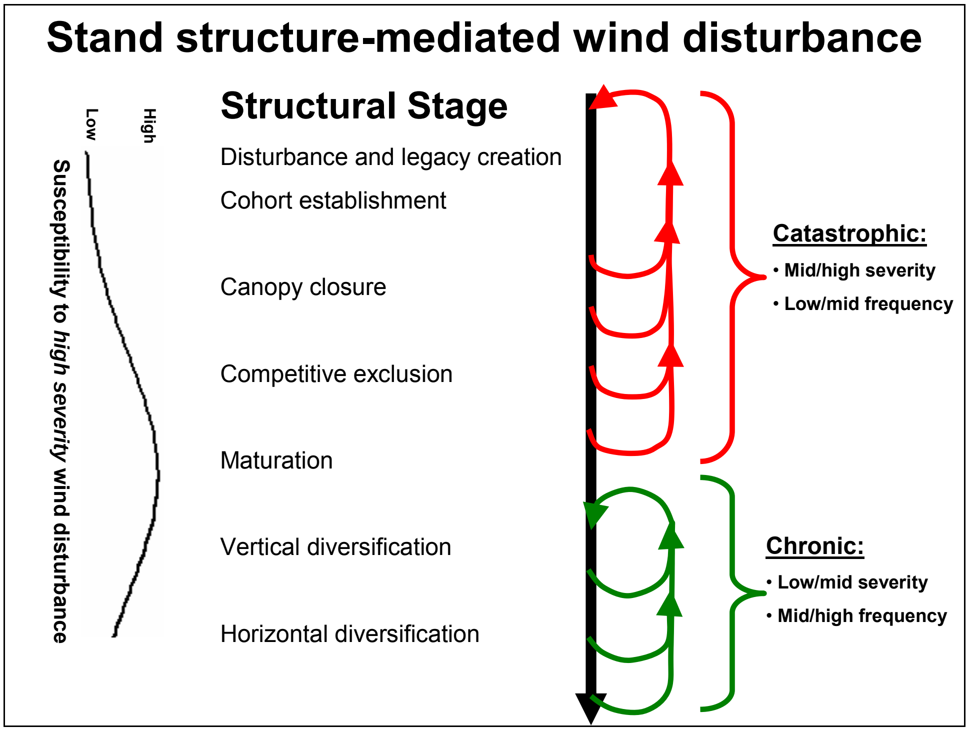


Figure 10: Stand structure-mediated wind disturbance

Fire Disturbance

In light of the old (750+ year old) red cedar still extant upon the landscape, suggest that the stand replacement fire regime interval for this area is 750 years or more. With the roading and harvesting of the area over the past 60 years, there are significant fuel breaks across the landscape—such as forest roads and young plantations. Consequently, the opportunity for a stand replacement level fire on a landscape level will be remote until the area reaches the desired future condition when the landscape simulates an old-growth regime.

On the other hand, smaller sized natural fire evens will periodically occur resulting in gaps throughout the forest. These may be man caused and/or lightning caused events. With the existing road network and State fire protection infrastructure in the area, these smaller fire events will be kept to relatively small acreages. These periodic events will be replanted with cedar and spruce to introduce these species across the landscape.

Insect Disturbance

As detailed earlier, observations of the extant old growth stands reveal that hemlock cohorts appear to be cycling at a different periodic rate than the cedar. The cedar appears to be cycling at a 750+ year interval; whereas, the hemlock appears to be cycling at a 200-300 year interval. It appears that the affect of periodic hemlock looper outbreaks, followed by a break down of the hemlock within the stand, followed by prolific seeding, followed by periodic wind events shape the uneven aged, species mosaic within old growth stands. This type of uneven aged natural cycling within these stands will likely continue across this coastal landscape.

Climate Change

Creating conditions across the SWBCA landscape that will facilitate resistance to climate change also surfaced as a DFC during the workshop. This objective is particularly difficult, as forecasting climate change and the accompanying consequences for the SWBCA landscape is an inexact, uncertain proposition. A cautious approach to management will be necessary, as attempts to "engineer" the SWBCA ecosystem in anticipation of climate change could easily result in undesirable (and dysfunctional) ecosystems. Returning the landscape to a resilient state requires the fewest assumptions, and likely carries the lowest level of risk of any anticipating-climate-change management action. This conservative approach will entail maintaining the suite of naturally occurring species. It may be desirable to manage for a relatively greater proportion of Douglas-fir, a naturally occurring tree species in the SWBCA landscape, than existed historically. Because Douglas-fir is able to occupy a broad range of biophysical conditions (McKenzie et al. 2003), maintaining a substantial Douglas-fir component may provide increased resistance to some climate change scenarios. However, the range of Douglas-fir is expected to remain stable or contract in the SWBCA landscape (Whitlock Cathy, Sarah L. Shafer and Jennifer Marlon 2003) (Shafer et al. 2001) suggesting that dramatically increasing Douglas-fir abundance may be unwarranted.

2. ***Landscape Composition and Pattern: Spatial and Temporal Heterogeneity***

Ecosystems are dynamic biophysical constructs, changing through time and across space. Natural disturbance events alter developmental processes and create a mosaic of compositionally and structurally complex conditions across the landscape (Turner et al. 2001). This disturbance mosaic is overlaid on the underlying physical template, adding even further heterogeneity to the landscape (e.g., Harcombe et al. 2004). With respect to stewardship of the SWBCA landscape it is important to recognize that the functioning "natural" landscape will almost never be entirely maintained in late-successional conditions. Late-successional conditions may dominate, and by all indications did dominate in recent pre-settlement times in the Ellsworth drainage (Powell 2003). Pre-settlement conditions on Willapa NWR lands are less well known. Based on landscape position—relatively greater exposure to winter storms—Long Island probably supported relatively lower levels of old-growth and a relatively greater proportion of successional stands originating from high severity wind disturbance. In addition, the large contiguous patches of old-growth forest that characterized historical landscapes had high within-patch heterogeneity (Franklin J.F. and Van Pelt 2004, Spies et al. 2002) described in section B, 3 different types of old growth forest exist within the SWBCA landscape that have different degrees of vertical and horizontal complexity. This complexity at multiple spatial scales is thought to be a key element of supporting biological diversity.

Current landscape pattern and composition is entirely the product of forest management (Powell et al. 2003). The SWBCA landscape is a mosaic of different aged stands, most characterized by a single cohort age structure (*sensu* Oliver and Larson 1996) with patches separated by linear, hard edges formed by clearcutting. Using the 1908 conditions as a reference and knowledge of natural disturbance regimes, the desired future condition, with respect to landscape composition and pattern, is a state characterized by a high proportion of structurally complex forest at multiple scales. Over time, much of the landscape will likely develop into late-successional forest. At the stand scale, a future condition of multiple types of old-growth with their respective degrees and patterns of complexity is desired. Some patches of old growth should have a high level of patchiness, understory development, vertical canopy layering, species diversity, and tree size distribution, while others should be relatively uniform with more of a single-storied, closed canopy. At the landscape scale, however, disturbance agents will create patches of younger age classes through time. Thus rather than a DFC of certain proportion of late successional forest, the landscape level DFC is maintenance of spatial and temporal heterogeneity by natural disturbance processes, except for fire which will be actively suppressed.

3. ***Functional Landscape Linkages***

The different ecosystem types (e.g., estuaries, streams and terrestrial uplands) contained in the greater SWBCA do not exist as independent units with discrete, impermeable boundaries. At the most basic level, the nature of these cross-system linkages is characterized by the transfer of material and energy across system boundaries. This transfer can be mediated by both physical and biological agents. For example, geomorphic events and processes (e.g., landslides, debris flows, hill slope hydrology) deliver the basic habitat constituents (sediment, woody debris and fine allotochonous organic inputs, and water) from terrestrial ecosystems into streams (Benda et al. 1998, Benda et al. 2004, Bilby R.E. and Bisson 1998a, Naiman et al. 2000) Further physical processing within the stream ecosystem, for example by flood events, transfers these materials (and new materials originating from within the stream ecosystem) to estuaries, and ultimately, the marine environment.

Biotic agents also transfer materials across ecosystem boundaries. Beavers (*Castor canadensis*) are a classic example of a biotic agent mediating entry of terrestrial organic materials into aquatic ecosystems (Naiman et al. 1998). Beaver activity also influences rates of material processing within the stream ecosystem (e.g., sediment and water retention behind dams). An important attribute of biotic-mediated transfer of material across ecosystem boundaries is the potential to move material against physical/energy gradients. Perhaps the best known example from the Pacific Coastal Ecoregion is the movement of marine derived nutrients (MDN) from the ocean through estuaries and into streams by anadramous fish (McClain 1998). The MDN contained in the salmon carcasses can then be further translocated by a secondary biotic agent (i.e. carnivorous mammals) from the stream ecosystem into terrestrial habitats, where the MDN are ultimately incorporated into the terrestrial vegetation (Helfield and Naiman 2006). Both beavers and anadromous fish are present in the SWBCA.

A DFC for the SWBCA is to restore and maintain functional landscape linkages for the movement of material across ecosystem boundaries, such that the functioning of each component ecosystem is maintained. Implicit within this objective is the restoration and maintenance of material pools that have been depleted by past management, such as the distribution of large live trees and woody debris across the landscape. Also subsumed within this broad desired future condition is constraining the rate of delivery of materials within the bounds of a "natural" range of variability —e.g., poorly designed, constructed or maintained road networks alter patterns of delivery of sediment and water from uplands into streams, inhibiting stream functioning and degrading habitat.

4. ***Habitat for Late-successional Dependent Species***

Late-successional habitats are extremely rare in the low elevation forests of southwestern Washington. The SWBCA plays a key role in the regional landscape since the Refuge and Preserve host some of the last old-growth forests in the area, and are some of the only locations where late-successional forests will be promoted and allowed to develop, assuming the current management regime of private forest land in southwest Washington does not drastically change. Of particular interest is the marbled murrelet, a seabird that requires large branches for nesting, typically of sizes found only on old-growth trees. Silvicultural intervention is thought to be a means to accelerate the development of late successional forest attributes in previously harvested forests. Long term restoration research at Ellsworth Creek will explore coastal forest restoration pathways at a landscape scale. These studies will provide valuable insight into effective strategies to accelerate the development of old-growth structure to provide habitat for late-successional dependent species. To be clear, the goal is habitat for late-successional species in general, rather than specific habitat elements, as in many single species restoration plans (Carey 2003a). It is assumed that returning the SWBCA to a condition where natural, as opposed to anthropogenic processes, are allowed to operate will result in the development and maintenance of late-successional habitats that provide suitable habitat for multiple late successional dependant species (see Spatial and Temporal Heterogeneity).

5. *Desired Future Conditions: Synthesis*

The desired future condition for the SWBCA is one characterized by resilient, functioning terrestrial, aquatic and estuarine ecosystems. This condition necessitates that landscape level linkages be intact, and that rates and quantities of materials flowing through system linkages are consistent with those that produce desired functionality. Recognizing that natural disturbance events will stochastically (randomly) occur, the DFC for SWBCA, in terms of landscape and stand level pattern and content, is also characterized by a spatially and temporally heterogeneous distribution of patches at various stages of response to (i.e. time since) disturbance. In contrast to current conditions, the desired future structure of the landscape will primarily be controlled by natural process, as opposed to human disturbances such as the recent management regime of timber harvest. It is assumed that the amount of late-successional forest habitat will increase substantially from the current level as the DFCs are realized.

B. Scientific Justification

1. *Scientific Basis for Restoration Silviculture in* Spruce-Hemlock Forests

Since the implementation of the Northwest Forest Plan restoration of young, previously harvested forest to late-successional structure, composition and function—particularly habitat function—has emerged as a management objective for many public, and increasingly, private forest lands. Large scale silvicultural experiments, as well as reconstructions of the developmental history of old-growth forests have been undertaken in an effort to inform silvicultural interventions in young previously harvested forests designed to accelerate the development of old-growth characteristics (Carey 2003b, Carey et al. 1999c, Harrington et al. 2005, Hunter 2001, Muir et al. 2002, Poage and Tappeiner 2002, Tappeiner et al. 1997, Winter et al. 2002a, Winter et al. 2002b, Zenner 2005). These studies have identified manipulation of forest stand density and species composition as a primary strategy for restoring late-successional characteristics in previously harvested young stands.

Truncating or completely bypassing the competitive exclusion stage of forest structural development is the core idea underlying the theoretical basis for restoration of late successional characteristics in young-managed conifer forests along the Pacific Northwest Coastal Region. With this direction in restoration, competitive exclusion is abbreviated via stand density management, and typically accomplished silviculturally with thinning (DeBell et al. 1997) - although planting at low densities following harvest may also minimize the competitive exclusion stage if natural regeneration is not abundant. Thinning reduces stand density, thereby increasing the relative amount of resources (light, water, nutrients) available to the residual stems left following thinning (Oliver and Larson 1996, Smith D.M. et al. 1997). Decreasing overstory density also increases the amount of resources available to understory herb and shrub species because the residual trees left following thinning cannot capture all of the available resources on the site. Understory vegetation in thinned stands has been shown to be more similar to old-growth than unthinned young stands (Bailey J.D. and Tappeiner 1998, Garman et al. 2003, Lindh and Muir 2004, Thysell and Carey 2001). Thinning stimulates establishment and development of understory shade tolerant conifers (Alaback and Herman 1988, Bailey J.D. and Tappeiner 1998, Curtis et al. 1998, Harrington et al. 2005, Ruth and Harris 1979). A vertically continuous understory and midstory shade tolerant canopy is a defining characteristic of old-growth forests (Franklin J.F. and Van Pelt 2004, Franklin J.F. et al. 2002). Recruitment of shade-tolerant trees is a rate-limiting factor in the development of old-growth structure (Acker et al. 1998, Keeton and Franklin 2005). The rate of understory development in natural stands is also related to overstory composition; understory plant community development proceeds particularly slowly in stands with a strong dominance of western hemlock in the overstory (Stewart 1988). Therefore, thinning provides a mechanism to accelerate the rate of development of old-growth canopy structure in young, single cohort stands, particularly in coastal stands dominated by western hemlock.

Responses of forest biota, in terms of both direction and magnitude, to thinning are variable across species. Abundance and development of understory vegetation including shade tolerant trees appears to increase in most cases (Bailey and Tappeiner 1998, Alaback and Herman 1988, Harrington et al. 2005, Ruth 1979, Lindh and Muir 2004, Bailey and Tappeiner 1998, Garman et al. 2003, Curtis et al. 2000, Thysell and Carey 2001). In contrast, thinning tends to adversely affect macrofungi species richness and biomass, at least in the short-term, and thinned stands tend to have less evenly proportioned species composition (Colgan et al. 1999, Durall et al. 1999, Fogarty et al. 2001, Norvell and Exeter 2004). . Thinning appears to have little or no effect, however, on lichen diversity (Curtis et al. 2000, Peterson E.B. 2002, Peterson E.B and McCune 2001). Because lichen diversity and abundance are positively related to stand age, development of the lichen communities in forests is thought to be a dispersal limited process (Curtis et al. 2000, Sillett et al. 2000). Hardwood patches have been identified as "hot spots" for epiphytic lichen diversity in young-managed western coniferous forests (Neitlich and McCune 1997), suggesting thinning entries should conserve hardwood tree species if maintenance of lichen diversity is an objective. Initial results have found little effect of thinning on invertebrate communities (Schowalter 2003); although additional time since treatment may reveal a treatment effect. Similar to lichens, hardwood trees are associated with increased diversity of arthropods in young conifer dominated stands (Muir et al. 2002, Schultz and De Santo 2006), suggesting that thinning treatments should maintain tree species diversity if arthropod diversity is a management objective. Thinning dense young conifer stands improved conditions for several bird species and heterogeneous thinning treatments including substantial unthinned "skip" areas within the thinned matrix appear to provide the greatest benefit to songbirds (Hagar et al. 2004, Hayes et al. 2003). Thinning effects on small mammals are quite variable across species, making generalizations difficult (Suzuki and Hayes 2003). Based on habitat associations and thinning effects on vegetation it is thought that thinning could have positive effects on small mammal populations (Carey 2000, Hayes et al. 1997). However, conclusive results linking thinning treatments to changes in small mammal populations remain elusive.

Studies of the habitat requirements of the northern spotted owl and its primary prey species (Carey 2000, Hayes et al. 1997) provide insight into the desired future forest structure and composition conditions and suggest pathways for managing young forests towards these specific late-successional characteristics. However, views differ about the types and scales of spatial patterning that should be introduced in restoration thinning treatments—termed variable density thinning (VDT) (Carey and Johnson 1995, Carey et al. 1992, Carey et al. 1999c), especially in regards to managing for listed species. Spatial heterogeneity, a defining characteristic in VDT prescriptions, is conspicuously lacking from restoration silviculture recommendations designed specifically to maximize marbled murrelet habitat development in coast redwood stands to identify in greater detail the DFC (in terms of forest structure and composition) for young forests being managed for late-successional characteristics. Data from these studies form the basis of arguments about the types and scales of spatial patterning that should be introduced in restoration thinning treatments—termed variable density thinning (VDT) (Carey 2003b, Carey et al. 1999a). Silvicultural strategies for developing murrelet habitat are forced to balance the tension that arises due to two conflicting objectives: 1) promoting the development of nesting habitat (i.e. large tree and branch size, multi-layered canopies) while 2) minimizing understory plant response to stand density reductions (which can have the effect of increasing local populations of murrelet nest predators (Carey et al. 2003)).

Partial harvest for timber production objectives in spruce-hemlock forests of southeast Alaska resulted in complex stands with old-growth attributes (Deal et al. 2002). Similarly, understory plant communities in partially cut stands did not differ from understory plant communities in uncut old-growth forests (Deal and Tappeiner 2002). These results suggest that silvicultural systems can be designed to produce economic benefit and timber products while simultaneously maintaining stand structural diversity and old-growth conditions (Deal et al. 2002). With respect to restoration silviculture in spruce-hemlock-cedar forests, these results provide circumstantial evidence in support of the idea that woody biomass can be removed during restoration silviculture treatments without compromising the objective of enhancing the development of old-growth structure. Additionally, biomass removal in thinning is not expected to adversely affect management objectives related to woody debris because stems removed in thinning entries will be from small size classes and primarily western hemlock, which decomposes rapidly (Edmonds et al. 2000, Hennon and Loopstra 1991). Woody debris loads are primarily limited by piece size, not total amount. Thinning treatments, even with biomass removal, will accelerate the rate of production of large woody debris by increasing residual tree diameter growth rates. However, the long term effect of removing biomass early on in stand development is one of the key uncertainties in restoration silviculture and will be examined as part of the experiment being installed within the Ellsworth Creek Adaptive Management area.

Results from research and current scientific thinking support the notion that thinning can be used successfully to direct and accelerate the development of forest vegetation structure and composition towards old-growth conditions, although results characterizing effects of thinning on some populations of forest biota are not yet available or able to be generalized. However, to the best of our knowledge restoration silviculture has not been attempted in coastal spruce-hemlock-cedar forests. One exception might be the "Fresca" block of the Olympic Habitat Development Study (Harrington et al. 2005) which is located in a spruce-hemlock stand. Most of the studies cited above share one condition: they were conducted in Douglas-fir forests. With respect to restoration silviculture, spruce-hemlock-cedar forests differ from Douglas-fir forests in several critical ways, including different environmental regime, species composition and relative abundance, and especially the dominant disturbance regime. One of the central underpinnings of restoration silviculture in Douglas-fir forests is that anthropogenic suppression of low and moderate severity fire has removed the key intermediate, natural disturbance agent that reduces stand density and creates spatial complexity (Spies et al. 2002a). Thinning is thus needed to take the place of fire. Conversely, wind, the primary driver of spatial complexity in Sitka spruce forests, remains very much part of the system. Thus, the available restoration literature (primarily studies in Douglas-fir forests) must be transferred to coastal forests with great care, with restoration prescriptions formulated as working hypotheses.

Applying principles of stand dynamics and disturbance ecology to achieve DFCs

The preponderance of silviculture studies in the Pacific Northwest have been conducted in Douglas-fir forests and thus don't necessarily translate directly to spruce-hemlock-cedar forests. However, a complimentary approach to transferring inferences about restoration is reasonable, if we begin by understanding where differences occur in spruce-hemlock-cedar stand dynamics and disturbance ecology principles. Thus, in the remainder of this section we further develop the scientific basis for restoration silviculture in spruce-hemlock-cedar forests by considering the relevant silviculture and stand dynamics literature with respect to the DFC's for the SWBCA.

- *Increasing forest stand resistance to wind disturbance:* Stands with a relatively high component of western redcedar tend to be more resistant to wind disturbance (Weetman and Prescott 2001). Historical upland forests in the Ellsworth Creek watershed appear to be dominated by western redcedar (Figure 4 – Historical Forest Composition), and current residual old-growth stands on Long Island are also characterized by large, old western redcedar. As described above, past management has shifted the current landscape to dense, even-aged western hemlock dominated stands that are much more susceptible to high severity, catastrophic blow down. In the absence of future management, structurally complex old-growth spruce-hemlock-cedar forest will take many centuries to develop. Abundance of western redcedar will slowly increase as it preferentially survives wind disturbance events, and will have colonization opportunities following wind disturbance. However, its slower growth early in stand development compared with western hemlock and Sitka spruce puts it at a major disadvantage in the dense single cohort stands that currently dominate the SWBCA. Increasing western redcedar dominance in current young stands via thinning and planting is expected to accelerate the development of large western red cedar, thereby increasing the resistance of SWBCA forests to wind disturbance, and helping to shift the landscape back toward a low-severity disturbance regime.

  A second strategy to increase forest stand resistance to wind disturbance is by decreasing tree height-to-diameter ratios via thinning. Evidence from several studies indicate that single cohort stands become increasingly unstable—less resistant to wind disturbance—as they reach the maturation stage of forest structural development (Harcombe et al. 2004, Harris 1989, Jane 1986, Rebertus et al. 1997). Trees growing in dense, maturing stands reduce their crown depth (Oliver and Larson 1996, Smith et al. 1997). As a result, stems reduce the degree to which they taper and height-to-diameter ratios increase, ultimately leading to less stable trees. Reducing stand density with thinning can decrease height:diameter ratio and increase crown depths, particularly if implemented early in stand development before crowns have been greatly reduced (Ruel 1995, Wilson and Oliver 2000, Wonn and O'Hara 2001). Sitka-spruce and western hemlock are known to increase diameter growth and decrease height-to-diameter ratios in response to thinning (de Montigny and de Jong 1998, Mitchell 2000, Ruth and Harris 1979)

Multi-cohort stands may be more resistant to wind disturbance due to lower height-to-diameter ratios (Mason 2002, Weetman and Prescott 2001). In addition to being more wind resistant, multicohort stands will be more resilient to wind disturbance. Because understory and midstory trees are already established in multicohort stands, overstory canopy gaps created by wind disturbance are likely to be already filled by understory and midstory trees (Winter et al. 2002b). Seedlings establish following thinning in coastal spruce-hemlock-cedar stands at high densities (Alaback and Herman 1988, Harrington et al. 2005, Ruth & Harris 1979), indicating that thinning is a mechanism to begin to transition stands from a single cohort to multicohort condition. Multi-cohort, multi-species stands are also typically more resistant to insect and pathogen outbreaks (Edmonds et al. 2000, Thies and Goheen 2002) and higher in overall biodiversity.

- *Developing late-successional habitat characteristics:* Large individual trees are a defining characteristic of old-growth forests (Franklin et al. 2002, Acker et al. 1998, Franklin et al. 2005), and are a prerequisite to large diameter snags and downed logs. Lack of large trees is the primary component lowering MOGI scores in maturing stands within the SWBCA. Additionally large, complex tree crowns provide habitat for a range of epiphytes, lichens, other plants, and cavity dependent wildlife species which is not afforded by structurally simple young tree crowns. Marbled murrelets also use large diameter branches as nesting platforms (Carey et al. 2003). Ongoing research is drawing increasing attention to the role of large horizontal structures and reiterated stems as drivers of crown level habitat complexity and epiphyte community development. Density management through thinning increases tree diameter growth (Marshall and Curtis 2002, Mitchell 2000, Ruth and Harris 1979) which then sets the stage for the development of larger trees, snags, and downed logs. In addition, increasing the growing space of individual trees slows crown recession (Ruth and Harris 1979, Smith et al. 1997) and enhances the development of large diameter branches (Maguire et al. 1991). Thinning can also stimulate epicormic branch development, particularly on Douglas-fir. Manipulations within crowns of individual trees to promote the formation of trunk reiterations may also be useful for developing murrelet nesting platforms (Berg et al. 1996, Carey et al. 2003). Given the DFCs and the significant lack of late-successional habitat in the regional landscape, accelerating the growth rate of trees, and formation of complex branch systems in young previously harvested stands throughout the SWBCA is desirable.

- *Enhancing spatial heterogeneity*: The spatial uniformity of managed plantations, especially those that underwent extensive site preparation and pre-commercial thinning, is one of the key factors limiting biodiversity. Silvicultural treatments can be used to restore and accelerate the development of heterogeneity at multiple scales and is one of the main objectives of many forest restoration treatments, particularly VDT (Carey et al. 1999a, Carey et al. 2003). In contrast to VDT, which was initially developed around the habitat needs of spotted owls, recommendations for treatments designed to specifically enhance development of marbled murrelet nesting habitat call for more spatially uniform thinning in order to prevent conditions attractive to murrelet nest predators (Carey et al. 2003). A landscape approach for the provision of habitat for listed species must use multiple approaches to provide murrelet nesting habitat and spotted owl habitat simultaneously. Thus, the type, extent and degree of spatial patterning introduced with thinning treatments should reflect the current stand conditions, landscape context, and specific management goals for the particular stand being managed. Some thinning treatments may be relatively uniform, while others more heterogeneous.

- *Restoring landscape linkages:* In many riparian areas dominated by red alder, accelerating the transition to conifer dominated forests and increasing tree diameter growth will increase the availability of large wood. In intensively harvested basins such as the Ellsworth Creek watershed, large diameter woody debris are lacking in streams (Bilby R. E. and Bisson 1998a, Rentmeester 2004). If large woody debris loads of large diameter pieces are below desired levels, it may be desirable to release suppressed conifers from overstory red alder competition with thinning (Deal et al. 2004, Emmingham et al. 2000); particularly in stream reaches where woody debris is delivered primarily from adjacent riparian stands. Thinning in riparian areas to increase the diameter growth of conifers should not eliminate overstory hardwoods however. Hardwoods are a source of diversity of arthropod (Muir et al. 2002, Schultz and De Santo 2006) and lichen species (Neitlich and McCune 1997) and provide qualitatively different allotochonous organic inputs into aquatic systems compared to conifers. Planting may also be required if conifer establishment in riparian stands is seed limited (Beach and Halpern 2001, Emmingham et al. 2000). Thinning dense, conifer dominated young riparian stands can also lead to faster development and recruitment of large wood, although in smaller streams, thinning can reduce recruitment of functional, small diameter logs from competition related mortality (Beechie et al. 2000, Roni et al. 2002). Streams need both large and small diameter logs and thus a mix of riparian thinning and no cut buffers are generally recommended in dense, conifer riparian stands (Naiman et al. 2005), P. Bisson pers. comm. 2006). Thinning to increase the availability of large wood in mass wasting zones is another consideration. Many of these areas are currently densely stocked with young trees and will be able to deliver large wood to the stream network for many decades.

In conclusion, decades of ecological and silvicultural research provide a strong scientific basis for forest restoration in the SWBCA. A treatment regime of density management and manipulating species composition with planting and thinning—tailored to individual stand conditions—will likely achieve the objectives of increasing forest stand resistance to wind disturbance, increasing tree diameter growth rates, restoring functional landscape linkages, and promoting the development of large diameter branches suitable for marbled murrelet nesting platforms. However, the ability of restoration silviculture to accelerate the development of old growth forests remains uncertain, particularly given the tremendous complexity of these forests, climatic variability, the long timeframes involved, and the lack of precedent in coastal spruce-hemlock-cedar forests. It will be necessary to formulate silvicultural prescriptions designed to meet the DFCs and associated silvicultural objectives as working hypotheses to be evaluated within an adaptive management framework.

2. ***Scientific Basis for Road Removal***

The ecological effects of forest roads have been extensively researched in the Pacific Northwest. They alter hydrology by reducing soil infiltration, converting subsurface flow to surface flow, concentrating water through road drainage structures, and increasing peak flows (Jones et al. 2000, Luce 2002). They can result in geomorphic changes, including chronic erosion and elevated sediment delivery into streams (Gucinski et al. 2000, Megahan and Kidd 1972), extension of channel networks (Wemple et al. 1996), and increased risk and rates of mass wasting (Montgomery 1994, Swanson and Dyrness 1975). Roads also influence the ecology of terrestrial and aquatic ecosystems through direct habitat degradation and fragmentation, loss of soil productivity, spread of exotic, non-native species, and associated human impacts as a result of increased access (Gucinski et al. 2000, Newcombe and MacDonald 1991). Individual road segments differ greatly in their ecological impact, however, due to site specific factors such as construction techniques, road grade, hillslope position, climate, basin hydrology, soil properties, and underlying geology (Gucinski et al. 2000, Switalski et al. 2004).

Types of Decommissioning

In order to address the negative effects caused by roads and restore natural hydrologic processes, road decommissioning has become an important management consideration on public and private forestland in the US and Canada. Many different interpretations of the term "road decommissioning" are used by different agencies, however. Depending on management objectives, access needs, road condition, relative risk, and budgets, several techniques or levels of road decommissioning exist. Below is a summary of the basic approaches and terms defined as they will be used the SWBCA.

- *Obliteration:* The goal of obliteration is to remove the road and its associated impacts from the landscape and set the stage for vegetation to re-colonize the site. All culverts are removed and stream crossings are restored by excavating the fill down to the original land surface, re-contouring the stream banks, and installing channel stabilization structures, sediment traps, and re-vegetating where necessary. Compacted road surfaces are ripped, then side cast and other fill material is moved to partially or fully re-contour to the natural hill-slope. Some combination of slash, woody debris, and mulch is typically used to cover the re-contoured slope. Seeding or re-planting is often a final step. Recovering the original topsoil may also aid in re-vegetative success and limit the spread of non-native species on the site (Walder and Bagley 1998). Ideally, following obliteration, subsurface water flow is no longer interrupted; peak flows, sedimentation, and mass wasting rates return to pre-road levels; vegetation recovers; and fragmented habitat is reconnected., This technique is generally restricted to roads that will be permanently removed from the road network, as re-opening an obliterated road costs the same as construction of a new road.

- *Putting to Bed*: The goal of stabilization, or "putting roads to bed", is to eliminate or minimize the hydrological and geological effects of a road, while leaving much of the road prism intact. Culverts and stream crossings are removed, water bars and cross-road drains are installed, and problem sidecast (soil cast aside during road construction) or cutslope areas (areas upslope from the road where soil was removed) are stabilized by removing material and bringing slopes to a stable gradient. In some instances, inboard ditches are removed and the road is out-sloped to restore sheet flow. The road bed may be ripped or left intact, and can be covered with slash, woody debris, or mulch. Putting roads to bed accomplishes three important mitigation goals: it stabilizes unstable fill and sidecast; it removes ongoing hydrologic hazards, allowing streams to run unimpeded; and dispersing concentrated water, surface water to the ground (Walder and Bagley 1998). Once put to bed roads can be left to re-vegetate and fill in through natural processes and subsequently re-constructed for future management entries if and when they are needed.

- *Conversion to Trail:* The goal is to reduce the impacts of the road, while converting it to a motorized or non-motorized trail. High impact stream crossings are typically removed, unstable fill, side cast, or cutslopes are treated, and cross-road drains or gentle waterbars are installed to disperse concentrated water. Lower risk culverts are often left in place and the road is generally not ripped, although some treatment may be done on the sides of the road to reduce the width. Roads can be easily re-constructed for future use. Ongoing monitoring and maintenance of these converted roads are typically necessary to prevent culverts from plugging and erosion and rutting of the trail surface.

- *Road Closure:* Roads are closed with gates, berms, or deep ditches (tank traps) to prevent un-authorized use. The rest of the road is left untreated. In some instances, the first quarter mile or the immediately visible part of a road is re-contoured and re-vegetated to camouflage the road and therefore discourage vehicular travel. Road closures, when effective, can help mitigate road impacts on road-averse species such as bears and elk (Walder and Bagley 1998). Closed roads can be easily re-opened for future use. If abandoned or not maintained, however, culverts may fail when plugged by debris or if they are insufficiently sized to convey peak stream discharges and the road will continue to alter hydrologic processes, and culverts will continue to act as barriers to fish passage (Walder and Bagley 1998).

- *Road Abandonment:* This is the same as road closure except that access is left open. These roads usually remain drivable until re-vegetation or erosion closes them in.

Effectiveness of Decommissioning

Although research into the effects of road decommissioning is relatively new, results indicate an overall positive effect. In Redwood National Park, where full obliteration was first introduced, a major storm in 1997 provided the opportunity to measure the effectiveness of two decades of road removal. Most treated roads produced very little sediment and 80% of the road reaches had no detectable landslides following treatment (Madej et al. 2001). In contrast, untreated roads produced four times the level of sediment delivery as treated roads, mostly in the form of landslides (Bloom 1998, Madej et al. 2001). Full obliteration has also been shown to greatly reduce landslide occurance in western Washington (Harr and Nichols 1993), coastal Oregon (Cloyd and Musser 1997), and north-central Idaho (USFS 2003). Results suggest that hillslope position and slope gradient are important factor in determining treatment success. Although treatments dramatically reduced landslide occurrence and sediment delivery from upper- and mid-slope roads, steep lower-slope roads continued to have high failure rates in some landscapes, no matter what treatments were used (Bloom 1998, Madej et al. 2001) .

Madej (2001) examined 207 stream crossings treated between 1980 and 1997 in Redwood National Park, and found that: "The greater the stream power and the larger the excavation, the more the channel eroded following treatment. Deeply incised channels that required more fill to be excavated were more vulnerable to post-treatment erosion than shallow crossings with less road fill because the reshaped stream banks were steeper and more likely to fail. Erosion following treatment is highly variable, and many site-specific conditions (such as the presence of bedrock, springs, poorly drained soils, incomplete excavations, and use of sediment control measures) can influence post-treatment erosion as well." In general, both Madej (2001) and Bloom (1998) found that most treated crossings produced very little sediment and none triggered landslides or debris torrents. Five to 20 years after culvert removals, Madej et al. (2001) found that pool habitat in excavated streams had only partially recovered but a riparian zone of young red alder was providing a closed canopy and shade over the streams.

The effectiveness of road decommissioning at reducing chronic erosion and sediment delivery has also been examined. A short-term problem with decommissioning occurs following treatment when bare re-contoured slopes or ripped road surfaces are most susceptible to erosion (Switalski et al. 2004). While erosion has been shown to increase post-treatment, rates typically decline within one growing season and eventually mimic natural slope conditions as vegetation returns (Gucinski et al. 2000, Luce 1997, Switalski et al. 2004, USFS 2003).The key to reducing chronic erosion is re-vegetation. Adding soil amendments, including sidecast topsoil, slash, mulches, biosolids (residual materials from wastewater treatment), and fertilizers to ripped road surfaces or re-contoured slopes has been shown to effectively increase infiltration and re-vegetation rates (Bergeron 2003, Bradley 1997, Luce 1997, Switalski et al. 2004). In regions where rapid natural revegetation occurs, such as coastal areas like the SWBCA, little to no mulching or replanting may be necessary.

Overall, results suggest that while road decommissioning creates short-term disturbances that can temporarily increase sediment delivery, it can reduce chronic erosion and the risk of landslides over the long term (Switalski et al. 2004). However, these conclusions are far from settled and site specific factors have a large influence on results (Luce 2002, Switalski et al. 2004). Also, the larger question of how effective road decommissioning is at restoring functional landscape linkages of stream and terrestrial ecosystems is only beginning to be addressed. The experiment being conducted in the

Ellsworth Creek Adaptive Management Area is expected to provide importation contributions to these questions.

3. ***Risks associated with Active vs. Passive Management***

While a solid scientific basis for active restoration of the SWBCA exists, there are risks and impacts that must be weighed and analyzed. Natural processes created existing old growth forests over hundreds of years, and some authors argue that managed forests are likely to eventually develop into old growth on their own (Spies et al 2002, Winter 2002a), although climate change is a major wild card. In addition, thinning and removing wood can have numerous negative impacts that may set landscapes back ecologically. These may include elevated risk of annosum root rot, soil compaction, loss of nutrients and organic matter, invasive species, loss of habitat features (snags, tall shrubs, rare plants), detrimental disturbance to sensitive wildlife, and negative impacts of forest road systems such as chronic, elevated sediment delivery to aquatic systems and habitat fragmentation. If stands are thinned heavily, the open canopy can cause excessive understory shrub response or western hemlock regeneration that can reduce habitat value for some species. Moreover, thinning to promote ecological objectives is relatively new and more complex than traditional thinning for spacing. There is always risk of misguided prescriptions and poor implementation that can homogenize or over-thin stands. Current research indicates that the fine scale spatial patterns of trees left following typical thinning treatments are different from those of overstory trees in old-growth forests (Larson, unpublished data). Specifically, thinning can result in residual trees being spaced some minimum distance apart, and this minimum spacing is greater than that observed for some overstory trees in old-growth forests. Thinning treatments , therefore, have the potential to eliminate a fine-scale spatial pattern characteristic of old-growth forests: closely spaced pairs and clumps of overstory trees as well as dense thickets of midstory trees.

Conversely, there is also a risk in walking away and letting nature runs its course. A number of researchers contend that plantations will not develop into old growth due to the suppression of diameter growth and increased windthrow risk from developing at high densities (Andrews et al. 2005, Poage and Tappeiner 2002, Spies et al. 2002a). Forests within the SWBCA are structurally and functionally very different from landscapes dominated by old growth forest, both at the stand and landscape scales. Stands also lack the legacies, species composition, and spatial complexity of a young forest recovering from a natural blowdown event (Kohm and Franklin 1997, Lindenmeyer and Franklin 2002). As described above, the whole system is likely to shift from a chronic, low-moderate severity disturbance regime to a high severity, catastrophic regime if left alone. Population declines in numerous terrestrial and aquatic species are unlikely to be reversed under such a scenario. Given the tremendous reduction of old growth habitat in the region, the recovery of these species may depend on actively restoring functional landscape linkages and encouraging specific structures and habitats.

Windthrow Risk

Stability of trees on wind prone sites is related to individual tree characteristics such as height, species, diameter, crown size, crown density and root or stem rots as well as site characteristics such as rooting depth, soil moisture, rooting substrate and topographic exposure and stand density (Edmonds 2002). In dense competitive exclusion stands, trees tend have high height to diameter ratios with small crowns and narrow rooting zones resulting in trees that are susceptible to complete blowdown or stem breakage when they are exposed to strong winds. Western hemlock, with its shallow roots and structurally weaker stems, is especially susceptible (Holmberg et al. 2006). In these dense stands, however, the neighboring trees provide shelter and support, thus reducing the potential for windthrow. Forest management can affect many of the tree and stand characteristics that drive the likelihood of windthrow. On one hand, thinning can lead to more stable trees with lower height to diameter ratios, especially if done early in stand development. On the other hand, opening up dense stands with tall, windthrow-prone trees can increase windthrow risk. Careful analysis of these two factors is critical in successful use of silviculture to achieve old growth structure.

A windthrow probability model developed by Scott and Mitchell (2005) for Vancouver Island was built into LMS to assess the current winthrow potential of stands and potential changes caused by treatments on the SWBCA. Parameters used by the model are height to diameter ratio, percent live crown, crown density, rooting substrate, post-thinning density and variable retention fetch, which is a measure of the level exposure of a tree to winds. These parameters for trees with a DBH of >4" are used to estimate the probability of windthrow for each tree in a unit after harvest. These probabilities are averaged for the entire stand for an overall windthrow probability. The current conditions of the SWBCA have a generally low probability of windthrow (Map – SWBCA Average Windthrow Probability) because many of the stands are dense providing shelter and support for reduced probability of windthrow. If not done carefully, active management could alter the current stability and increase the probability of windthrow within treated stands.

Topographic exposure is an important aspect of windthrow that was not used in this model. Scott and Mitchell (2005) compared their stand level model with a more complex model that incorporated topographic position and storm patterns with structural variables. Based on field verification, they found that the stand level model predicted windthrow risk as well or better than the more complex model. Nevertheless, topographic position must also be taken into account in evaluating windthrow risk. As winter storms that affect the SWBCA generally come from the southwest, areas with a south and western exposure, especially along Bear River Ridge and the west side of Long Island, would be expected to have a higher potential for windthrow. Ridge tops are also areas of high exposure to winds and windthrow of trees. Evidence of this is seen in the SWBCA where there are areas on ridges with a higher proportion of wind-firm western redcedar and less windthrow-prone western hemlock.

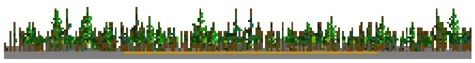
Modeling thinning treatments

To analyze the potential benefits and risks from thinning, the Pacific Northwest Coast variant of the Forest Vegetation Simulator (FVS) (Donnelley 1997) growth model was used within LMS to model several basic treatment scenarios on 2 stands within the SWBCA (#17484 and #30027). FVS tends to grow stands that have a lower height to diameter ratio and lower density than those found in the real world. Fortunately growth in FVS can be adjusted. For this model FVS was calibrated by setting a maximum SDI of 800 for all species other than Douglas-fir, which was set to 600, and then reducing the basal area increment for the stand incrementally as it approaches the maximum SDI value. These adjustments result in QMD increments that approximate those Curtis and Marshall (1986) found in the LOGS studies as sites in SW Washington. As FVS is a not a spatially explicit model, it cannot model horizontal spatial variability. It also does not model natural understory regeneration, but understory trees can be added in. The simulators utility lies in modeling growth rates, mortality, changes in stand density, height to diameter ratios, and crown development. In terms of old growth structure, it can thus predict the development of large trees, snags, downed logs, and shifts in species composition and diameter distribution. The Modified Old Growth Index (MOGI) was incorporated into LMS to measure these output variables. A snag to downed wood algorithm and a decay function that accounts for differences in decay rates by species and log sizes were both built into the LMS MOGI output. This approach is similar to other simulation studies that have used growth models to test the effects of thinning on development of old growth structure (Acker et al. 1998, Andrews et al. 2005, Garman et al. 2003)

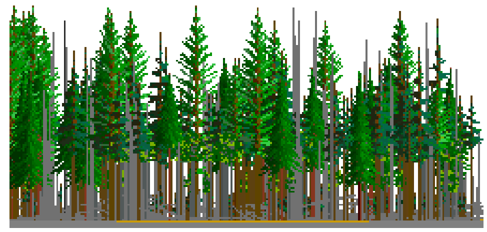
The first stand, #17484 is a dense 13 year old plantation, but young enough where tree competition has not become intense. Three treatment scenarios were run: 1) a no-thin, 2) 2 light thinning entries (L-L) in 2010 and 2035 to increase diameter growth while favoring western redcedar and Sitka spruce, and 3) a heavier initial thinning (H-T) to encourage Douglas-fir growth followed by a second thinning where nearly all Douglas-fir are removed. The stands were grown out 50 years. Both the thinning treatments moved the stand from hemlock dominance to redcedar and Sitka spruce dominance and result in significantly higher diameter growth than the no-thin. The H-L treatment results in larger number of big trees (20-40" dbh). The MOGI value is higher in L-L because of a higher number of large snags (20"+dbh) and more downed wood. The All MOGI values are heavily influenced by the presence of large volumes of dead wood. Mortality from self-thinning within FVS is known to be excessively high and thus it is likely that actual snag TPA and CWD volumes will be lower in all scenarios, but especially in the no-thin. The excessive mortality also reduces diameter growth suppression in dense stands and number of large trees and snags may be even lower in the no-thin scenario. L-L may provide the best trajectory to move the stand to a higher MOGI as it balances diameter growth with snag and downed wood generation. However, a large input of dead wood could easily be created by a windthrow event in the H-L scenario. This dead wood would likely be larger than in the other two scenarios and thus persist for longer. Both L-L and H-T have a SDI of 333 at year 2055 and may need to be thinned in the future to maintain tree growth. Finally, windthrow risk was not affected by thinning.

The second stand #30027 is a 76 year old, dense western hemlock stand on Long Island. Its current MOGI score is low due to a lack of snags over 20" dbh and low downed wood levels. Three treatment scenarios were also run: 1) no-thin, 2) a single mid-story thin (H) to encourage development of trees over 40 inches dbh, and 3) 2 lighter thins (L-L) to remove trees in the 6-20 inches dbh classes to reduce competition and encourage overall tree growth. Both the thinning options increase MOGI over the no-thin alternative due to a higher number of trees over 40" dbh. Downed wood is lower in both the thinning treatments, while large snags remain the same. The relatively small increase in diameter growth from thinning is due to the stands older age and the fact that competition has reduced crown lengths. In general, once conifers in this region start slowing down in height growth around age 70, their ability to build crown and accelerate growth rates in response to thinning decreases (Oliver and Larson 1996, Tappeiner et al. 2002). Older trees still respond to thinning, however, and growth responses are generally observed over time (Latham and Tappeiner 2002). The same issues with the FVS as discussed above are likely reducing the difference in diameter as well. Of the two thinning treatments H has a slight decrease in windthrow probability over no-thin because average height:diameter ratio improves as many of the small diameter trees are removed with little change in the amount of exposure to the overstory trees. In contrast, L-L does increase windthrow potential by further exposing the overstory trees to wind by reducing the density of the overstory in the second thinning.

The two treatment scenarios are provided as a modeling exercise and do not represent actual prescriptions that will be implemented. The results of these treatment scenarios are presented in SVS visualizations in Figures 11 and 12. The images are caricatures and do not represent the actual location of trees in the stand. These scenarios do show, however, that opportunities do exist for accelerating the development of large trees and snags, and shifting species composition, without dramatically affecting the amount of live and dead biomass on the site. Thinning treatments can also be designed to minimize a future increase in windthrow probability. Having the windthrow model implemented within LMS allows assessment of treatments in a gaming context to assess changes in windthrow to guide the development of prescriptions. More than anything, the scenarios clearly show that thinning early in stand development produces much greater differences in diameter growth over later thinning.



Current, Age 12

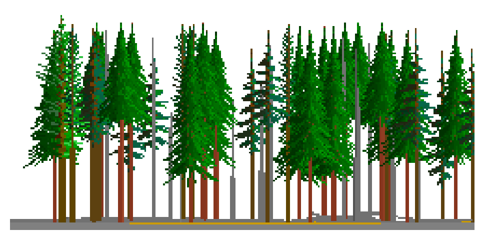


Age 52 No-Thin

		No Thin	L-L	H-L
Year	**2005**	**2055**	**2055**	**2055**
Age	12	52	52	52
TPA	2,328	1,035	126	133
DBHq	1.1	6.9	18.4	17.8
Avg. Ht	8	54	105	110
SDI	66	574	334	333
Vol/Ac	0	34,215	50,083	37,278
Wind Pb	0.00	0.00	0.01	0.01
MOGI	11	43	56	45
10-19.9"	0	123	72	84
20-39.9"	0	11	39	48
40"+	0	0	0	0
L Snags	0	2	14	5
CWDVol	1087	5581	4960	3688
DDI	10	42	51	50

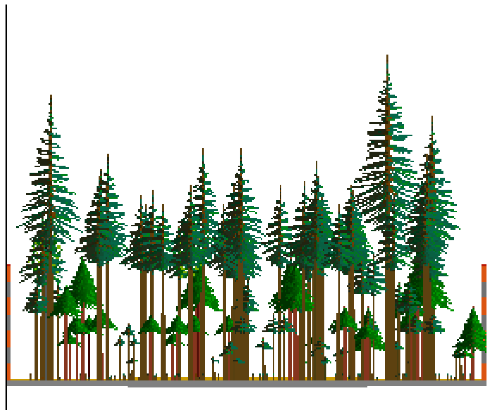
DBHq: Quadratic mean diameter (inches)
Avg Ht: Avg height (feet)
LCR: Live crown ratio
SDI: Stand density index
Vol/Ac: Scribner bf volume/acre (mbf)
Wind Pb: Windthrow probability
MOGI: Modified old growth index
10-19.9": Trees per acre of trees 10-19.9" dbh
L snags: Snags per acre over 20" dbh
CWD vol: Cubic volume of CWD; ft^3/ac
DDI: Diameter diversity index

Age 52: 2 Light Thins (L-L)

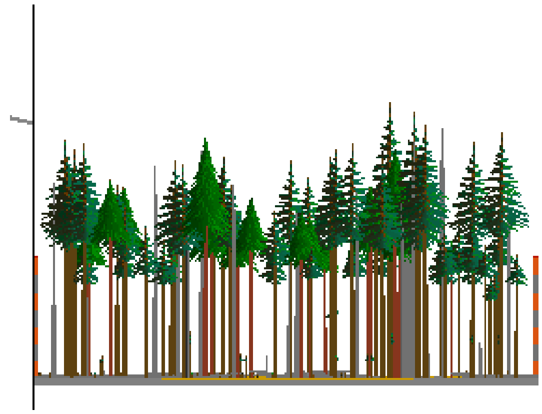


Age 52: 1 Heavy, 1 Light Thin (H-L)

Figure 11: Treatment scenarios and results for stand # 17484.



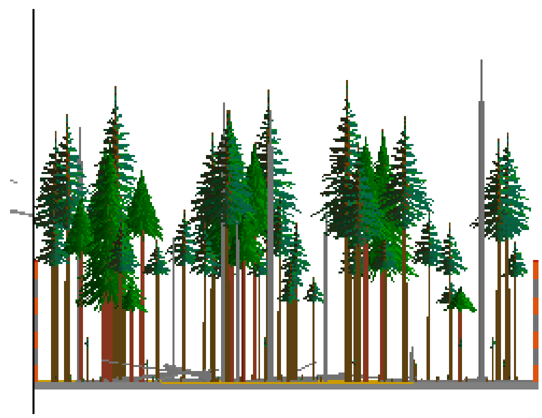
Current, Age 76



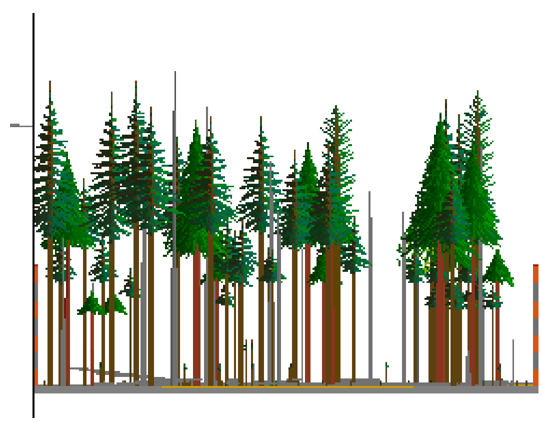
Age 126 No-Thin

		No Thin	H	L-L
Year	**2005**	**2055**	**2055**	**2055**
Age	76	126	126	126
TPA	590	428	285	223
DBHq	10.4	12.37	13.46	13.48
Avg Ht	46	66	52	52
SDI	628	602	459	440
Vol/Ac	69.0	87.1	84.6	81.5
Wind Pb	0.01	0.13	0.12	0.19
MOGI	29	64	71	69
10-19.9"	148	115	49	26
20-39.9"	42	50	40	46
40"+	1	2	5	4
L Snags	0	14	13	15
CWDVol	1003	7379	6009	6586
DDI	65	65	71	65

DBHq: Quadratic mean diameter (inches)
Avg Ht: Avg height (feet)
LCR: Live crown ratio
SDI: Stand density index
Vol/Ac: Scribner bf volume/acre (mbf)
Wind Pb: Windthrow probability
MOGI: Modified old growth index
10-19.9": Trees per acre of trees 10-19.9" dbh
L snags: Snags per acre over 20" dbh
CWD vol: Cubic volume of CWD; ft^3/ac
DDI: Diameter diversity index



Age 126: 1 Heavier Thin (H)



Age 126: 2 Light Thins (L-L)

Figure 12: Treatment scenarios and results for stand # 30027

C. OPERATIONAL CONSTRAINTS

1. *Staff Capacity*

The Refuge and the Conservancy have limited resources devoted to management and restoration of the forested landscape. Existing staff resources for the Refuge include a Refuge Manager and Wildlife Biologist, while the Conservancy's staff includes a Program Director, and Project Ecologist. Both managers are responsible for all stewardship, managerial, and administrative issues on their respective ownerships while the biologist and ecologist lead research and monitoring activities. A Forester and Forest Technician are also employed by the Conservancy to meet obligations under existing federal grants for implementing restoration actions across the SWBCA landscape. These two positions are largely dedicated to scoping and supervising contract work associated with road removal and forest thinning projects. Additional support for road removal comes from a small staff of heavy equipment operators at the Refuge who can be assigned to restoration projects as time allows.

2. *Financial Resources & Considerations*

Financial resources to cover the expenses of restoration come from internal operating funds, public and private grants, and other private fundraising activities. As of 2006, two federal grants comprise the majority of all funds used for restoration – a U.S. Fish and Wildlife Service Community Conservation Initiative (CCI) grant ($750,000) and a grant from the Nestucca Oil Spill Mitigation Fund ($215,000). The five-year (2005-2009) CCI grant is administered by the Conservancy specifically to remove or repair 15 miles of forest road and ecologically thin 1,500 acres of young-managed forest across the SWBCA. Nestucca mitigation funds are administered by the Refuge primarily for road removal, forest restoration, and monitoring of marbled murrelet populations on the Refuge. Given the existing staff capacity, these grant resources are expected to cover the on-the-ground costs of restoration activities through 2008. It is expected that approximately 3-5 miles of forest road and 500 acres of young-managed forest can be treated on an annual basis during that time period. Beyond 2008, additional funds must be raised through some combination of new grant sources, fundraising efforts, or the sale of timber from restoration thinning to sustain restoration activity within the SWBCA.

While producing revenue is not the primary management objective, the ability of the Conservancy and Refuge to fund road decommissioning, road maintenance, and forest and stream restoration activities will be significantly affected by the revenue that can be produced from forest thinning. Even though the decision of when and how to treat stands will be driven by ecological criteria, the costs and potential revenues from alternative treatments must be factored in as they will determine what is economically feasible. The following assumptions and considerations will be used to assist managers in being as efficient as possible while allowing for the generation of revenues within the boundaries of the overall ecological objectives.

Management Costs

The costs of management activities will always be highly dependant upon regional rates within the forest industry in southwest Washington and northwest Oregon (Table 8). Fortunately, this region has a high likelihood of maintaining its forest management infrastructure over time and so costs should stay relatively low compared to other geographic areas. Ranges for average costs for different activities were researched relative to the local area. These numbers are only contractor costs and do not include administration costs. They also will change over time.

Table 8: Average range of contractor costs for management activities in 2006 in southwest Washington - administration costs are not included. Costs are expected to change constantly over time.

Management Activity	Contract cost range
Ground based thinning (less than 35% slopes)	$125-175/ mbf (1000 board feet)
Cable thinning (uphill) (greater than 35% slopes)	$200-250/ mbf
Cable thinning (downhill)	$300-350/ mbf
Helicopter Yarding	$350-450/ mbf
Hauling	$30-65/ mbf
Pre-commercial thinning	$100-150/ acre
Falling and leaving selected trees. (MDL treatments)	$40-50/ hour
Vegetation Control (Manual slashing)	$0.50 per seedling
Vegetation Control (Spot spraying)	$0.40 per seedling
Planting & Browse Control	$150/acre (100 tpa)
Road Obliteration	$15,000-100,000/ mile
Putting roads to bed	$5,000-50,000/ mile

Reducing harvest costs is dependent on a number of factors.

- Projects must be large enough to absorb a contractors mobilization costs (moving equipment in and out) and keep the equipment and crews busy for as long as possible.
- Projects should aim to be at least 50 acres in size for any single type of yarding, and over 100 acres for combined operations (e.g., cable/ ground).
- Several stands may make up one project, but stands should be as close together as possible.
- Thinning should be combined with road decommissioning in one contract to increase project size and get better bids as many logging contractors have excavators and bulldozers and are happy to have more work for their machines.

Another major factor in reducing yarding costs for forest thinning is production rates (Kellog et al. 2002). As logging contractors base their bids on the estimated number of truck loads they can produce per day, average yarding distances, volumes removed per acre, and log size will largely determine yarding costs. For ground base yarding, average yarding distances should be no more than 600 feet with a maximum yarding distance of 1,200-1,500 feet, depending on whether yarding is uphill or downhill. Distances can be longer, but it is general ecologically less damaging and economically advantageous to build temporary spur roads to avoid longer distances. For uphill cable yarding, 1,000-1,200 feet average distance is ideal with a maximum of 1,600-1,800 feet. Downhill cable yarding is much slower and damaging, and distances should be no more than 500 feet. For helicopter yarding, average distance should be no more than 1 mile, and ideally 0.5 miles. In terms of log size, the larger the logs that will be removed, the higher production rates will be. As the planned thinning in the Refuge and Conservancy ownerships will involve thinning primarily small trees (7-14 inches dbh), production rates will be slower and costs higher. Finally, production rates are highly dependent on the volumes per acre removed. In general, removing less than 10 mbf (thousand board feet) per acre of small diameter, low value logs with cable yarding is not economically viable. This level can be lower if higher value species such as red alder are removed or ground based yarding is being used. Overall, it is unlikely that it will be economically desirable to remove wood in stands younger than 25 years of age, or in stands with total volumes less than 20 mbf/acre. However, there are no magic numbers in terms of age, standing volume, or tree size for when wood should be removed during a thin. Site specific conditions, prescription objectives, contractor rates, log prices, thinning history, and many other factors play into these stand by stand decisions.

Due to the relatively low economic value of western hemlock (which will be the primary species removed within the SWBCA), the removal of small diameter trees, and the amount of steep ground that will require cable yarding, it will be a challenge to ensure that thinning projects are economically viable. To address this reality, managers should creatively factor in logging system requirements into prescriptions and work constructively with contractors. For example, heavier thin areas and gaps can be placed in areas that are closer to landings and easy to yard from, while lightly thinned areas and skips can be left to the logging contractor to place in areas that are difficult to yard from. If done with care, this approach can reduce costs without sacrificing any of the desired ecological objectives.

Costs for pre-commercial thinning (young drop-and-leave), planting, and vegetation control are also driven by production rates. Dense stands with larger trees will be more expensive to pre-commercial thin. Also, complex prescriptions that are hard to understand and implement will increase costs. Yet, with creativity and through trial and error, prescriptions that achieve the desired ecological objectives can be made simple enough for most contractors to implement at competitive rates. SWBCA managers have already begun to work closely with contractors to make this happen. Costs for road decommissioning are determined by the level of re-contouring desired, topographic position, grade, road width, the amount of fill or side cast material to be removed, the number of culverts and stream crossings, and how the final surfaces will be treated (mulched, covered with slash, seeded, etc). In general, managers must weigh the ecological gains of full vs. partial contouring against the exponentially higher cost of full re-contouring.

Revenues

Gross revenues from thinning projects will depend on the prices of the species and log sizes that are removed. The primary species to be harvested will be western hemlock, Douglas-fir, and red alder, in that order. Small diameter Sitka spruce and western redcedar may occasionally be removed from stands dominated by those species. Log prices from local mills as of October, 2006 are provided in Table 9, for the three primary species. Although log prices will fluctuate significantly through time, it is likely that the relative order of value for different species will remain the same over the next 10-15 years. Markets for FSC certified logs or logs with unique qualities should be periodically explored as higher prices may be found.

The basic log sizes, or "sorts" currently used by mills are based on inside bark, top diameters, but typical dbh values are also presented using a log length of 30 feet (Table 9). These sorts are likely to change through time as markets and mill technologies evolve. Minimum top diameters are currently 4.5 or 5 inches, which translates into a minimum 7 inches dbh tree. Logs with a top diameter smaller than 4.5 inches may be removed and sold as pulp, but pulp prices are currently too low to make this economical.

Table 9: Average log prices in southwest Washington for Oct 2006. Prices are per thousand board feet (mbf). Tonnage prices for chip and saw logs were converted using 6.9 tons/mbf for Douglas-fir and 7 tons/mbf for western hemlock. Source (Log lines, Oct 2006)

Sort	Western Hemlock	Douglas-fir	Red Alder
Chip & Saw (#4 saw) 5-7" top (7-12" dbh)	$315	$445	$625
Small Sawlogs (#3 saw) 8"-11" top (12-15" dbh)	$410	$500	$730
Large Sawlogs (#1-2 saw) 12"+ top (15-22" dbh)	$440	$575	$830

3. ***Applicable forest practice laws and policies***

The Refuge and the Conservancy must comply with similar but somewhat different set of state and federal laws and regulations when conducting forest management activities. The Conservancy, as a private forest owner, must comply with Washington State Forest Practice Act (FPA) and water quality laws. This requires the Conservancy to apply for permits under FPA regulations for forest management actions that may affect the resources of the state. The Refuge, as a federal agency, is not required to obtain state permits for similar work (the Refuge nonetheless strives to conduct work at or above these standards). The Refuge is required, however, through the National Environmental Policy Act (NEPA), to conduct a review of significant management actions. NEPA also requires the Conservancy to consult with federal natural resource management agencies prior to using federal dollars to conduct management actions.

Riparian Areas, Shorelines, and Wetlands

Based on the current FPA, the approximately 45 miles of fish bearing (type F) streams within the SWBCA are required to have a 170 foot buffer for site class 2 areas and a 140 foot buffer for site class 3 areas on both sides of the stream. Shorelines have the same buffer requirements. Partial harvesting can take place outside of an inner, 50 foot no cut buffer. Non-fish bearing, perennial streams (type N) are required to have a 50 foot no cut buffer on each side, on half of the entire stream length. Harvest machinery is not allowed in forested wetlands, but trees may be removed via skyline or ground based cable yarding.

Topography and Unstable Landforms

As described previously, the steep terrain, heavy precipitation, and susceptible bedrock types make soils in the SWBCA prone to mass wasting events. The Map – Ellsworth Creek Unstable Landforms displays the watershed contains a large number of convergent headwalls, bed rock hollows, inner gorges, and unstable sections of former deep-seated landslides (Map – SWBCA Slope Stability Hazard). These features will need to be carefully identified on the ground when managers plan forest thinning and road removal projects. In order to remove wood from these areas, FPA rules require a Class 4 Special permit. This involves obtaining a geotechnical design and report that describes how the risk of mass wasting and damage to streams, shorelines, and public safety will not be increased.

State and Federal Listed species

The Conservancy and Refuge must follow all applicable laws and regulations pertaining to active management which could impact endangered species. As stated above, a particular emphasis will be placed on avoiding disturbance to listed species. All forest management activities will be aimed at increasing suitable habitat over time.

The principal operational constraints on forest management activities pertaining to listed species occur in relation to marbled murrelets and, to a lesser degree, spotted owls. Both species have specific protection measures codified within FPA regulations. These regulations are largely intended to control the level of impact from industrial scale forest practices, such as clearcut harvesting, where listed species are present. Since forest restoration is the primary goal within the SWBCA, alternative practices may be appropriate. The Conservancy will consult with the appropriate State and Federal regulators prior to implementing alternative practices.

4. ***Access, road network, and logging systems***

The extensive road network in the SWBCA provides sufficient and often redundant access for wood removal for almost every part of the landscape. Recent and planned road obliteration has and will remove access to some areas, although a significant number of road segments can be removed from the system without reducing the number of acres that can be accessed. Maintaining roads on the steep terrain of Bear River Ridge will require significant time and resources. Fully putting road segments in steep terrain to bed between treatments is possible in most cases, but may not be much more economically advantageous than obliteration. The roads on gentle topography to the west and south of Bear River Ridge and on Long Island, however, will be much easier to put to bed between treatments.

On terrain with slopes below 35%, ground based yarding is possible in most cases (Kellog et al. 2002) whereas on steeper ground cable yarding will be necessary. Forwarders can operate on slopes as high as 45%, but they can only move downhill when loaded and must have a gentler path to get to the top of the slope. In stands that are mostly below 35% slope, but have occasional steeper pitches, ground based machinery can pull logs in with a winch when necessary. Landings appear sufficiently close together, in most stands throughout the SWBCA, to avoid the need for temporary spur roads. As the road system is mainly on ridgetops, most stands are well positioned for uphill cable yarding with maximum yarding distances of around 1,200-1.800 feet. Yarding corridors for cable thinning are typically 100-150 feet apart and are 6-12 feet wide. Several contractors in the region have small, light, and mobile yarders that are well designed for thinning small diameter trees and have experience implementing ecologically oriented prescriptions.

5. ***Community & stakeholder context and desires***

Various people, communities and organizations have interest in the Refuge for a variety of reasons and purposes, and must be considered in making management decisions. Local individuals and tourists have common interests in the Refuge as a place that provides hiking, boating, hunting, camping, wildlife viewing, bird watching and interpretation of the natural world. The Refuge is also valued for its role in protecting and enhancing wildlife and natural habitats, apart from these recreational offerings. Local communities use the Refuge as a place to conduct educational field trips. The Refuge is also valued for the aesthetic beauty it imparts to the area and the effect that has on quality of life for residents and for the draw it imparts on tourists.

Local individuals have mixed feelings about the Ellsworth Creek Preserve's value considering its recent history as commercial timberland and the importance of logging jobs and revenue to the local economy. However continuing uses such as hiking and hunting mean that the land is valued for similar purposes under the Conservancy's ownership. Camping is not permitted on the Preserve, and nature interpretation is not currently presented in any regularly organized fashion. The limited drive-in access is valued because most private forestland roads in the area are gated.

RESTORATION PROGRAM AND SCHEDULE

Excavator recontouring at a stream crossing road removal site

A. MANAGEMENT APPROACH

1. *Silvicultural System*

A silvicultural system is a progression of treatments during the life of a stand designed to achieve the desired stand level structural objectives (Smith D.M. et al. 1997). The set of treatments is heavily influenced by the ecosystem characteristics, landowner goals, and management constraints of a particular ownership. The system outlined here for the SWBCA reflects the over-aching goal of restoring resilient old-growth forests and habitat for threatened species, the desire to generate revenue to help defray the costs of landscape restoration, and the ecological dynamics of spruce-cedar-hemlock forests. The system combines silvicultural treatments with natural stand development processes and disturbance agents to shift stands onto development trajectories that meet the DFCs (Figure 13 – Conceptual Harvest Systems). A key principal of the system is to restore the species diversity, spatial complexity, and decadence that exist in natural young stands recovering from disturbance but are not present due to past management. A second key principle is to accelerate the development of large trees, future large snag and CWD recruitment, and vertical canopy layering. A third principal is that while natural processes serve as an important guide, actively manipulating developmental processes to achieve the DFCs may move stands through an unnatural pathway for a period of time.

Response to Disturbances and Forest Health Issues

Unlike traditional silvicultural systems, the system for the SWBCA does not view natural disturbances and forest health issues as factors that must be controlled and stopped to reduce losses to timber value. Instead, disturbances are viewed as key architects of the complexity inherent in old growth forest (Franklin et al. 2002). Dwarf mistletoe, for example, plays a key role in developing murrelet nesting platforms in western hemlock and will generally be promoted in treatments. Wind and annosum root rot act together as major drivers of overstory mortality, decadence creation, and horizontal diversification. Salvage operations to remove wood in blow down patches will not likely occur, as downed logs are a key habitat feature and substrate for tree species colonization. Animal damage often creates decadence in trees that lead to cavity formation in live trees. Decadence in live or dead trees provides critical nesting, hiding, and foraging habitat for suites of wildlife, fungal, and insect species.

While most disturbances are "natural", they may or may not push the stand towards the DFC's. Thus, when disturbances threaten to move stands away from key structural goals, they will be managed or contained as much as is practical. Fire, while a historic disturbance agent, will be actively suppressed, given the small amount of old growth forest left with the regional landscape. Too much annosum root rot can lead to early mortality of the overstory and preclude the development of large diameter trees. It will not be encouraged and stumps will be cut at least 12 inches high to avoid spread. Planted seedlings will be protected from browse to improve their chance of survival. Salvage may occur in cases of severe blow down where subsequent outbreaks of Douglas-fir beetle (*Dendroctonus pseudotsuage)* or other beetles threaten remaining stands. Most importantly, stands will be managed to promote species and structural diversity that will act as a buffer against epidemic outbreaks of hemlock looper, spread of Swiss Needle cast, or catastrophic blow down (Edmonds et al. 2000, Thies and Goheen 2002).

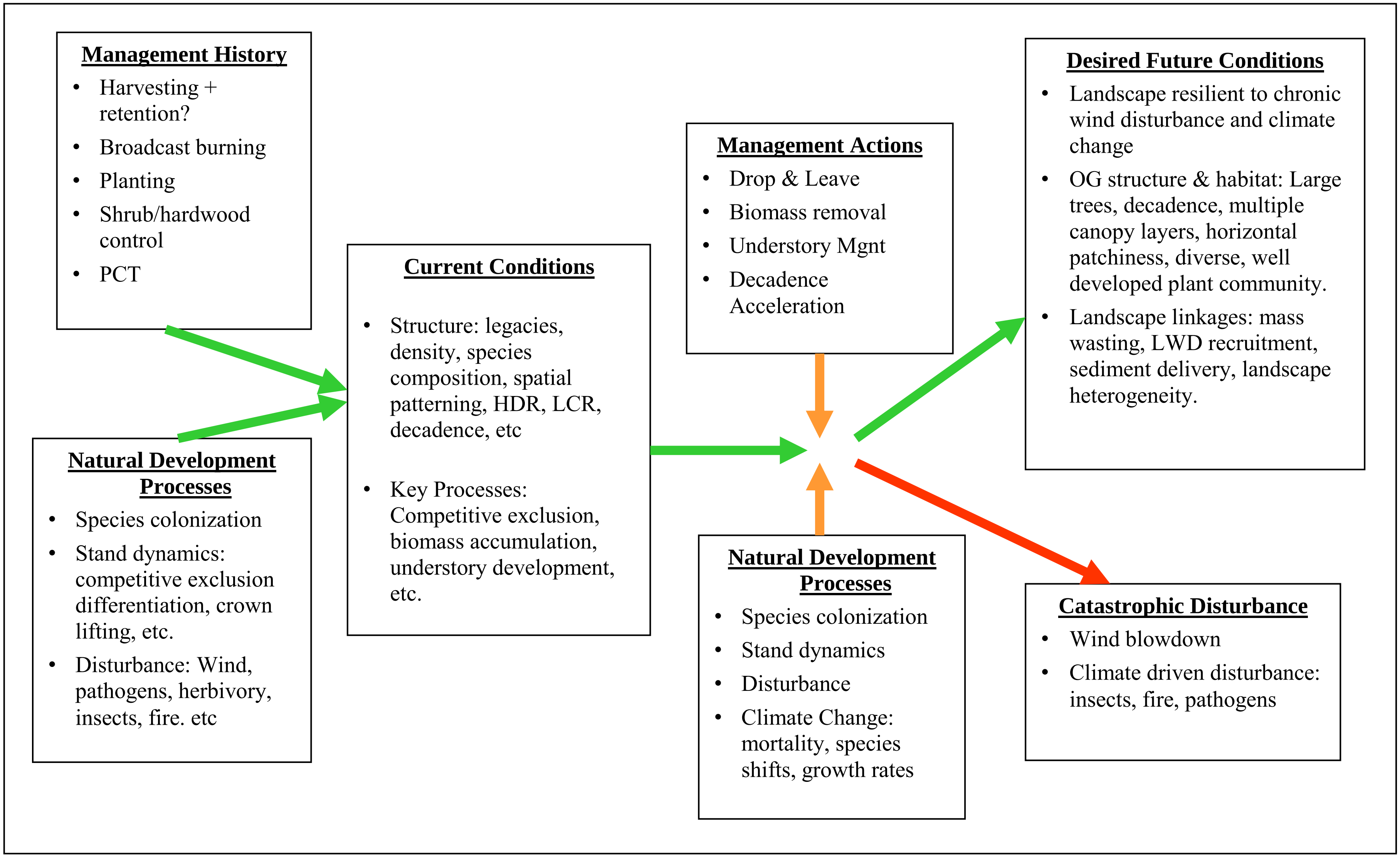


Figure 13: Conceptual diagram of silvicultural system designed for the Refuge and Conservancy ownerships.

New Terminology:
In an effort to distinguish ecologically oriented silvicultural systems from traditional wood production forestry, other ownerships and authors have coined many new terms such as "Thinning for diversity" (Hunter 2001), "Ecological thinning", "Restoration thinning" (Erckmamn and others 2000), "New forestry" (Holmberg et al. 2006), and "Biodiversity pathways" (Carey et al. 1999b). These terms are often vague descriptions of approaches that involve a mix of truly new restoration techniques and traditional silvicultural tools applied to non-traditional objectives. They have generated confusion among stakeholders and the forestry community and skepticism among some older foresters. To avoid confusion, terms from traditional silviculture are used in this plan where possible. However, the silvicultural system defined here is fundamentally different from traditional even or uneven-aged systems where the primary reason to grow and harvest trees is wood production and revenue generation. In this system, the primary reason to cut, remove or plant trees is to achieve ecological objectives. In many cases, the felled trees will be left on the ground. In other cases, the wood will be removed to generate income for other restoration when it can be done without compromising long term ecological objectives. Thus new terms were created for this system to where it is necessary to capture this fundamental difference and also to use terms that more precisely reflect their meaning.

Treatments
The silvicultural system consists of 4 different treatment categories that are described below, each containing multiple treatment types (Table 10). Treatments will be done at various stages of stand development with an end goal of an old growth dominated, self-sustaining forest ecosystem that is not dependent on perpetual management intervention. Unlike even-aged or uneven-aged silvicultural systems, it does not have a regeneration harvest component.

Table 10: Categories and treatment types for the Conservancy/NWR

Category	Treatment Type	Acronym
Drop and Leave	1. Young: Variable Density Thin 2. Mature: Individual Tree Selection	YDL MDL
Biomass Removal	1. Variable Density Thin 2. Individual Tree Selection 3. Group Selection	BR
Understory Management	1. Planting 2. Shrub Control (around seedlings) 3. Browse Protection (seedlings) 4. Understory, Variable Density Thin 5. Invasive Species Control	UT
Decadence Acceleration	1. Snag or Wildlife Tree Creation 2. Course Wood Creation 3. Fungal/Mistletoe Inoculation	DA

a. Drop and Leave

This category applies to all treatments where trees are felled and left on the ground to decompose. Such treatments will be used in both young and older stands when it is not ecologically appropriate and/or economically viable to remove wood from a stand. In dense, young stands (typically 12-25 years old) with small diameter trees that are not merchantable, young drop and leave treatments (YDL) will be used. While these are similar in many respects to “pre-commercial thinning” (PCT) and PCT crews will be contracted to get the work done, they will not be designed to set stands up for commercial harvest, and thus a different name is warranted. Instead of thinning for spacing as in traditional PCT treatments, “variable density thinning” (VDT) (Public Forestry Foundation 2001) will be used. Variable density thinning is similar to traditional thinning in that it seeks to reduce stand density to increase diameter growth and crown development on residual trees throughout a stand. It differs, however, in that it also seeks to create varying densities in a stand to promote horizontal patchiness, species diversity, and multiple canopy layers (Carey 2003b, Lindenmeyer and Franklin 2002). This patchiness is achieved in prescriptions by a combination of favoring certain tree species; varying spacing targets; leaving pairs or clumps of dominant trees, and by adding in “skips” or no thin areas, and heavy thin areas, or gaps.

In older stands, drop and leave treatments will be generally be targeted at fostering specific, individual tree attributes in certain parts of a stand, and not involve treating entire stands to achieve a specific density reduction goal. Examples include increasing habitat suitability near large trees with murrelet nesting platforms, releasing understory conifers in red alder dominated stands, accelerating diameter growth of a selected number of dominant conifers on unstable slopes or riparian areas for future LWD recruitment, and creating small gaps where conifers can be planted. The best term for this approach is “Individual Tree Selection” (Smith D.M. et al. 1997), which is used in uneven-age management systems to target individual trees or small groups of trees for release or removal. This approach has also been called “Individual Tree Culturing” or “Crop Tree Management” – here we use the term mature individual tree selection or just mature drop-and-leave (MDL). In some cases, girdling may be used to kill trees instead of falling them. This is cheaper and usually effective as girdled western hemlock trees tend to fall over quickly (Hennon and Loopstra 1991).

b. Biomass Removal

This category applies to treatments where felled trees can be removed from stands without compromising long term ecological objectives. Treatment types used will generally be variable density thinning, individual tree selection, or a combination of the two. Group selection may also be used to transition some mature red alder stands to conifer dominated stands by creating larger gaps or patch cuts, or to treat extremely dense conifer stands that will not respond well to thinning and are likely to experience significant windthrow. Generally, biomass removal (BR) treatments will occur in 30-80 year old stands were net positive revenue generation is possible, or at least where projects are revenue neutral. While biomass removal treatments are similar to “commercial thinning”, they are not “commercial” in that they are not designed to be intermediate treatments that set stands up for a final regeneration harvest where revenue generation is a major goal. Instead, they are designed to accelerate or reduce specific stand development processes to create complexity and develop old growth structure. What distinguishes them ecologically from drop and leave treatments is that the logs or “biomass” created from felling targeted trees will be removed from the system. Hence, the term “Biomass Removal”. Where necessary or more appropriate, areas of drop and leave treatments may be embedded within an overall biomass removal treatment for a specific stand (i.e. shoreline buffers, unstable slopes, etc).

c. Understory Management

While natural regeneration will be relied on as the main source of understory colonization in stand development, trees may be planted in some circumstances at various stages of stand development. To accelerate the development of a large western redcedar component, it may be planted in stands where it is poorly represented and few overstory trees exist to provide seed source. In stands heavily dominated by red alder, a mix of conifers may be planted in gaps to prevent shrubs from dominating the site and making natural regeneration very difficult (Tappeiner et al. 2002). In general, planted seedlings, along with some natural seedlings of desired species, will be protected from the heavy browse and intense shrub competition that exist in this area until they are "free to grow". Without such follow-up management, survival and growth of planted seedlings is typically poor (Emmingham et al. 2000). Non-native species will also be controlled as needed, especially highly invasive species that can overwhelm native plant communities. Manual and chemical means will be used.

In older stands where the understory tree layer is uniformly dense throughout a stand and is shading out other understory plants, variable density thinning of the understory layer (UM) may be used to create patchy understory and midstory canopy layers. This may be necessary in stands where dense western hemlock regeneration results from heavy overstory thinning or has already occurred in small fragments of mature or old growth forests adjacent to clearcuts. While this type of thinning is similar to young drop and leave treatments, it is specific to managing the understory. In general, understory management will typically be done in conjunction with overstory treatments, but may occur on its own in certain cases.

d. *Decadence Acceleration*

Downed logs, snags, or wildlife trees (e.g., live trees with broken tops, cavities, large branch platforms, or other decadence) may be created in stands deficient in these critical habitat structures. Inoculation of trees with specific fungi or mistletoe may also be pursued where deemed necessary. These treatments may be done in conjunction with other treatments, but may also occur on their own.

2. *Determining and Prioritizing Forest Treatments*

Landscape Scale Management Designations

The first step in determining which parts of the Conservancy and Refuge ownerships should be treated, and which treatment method was appropriate, was done at the landscape scale. Areas of high value to landscape processes, areas high in biodiversity, or other unique or sensitive areas were first identified and the appropriate type of management determined. The experimental treatment (control, road removal, or thin) designations for each basin within the Ellsworth Creek Adaptive Management area was then incorporated. Next, the remaining portions of the landscape were analyzed to determine what categories of treatments were appropriate, given stand conditions and landscape scale considerations (Figure 14 – Decision Model).

As both ownerships had been previously partitioned into defined stands based on past timber management, the final step was to place each stand into a specific management designation based on the above analysis (Map – SWBCA Management Designations). In most cases, designations were clearly prescribed by the management objectives, legal requirements, or practical considerations such as road access or social factors. As new knowledge is gained, forest conditions change, and roads are removed through time changes in designations may occur and boundaries are expected to shift. The designations are described below:

- *Reserves*. These include the existing blocks of old growth larger than 5 acres and the Research Natural Areas. The only management intervention that may take place is fire suppression and removal of invasive non-native species. The area in this category is 965 acres.
- *Control Areas:* These are areas where silvicultural treatments will not take place, for at least the next 10 years, in order to have an experimental control to evaluate the effects of restoration silviculture in other parts of the landscape. They also provide for landscape heterogeneity by ensuring that a portion of young stands remains in an untreated condition. They include the no-thin and road removal basins within the Ellsworth Creek Adaptive Management area, as well as a control area on the north end of Long Island. The total area in this category is 2,418 acres.
- *Limited Management Areas:* These are areas where biomass removal treatments are rarely appropriate given regulatory requirements or organizational management constraints. Other silvicultural

treatments such as drop and leave, decadence acceleration, or understory management treatments may be more appropriate to achieve ecological objectives. Limited management areas include shoreline, wetland, and stream buffers; 300 ft. murrelet buffers around existing old growth stands and occupied habitat; unstable landforms; and a visual buffer around the Refuge headquarters complex. The approximate area in this category is 3,961 acres, although this number is likely to rise as additional unstable slopes or other sensitive areas may be identified and reclassified in the future.

- *Unreserved Management Areas:* This is the remaining part of the landscape where restoration silviculture may be fully applied. The types of treatment used in specific areas will be driven by the process outlined in the decision model (Figure 14– Decision Model). In areas where wood can be economically removed without compromising long term ecological objectives, biomass removal treatments will be done. In other areas, young or mature drop and leave, decadence acceleration, or understory management treatments may be done as needed to achieve ecological objectives. Areas that are not appropriate, or are not expected to benefit from active management, will not be entered (i.e., estuarine forested wetlands, no cut "skips" embedded within other treatments, etc). The total area in this category is 6,828 acres. However, as additional unstable slopes and other sensitive areas may be designated, the total acreage in this category is likely to decrease.

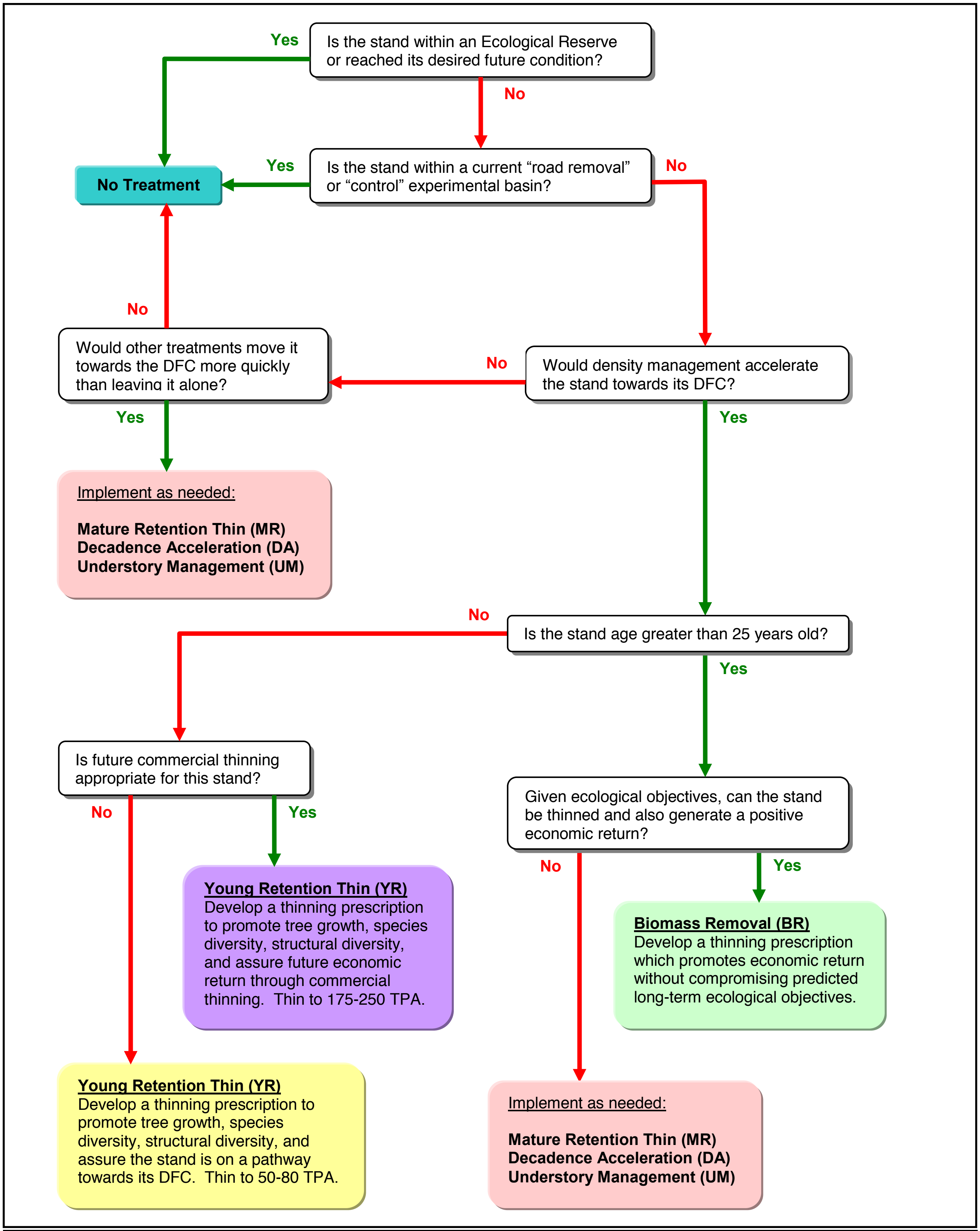


Figure 14: Decision Model for designating treatments on the Ellsworth Creek Preserve and Willapa National Wildlife Refuge.

Prioritization Framework for Scheduling Treatments

Prioritization is rarely a linear, formulaic process. Instead, it involves considering and balancing a number of overlapping, conflicting, or interconnected factors that operate on multiple scales. In order to prioritize treatments for this plan within the given management designations, the following set of considerations were used. The framework provides guidelines for future planning and scheduling efforts and is summarized in Table 11.

Table 11: Prioritization framework for scheduling treatments

Factors	**Components**
Contribution to Major Landscape Goals	• Expand and connect blocks of late-seral forest • Stream Network Function (LWD & sediment) • Murrelet Habitat • Landscape Windthrow Dynamics (restoring landscape level disturbance resiliency)
Coordinating treatments with road system needs	• Grouping stands for treatment within a road system • Putting road systems "to bed" after area is treated • Treating stands were road removal is a high priority
Stand Level Structural Conditions	• Stand density • Windthrow susceptibility: Topographic position and HDR • Response to thinning: Live crown ratio & diameter growth • Thinning window: projected loss of crown & stability • Species loss: competitive Exclusion of WRC
Economic Factors	• Markets, harvest costs, revenue potential • Revenue potential now vs. later weigh against structural tradeoffs
Management Needs:	• Experimental design needs • Regular and manageable work flow • Stable revenue stream

The contribution of individual stands to landscape processes and the timeline in which they can provide key functions were the first considerations that were evaluated. Stands that could expand marbled murrelet nesting habitat, increase availability of large woody debris to the stream network, or enlarge and connect existing blocks of old growth habitat in the short to medium term (5-50 years) were given high priority. Examples include mature drop and leave or biomass removal treatments in 60-80 year old stands to promote trees with large branch platforms, or mature drop and leave treatments in riparian areas where midstory conifers are suppressed by mature red alders. The potential for a particular stand to improve its contribution to functional landscape linkages through treatments should always be the first consideration in restoration silviculture as the major goals are generally landscape based. In contrast, focusing first on the stand level makes sense when wood production is the driving goal.

Coordinating treatments with road system needs was another major factor. In most cases, groups of stands that are accessed by the same road system will be treated in the same time period. Roads will be opened or re-constructed to access a particular area and then those that are not critical to the overall road network will be obliterated, put to bed, or converted to trails once the treatments are completed. Roads that are put to bed can then be re-opened to access stands that will receive another biomass removal treatment in 15-30 years and subsequently obliterated. This will allow for operational efficiencies and reduce the number of road system miles that have to be kept open and maintained. Groups of stands accessed by roads that are a high priority for removal were given extra priority in the near term.

Stand level structural conditions such as stand density, wind firmness, crown ratios, and competitive exclusion of key species were also factored in. Stands that are nearing the end of their "thinning window", the period when response to thinning will be high and the risks of post-thinning windthrow the lowest, were given high priority. Key thresholds used were height to diameter ratios (HDR) that are approaching 80 (measured at dbh) (Mustard and Harper 1998, Newton and Comeau 1990, Wonn and O'Hara 2001) and live crown ratios (LCR) approaching 40% (Emmingham et al. 2000, Holmberg et al. 2006, Oliver and Larson 1996) in the dominant and co-dominant trees. An HDR threshold of 60 was used for stands in topographic positions that are subject to high winds. The wind model was also used to evaluate the windthrow risks of thinning vs. not thinning. Trees can recover from high height to diameter ratio and low live crown ratio, but as trees exceed the levels described above the risk of windthrow increases significantly and response to thinning will take a long time (Deisenhofer 2000, Kneeshaw et al. 2002, Wright E.F. et al. 2000). In general, if even-aged stands in this forest type are kept below an overstory Stand Density Index of 350-400 they will not miss their thinning window (Holmberg et al. 2006). Stands that have exceeded these levels and are well past their window were given a lower priority and may be more suitable for a group selection treatment. Another factor included was increased competitive exclusion of understory plants as canopies close and shade out the understory with time. In particular, the likelihood of losing western redcedar if thinning was delayed and the opportunity to promote its growth and presence within the overstory was examined.

Structural conditions were also weighed against economic considerations. For some 25-60 year old stands, waiting 5-10 years before thinning will not make much difference structurally, but will have a big impact on the revenue side. For example, in some young stands that missed an early young drop and leave treatment waiting until a revenue positive biomass removal treatment was feasible made sense as increases in heigh to diameter ratios, declines in live crown ratios, and effects on long term diameter growth were minimal. On the other hand, implementing a drop and leave treatment in the next few years sends other stands on a faster track to achieving old growth structure and created an opportunity for a net positive second thinning entry in 10-20 years. High and low prices for particular species were also considered in cases where ecological factors were roughly equal. Staying attuned to market changes in the future will likely have a significant impact on revenue generation without compromising ecological objectives.

Growth models, economic analysis tools, and wind models within LMS were used to evaluate the ecological and economic tradeoffs between treating stands under alternative treatment scenarios. While these must be balanced with field evaluation and human judgment, they provide powerful analytical tools for managers to use in future planning efforts provided that their limitations are fully understood.

A final set of considerations used in prioritizing stands were management needs. The "vegetation manipulation" basins within the Ellsworth Creek Adaptive Management Area were prioritized for early treatment in the same year to begin the experiment and minimize treatment differences. The other management need was a regular work flow that fit within staffing and budgetary constraints and produced a stable revenue stream. As a good portion of the young plantation stands in the SWBCA have not been thinned, there is backlog of thinning needs. Not all stands will be able to be thinned at their ideal time, however, due to the practical limits of management resources.

3. *Determining and Prioritizing Road Treatments*

Forest roads within the SWBCA were built with commercial timber hauling as the main purpose. Purchase for the purpose of conservation has changed that rationale. Although timber hauling for restoration purposes will remain a priority for some time, ecological considerations have become equally or more important. The Ellsworth road inventory ranked mass wasting hazards by severity and imminence, each on a scale of 1 to 10. Approximately three miles of the higher combined ranking roads have been removed already. The Refuge road inventory identified hazard sites and highlighted the most urgent. One mile of road including multiple urgent hazards has already been removed at Teal Slough.

On the Ellsworth Creek Preserve, roads located within experimental basins were randomly assigned a fate. All roads will be removed from road removal basins (although roads skirting the edges along the ridge top between two basins may be kept to avoid creating a highly inefficient road system). Roads within the control basins and thinning basins will be maintained to standards that reduce threats to the forest and aquatic ecosystems. Some roads in these basins will be removed if that is the most appropriate threat reduction strategy. Roads completely outside the experimental basins will be upgraded to similar high standards or decommissioned depending upon the access need and the inventoried condition and risk, as well as timing considerations and available budget.

On the refuge, experimental considerations do not apply. Forest road upgrade and removal decisions on the refuge were made with the following considerations: In general, in order to reduce forest fragmentation, roads will be removed as soon as access is no longer required. Mainline roads required for emergency access will be maintained. Other roads may be kept as or converted to hiking trails. Where near-term hazards are minimal roads will be kept until forest restoration activities can take place.

4. *Generalized Forest Treatment Scenarios*

The generalized prescription concepts that follow focus on the main, stand level processes at play. Site specific factors such as protection and special management for sensitive habitats, legacy features, unstable slopes, riparian areas, etc are implicit and not described here. Actual stand-level prescriptions are not presented in this plan as they cannot be developed without a forester completing a detailed assessment of the forest inventory data and evaluating site specific field conditions (see Appendix B for a more detailed process to follow in developing actual stand-level prescriptions).

Young Stands: Cohort establishment (0-10 years)
The key developmental process occurring in these stands are cohort establishment and canopy closure. If canopy closure has not set it and openings in the young canopy are still present, the opportunity to impact the long term species composition of the overstory by planting exists. Once canopy closure sets in, introducing new species that will occupy the overstory will be practically impossible for many decades. Also, western redcedar is unlikely to naturally colonize the understory until much later in stand development. In several very young stands that were clearcut and planted just prior to being acquired by the Conservancy or Refuge, abundance of western redcedar and Sitka spruce is quite low. Thus planting 20-50 trees per acre is recommended, and some shrub control and removal of western hemlock around the seedlings will likely be necessary as part of the planting effort. Browse control will also be necessary.

Young Stands: Canopy Closure (10-30 years)
In stands where canopy closure is just occurring, an early young drop and leave treatment combined with planting can achieve the twin goals of increasing the abundance of western redcedar and Sitka spruce where necessary and maintaining rapid diameter growth throughout early stand development by delaying the onset of crown recession. Seedlings should be planted in small gaps. Depending on the height of the existing trees, the seedlings may not grow into the overstory over time, but will form a midstory layer.

Once canopy closure sets in, the main processes that will shape long term vertical and horizontal complexity at this stage of stand development are crown class differentiation and early stratification. Young drop and leave treatments should seek to prevent a portion of intermediate western redcedar and Sitka-spruce from being overtopped and relegated to the midstory by having wide spacing targets around select trees of those species. In the rest of the stand, trees of all species that are at lower end of the height distribution and clearly in the midstory should be left to form a future mid-story. This can be accomplished with a minimum height threshold. Care should also be taken to not eliminate fine scale heterogeneity: clusters or pairs of dominant trees. Upper diameter targets, or specifying that trees within a certain distance of each other be left, can achieve this.

In terms of density reduction targets, the projected timing of the next entry and the landscape level need for early-seral habitat are key factors. The heavier the thinning, the longer crown closure, the onset of increasing height to diameter ratios, and competitive exclusion of shrubs and slower growing western redcedar will be delayed. The thinning window for future thinning entries will also be prolonged. If thinning is very heavy (below 150 tpa), however, a second wave of cohort establishment may occur that will set back the density reduction goals of the treatment and possibly create a need for another young drop and leave treatment. Also, opportunities for future, revenue generating biomass removal treatments will be reduced.

To introduce additional spatial complexity in young drop and leave treatments, some areas of the stand should be left un-thinned or lightly thinned to allow for the onset of competitive exclusion and all the habitats and subsequent processes associated with it. For example, understory tree colonization later in stand development is greatly facilitated by an understory with few no shrubs and other plants. This in turn is one of the key processes of vertical canopy development and horizontal complexity. Unless there is a landscape level need to maintain early-seral shrub communities throughout stand development, gaps are generally unnecessary. Likewise, introducing additional variation in spacing is typically not necessary unless further treatments are not likely for the particular stand. In that case, 20-50 dominant trees per acre should be thinned to a wider spacing so they can maintain rapid diameter growth and avoid intense competition for many decades. This can be done with a diameter and species rule, where trees of a certain species and/or above a certain diameter receive a wider spacing target. Uniform, heavy thinning (below 150 tpa) should be avoided as it tends to homogenize stands and sets back the natural processes that set stands up for later development of horizontal and vertical complexity. In general, multiple thinning entries are preferable to a single entry as unintended consequences are not as severe and mid-course corrections are possible. The option of follow-up mature drop and leave treatments should be maintained if possible where future biomass removal treatments are unlikely.

In stands with high proportions of Douglas-fir or red alder in the dominant and co-dominant crown classes and where future biomass removal treatments are likely, young drop and leave treatments should seek to keep a significant proportion of these two species while maintaining a component of intermediate or suppressed western hemlock, Sitka spruce, and western redcedar that will be overtopped by the dominant trees and move into the midstory. Eventually, much of the Douglas-fir and red alder can be "thinned from above" to produce revenue and release the remaining trees. As long as the other species do not have too much side competition from other trees in their cohort, they should retain enough crown to maintain their release potential (Deisenhofer 2000, Emmingham et al. 2000, Kneeshaw et al. 2002, Miller and Emmingham 2001, Wright E.F. et al. 2000).

Finally, within older stands in this category, where competitive exclusion has been the dominant process for some time, the thinning window may have passed. In such cases, the understory is typically completely shaded out, crowns have lifted beyond 40% live crown ratio, and midstory trees (often western redcedar) have very high height-to-diameter ratios and low live crown ratios leading to low vigor and imminent mortality. In these cases, a moderate to light young drop and leave treatment, with heavier release of dominant trees and any western redcedar that has a lower height-to-diameter ratio and higher live crown ratio is advised. Gaps that open the stand to excessive windthrow risk should be avoided. Once the stand has recovered live crown and height-to-diameter ratios, another entry will likely be necessary to keep excessive competition from returning to the stand.

Mid-age stands: Competitive exclusion and biomass accumulation (30-60) years

Once the process of competitive exclusion is well underway, opportunities to shape species composition, manipulate stratification to encourage midstory development, build stem stability, slow crown recession, and maintain diameter growth begin to decrease exponentially with time in dense stands. If a stand received a prior young drop and leave treatment, densities are not too high, understory shrub communities are still present, and height to diameter ratios of the overstory trees are below 60, a similar approach as described above for young drop and leave treatments should be taken.

Several key differences exist, however. Selecting 20-50 dominant trees per acre for heavy release should be given high priority. These are the "golden years" of height and diameter growth and the opportunity to influence the development of large trees with long full crown is greatest at this stage. Understory tree and shrub colonization will likely be stimulated in these areas. Depending on how much past PCT treatments homogenized the stand in terms of spacing and species composition, small gaps and planting may be necessary to add trees species diversity. For stands dominated by Douglas-fir or red alder, a large portion of these species can be removed from the overstory at this time. If any midstory western redcedar exist and have good stem form, they should be released. Skips are still necessary for the reasons stated above, and to allow for intense competition to create areas with unstable trees in parts of the stand. If a whole stand consists of large, stable trees, the ability of wind to create heterogeneity later in stand development may be reduced. Skips will also be necessary to protect sensitive habitats, critical habitat features, and provide refugia for fungal mats that can be damaged by ground based thinning (Colgan et al. 1999, Smith J.E. et al. 2002). In general, the more complex these stands are, the less additional heterogeneity will need to be introduced. Creating or greatly expanding gaps to promote early-seral habitat is likely to be low priority at this phase as maintaining these early-seral habitats can be accomplished with greater success in younger or older stands. Likewise, accelerating decadence through snag or CWD creation at this stage is not likely to be a high priority. Protecting existing snags and wildlife trees, relying on natural decadence formation processes, and waiting until trees are larger is advisable. Habitat needed at the landscape must be taken into account, however.

In stands where competition has been intense for many years, height to diameter ratios are high, and live crown ratios are low, several critical questions must be addressed: Do the dominant and co-dominant trees have sufficient live crown to respond to thinning? Is the stand heavily dominated by hemlock, or is a significant Sitka-spruce, western redcedar, and Douglas-fir component present? How much will thinning increase the risk of major windthrow? Given the answers to these questions, is shifting the stand away from a catastrophic windthrow trajectory possible? If it is, then several light, relatively uniform thinning entries with skips and attention to fine scale heterogeneity should be pursued. If not, and the stand is important at the landscape scale for marbled murrelet habitat, it should be left alone or given a light MDL treatment targeted at enhancing branch structures on specific trees to create better marbled murrelet nesting platforms. If the stand is not important for marbled murrelets, a group selection approach can be taken to create large gaps or expand existing ones. This will accelerate the process of re-initiating the stand through gap-phase development as wind will expand the gaps over time. If natural regeneration of western redcedar and Sitka spruce is not sufficient, they will need to be planted in the gaps to ensure that relatively species composition shifts away from hemlock. Group selection can also be used in red alder stands to transition large patches of pure red alder towards mixed conifer stands. A significant portion of the alder should be left however.

Mature stands (60-100 years)

Similar to the previous category, the stability, risk of windthrow, and existing complexity of these stands will determine what treatments are appropriate. As height growth is peaking and beginning to slow at this stage, opportunities to build crown, significantly increase diameter growth, and build stem stability by thinning are declining. Wind and other exogenous mortality agents are likely to start breaking these stands up and thus gap creation, understory tree colonization, mid-story development, and decadence creation will slowly become the dominant processes as competitive exclusion wanes.

In stands with a high ratio of trees with long crowns and a balanced composition of species, opportunities to prolong the period of rapid diameter growth and crown development still exist. A mix of heavier release of dominant and midstory trees, small gap creation or expansion to stimulate understory development, light to moderate thinning in the rest of the stand, and significant areas in skips should be pursued. Individual tree selection approaches to target specific species and trees for release and to promote large branches or epicormic branching should be included. In areas where murrelet habitat is a high priority, lighter, more uniform thinning and avoiding heavy stimulation of the understory is preferable. Decadence acceleration through snag creation or drop and leave treatments should be considered in stands where windthrow or other agents are not creating these structures.

In stands in this category where competition has been intense for many years and height-to-diameter ratios are high, the same questions and choices must be faced as stands in this condition in the last category. Thinning these stands too heavily will significantly increase their risk of windthrow. Group selection treatments combined with planting are likely to be preferable to thinning. Either way, treatments must be designed with a higher level of stand examination and analysis.

5. ***Sale and collection of non-timber forest products***

Many current non-timber forest products exist on SWBCA ownership such as: cedar shake/shingle logs, salal, ferns, moss, and hard rock with the potential to generate revenue. However, the expected revenues from these non-timber forest products, when compared to expected timber sale revenue, would generate less than 1% of projected revenues for the Conservancy and/or Refuge lands. The level of ecological risk associated with these activities likely ranges from minor to severe. In addition, a program to sell and administer contracts to remove these minor forest products is very labor intensive and difficult to monitor and control.

Since cedar logs and trees are recognized as being valuable for their contribution to LWD, long-term snag retention, and other ecological processes, it would be counter-productive to have it removed as shake or shingle bolts. Therefore, it will be the policy of SWBCA to not engage in marketing commercial cedar bolt sales.

The removal of salal, fern, moss, and other minor forest products may impact the long-term ecological recovery of SWBCA forests. Furthermore, a program to sell, monitor and administer contracts for these products would likely exceed the revenue that would be generated. Therefore, it will be the policy of SWBCA to not engage in marketing commercial minor forest products.

6. ***Development and use of onsite rock resources***

Within the local area, hard rock is a limit resource and in high demand. Because the supply of hard rock on the ownership is scarce and can be quite costly to purchase, even from neighboring Templin Pit, it is not advisable to sell hard rock if only to preserve it for long term use within the ownership. It will be the policy of SWBCA to not engage in marketing its limited rock supply.

The Conservancy is committed to developing and using its hard rock resources in a manner that limits the disruption of natural systems. All rock development activities will be conducted following a written Pit Development and Reclamation plan. These plans will identify the limits of mining and present the intended methods and sequence of development and reclamation. Methods to minimize the delivery of sediment to the aquatic ecosystem are by nature, very site specific and will be addressed on a site by site basis within the Pit Development and Reclamation plan for each rock source.

Disturbance potential from loud rock development activities, especially blasting, on nesting murrelets and their chicks is of particular concern. Fortunately, because none of the available rock pits occur near suitable murrelet habitat, the likelihood of disturbance is minimal in the near term. As adjacent forests mature, disturbance potential could rise. To minimize potential for disturbance, where rock pits occur within ¼ mile of suitable marbled murrelet nesting habitat, the Conservancy will not conduct blasting or mechanical crushing activities during the breeding season, from April 1 to September 15. Less noisy activities like loading and hauling at these rock pits will not occur during the "daily peak activity period" of one hour before to two hours after sunrise, and one hour before to two hours after sunset during the breeding season. Where pits occur more than ¼ mile from suitable habitat blasting will normally be restricted to dates outside the breeding season, but loading and hauling will not be limited by the daily peak activity period.

7. *Use of chemicals*

Forest management on the SWBCA will employ silvicultural systems, integrated pest management, and strategies for controlling pests or invasive species that minimize the need for the use of chemicals. Specifically, chemicals should only be used where less environmentally hazardous techniques have been shown through research or empirical experience to be ineffective. Chemical use may be necessary to control invasive weed species that have the potential for altering forest habitat function and in some cases where invasive or native species are aggressively encroaching on active forest roads. When chemicals are applied, the least environmentally hazardous option will be used to minimize effects on non-target organisms or ecological systems. Furthermore, where chemical use is deemed necessary, trained applicators will follow all applicable safety precautions and chemicals will be stored and disposed of in a safe and environmentally appropriate manner.

8. *Local access and hunting*

Both the Refuge and the Conservancy are committed to continue providing access for hunting, hiking and other hike-in recreational activities. Hunters and hikers may be affected by the removal of roads, but sufficient active roads and trails will remain to provide reasonable access. Vehicular access is likely to remain restricted to the existing open roads.

Vehicular access is to remain restricted to the existing open roads. Use of off road vehicles (i.e. motorcycles, ATV's, 4-wheel drive trucks, etc.) often cause unacceptable impacts to soil and water resources, and are difficult to monitor and control. Therefore, it will be the policy of SWBCA to not allow these motorized vehicles in the forest, unless specifically granted to conduct authorized research, monitoring activities, and directly related Conservancy and/or Refuge business.

Although it generally does not allow hunting on its preserves, the Conservancy recognizes the importance of the long-valued local tradition of hunting in the Ellsworth Creek/Bear River to the community. Therefore, hunting for Roosevelt elk, Black-tailed deer, and black bear in accordance with State laws and regulation is allowed on Ellsworth Preserve. Incidental take of cougar and coyotes is known to occur but is not condoned. Refuge forestlands are also generally open to hunting activities.

9. *Use of revenue generated from timber sales*

As discussed above, revenue generation is expected when thinning commercial aged forests to reach ecological targets. These revenues will be solely used to fund additional restoration work within the project area in accordance with all applicable state and federal regulations and guidelines, and policies of the Conservancy and Refuge System. Accounting mechanisms have been put in place to ensure detailed tracking of these restoration revenues.

B. Implementation Schedule

1. *Restoration Thinning and Road Treatment Schedule*

Based on the landscape level management designations, the generalized treatment scenarios described above, and other factors outlined in this plan, forest stands throughout the SWBCA were placed in a treatment category (i.e., biomass removal, drop and leave, etc). Stands where active management will occur were then scheduled for treatment at least once in the 20 year planning horizon considered in this plan. Five time periods used for scheduling were used (Table 12); an annual basis for the first three years (2007-2009), the subsequent 7 year period (2010-2016), and concluding with a final 10 year period (2017-2026), (see corresponding Treatment Maps for these periods). The first three years were planned out in greater detail to give managers a concrete action plan for the immediate future. It is likely, however, that minor changes will be made in these first three years due to more detailed site specific analysis, market changes, and management practicalities. The forth (2010-2016) and fifth (2017-2026) time periods should be considered pools of stands in which treatment will likely be appropriate, based on current data and growth modeling. The fifth period includes approximately 2,900 acres of stands treated in the first 4 periods that are likely to be ready for a second entry. In this plan, a special effort was also made to optimize the timing and extent of management activities so road improvements and thinning are coordinated to reduce road system impacts and achieve operational and cost efficiencies.

Managers will need to continually re-assess the thinning pool and establish concrete management schedules in 2-3 year annual increments. It is likely that not all the acres identified in a single time period will actually be treated as some will be deferred or deemed not necessary to achieve the overall ecological objectives. What is important is that all of the stands within each pool are assessed at the beginning of the time period to determine when a treatment is appropriate. New information from adaptive management, natural disturbances, changing markets, and evolving management approaches will affect management direction over time, and thus more concrete plans for the forth and fifth time periods were not made at this time.

Table 12: Restoration thinning treatment types and acres per time period for each ownership.

Treatment	Owner	2007	2008	2009	2010-2016	2017-2026	Totals
Young Drop & Leave	TNC	405	674	544	762	188	2573
	WNWR	163	0	108	671	45	987
	Total	567	674	652	1433	233	3561
Mature Drop & Leave	TNC	0	0	26	59	0	85
	WNWR	8	98	169	13	0	288
	Total	8	98	195	72	0	373
Biomass Removal[1]	TNC	0	261	345	871	3238	4715
	WNWR	0	148	0	2673[2]	519	3339
	Total	0	409	345	3545	3756[3]	8054[1&3]

[1] Not all the acres in this category will be treated as up to 1/3rd of the total acreage in individual stands may be left in buffers or skips for streams, sensitive areas, or stand level variability. A portion of these buffers may be treated with MDL treatments where appropriate.
[2] Some of the BR treatments in years 2010-2016 may pushed off until 2017-2026
[3] This includes acres that receive YDL and BR treatments in years 2007-2016 and will likely be ready for a second treatment in years 2017-2026.

It should be noted that wood will not be removed from all the acres within the biomass removal category. In each stand, up to 1/3rd of the total acreage may be left in buffers or skips for streams, unstable slopes, sensitive areas, or stand level variability. A portion of these buffers or skips may be treated with mature drop and leave treatments where appropriate. For example, many stands on Long Island slated for a biomass removal treatment will contain shoreline buffers where mature drop and leave treatments or no treatment will occur. In addition, the 8,054 total acres in the biomass removal category (Table 12) includes 3,000 acres of 2nd entries into stands that were treated with young drop and leave or biomass removal treatments in the first four time periods years. Subtracting these 3,000 acres and assuming 20% of the remaining acres will be left in buffers or skips, an approximate total of 4,000 acres of the SWBCA will be treated with biomass removal treatments. This equates to roughly 30% of the 14,170 acre of forested habitat in the SWBCA.

From 2007 through 2016, the active road system will be reduced by a projected total of 53.8 miles (Table 13) or roughly half of the current total for the total landscape. This is in addition to the 4.5 miles of road that have already been obliterated. Roughly 5.7 miles of new road will be built, primarily to move the road system to ridge top locations and away from mid and lower slope positions. Following treatments, the road density will decline significantly from the current level throughout the SWBCA. The road treatments listed in table 13 and shown in the Treatment Maps do not include the re-opening of previously put-to-bed roads for 2nd entries in the 2017-2026 time period. As the need for 2nd entries for specific stands is not certain at this time, it is difficult to predict which roads will be re-opened and when. After the 2nd entry, these roads may be obliterated or put to bed again, depending on the likelihood of future entries.

Table 13: Road treatment types per time period and ownership

Treatment	Owner	2007	2008	2009	2010-2016	Totals
Obliterate	TNC	2.8	6.6	8.9	0.3	19.3
	WNWR	0.3	0.0	0.0	9.5	9.8
	Total	3.1	6.6	8.9	9.7	29.1
Put to Bed	TNC	7.2	1.5	2.3	3.0	15.8
	WNWR	0.0	1.4	0.0	1.3	2.7
	Total	7.2	2.9	2.3	4.2	18.5
Convert to Trail	TNC	0.1	0.0	0.8	0.2	1.1
	WNWR	0.0	0.0	0.0	5.1	5.1
	Total	0.1	0.0	0.8	5.3	6.2
Build	TNC	2.1	1.3	2.1	0.0	5.7
	WNWR	0.0	0.0	0.0	0.0	0.0
	Total	2.1	1.3	2.1	0.0	5.7

2. ***Landscape Simulation of Treatments***

The Landscape Management System (LMS) was used to model the effects of restoration thinning. Stands were grown out 50 years in 5 year increments and treated according to their scheduled timeframe and type of treatment young drop and leave, biomass removal, mature drop and leave, or no entry. Only treatments in the first 20 years, as covered by this plan, were included. A no-treatment scenario was also run as a baseline to compare to the effects of thinning. The Pacific Northwest Coast variant of FVS was used in the model and was calibrated based on data from the LOGS Studies (Curtis and Marshall 1986, Hoyer et al.

1996). As complete inventory data was not available for all stands, average stand metrics were used to create a “sample” stand for each stand type. These “sample” stands were used to model stands for which stand data was not available. Treatments were not designed to exactly mimic the individualized treatments for each stand that will occur in reality. Instead generalized treatments were used for each treatment type. Also, FVS and LMS cannot model variable density thinning or group selection treatments. Thus the rationale for the modeling scenario is not to predict the exact consequences of treatments, but rather to examine the relative effects of thinning vs. no-thinning on different components of forest structure and explore the hypothesis that thinning will accelerate the development of late-seral structure. While modeling cannot provide an answer to this hypothesis, it can provide important insights and help frame questions for monitoring and experimentation over time. The treatments incorporated into the landscape model were as follows:

- *Young drop and leave* : Thin trees over 5 inches dbh from below to 100 SDI, thin trees under 5 inches to 150 TPA, then plant 75 tpa of western red cedar and 75 tpa of Sitka spruce. The stands that are slated for follow-up biomass removal treatment in years 2017-2026 in the plan were then thinned back down to 100 SDI in from below, but leaving all trees under 8 inches dbh. This follow-up treatment was done in year 2025.

- *Biomass removal*: Stands were thinned to 50 tpa from below in the 6-12 inch dbh range and 25 tpa from below in 12-20inch dbh range. All trees less than 6 inches dbh and larger than 20 inches dbh were retained. This thinning from the middle approach was derived from the rules in the WA DNR Forest Practices Regulations for buffers adjacent to marbled murrelet habitat (WAC 222-16, 2006) While this treatment removed too many large trees in some stands, it was a good generalized prescription that thinned stands heavy enough to see significant effects from thinning 50 years in the future. Actual prescriptions for older conifer stands will generally be lighter and may involve multiple entries. Red alder stands were thinned with this same prescription as it removed most of the alder and left behind the smaller conifers.

- *Mature drop and leave*: Reduce BA of all trees in the 8-20 inch dbh range by 50%, leaving all trees less than 8 inches and greater than 20 inches dbh.

- *No entry*: Approximately half the stands in the SWBCA are within reserves, control areas, or limited management areas.

The Modified Old Growth Index (MOGI), as described previously, was used as the primary metric to evaluate the results of the modeling exercise. The MOGI scores for all the stands in the entire SWBCA landscape were calculated at 5 year intervals for both the thinning and no-treatment scenarios (Figure 15). The box plots reveal very little difference in MOGI scores between the treatment and no-treatment scenarios. Further analysis of the data showed no statistical differences. This result should be viewed with caution due to a number of factors. First, roughly half of the stands in the SWBCA landscape will not be entered and thus have the same MOGI scores in both scenarios. This suppresses the effect of thinning vs. not thinning. Second, an examination of the 4 different components of the MOGI shows that thinning increases some components while depressing others. Third, thinning effects on MOGI scores vary considerably for different stand types and age classes.

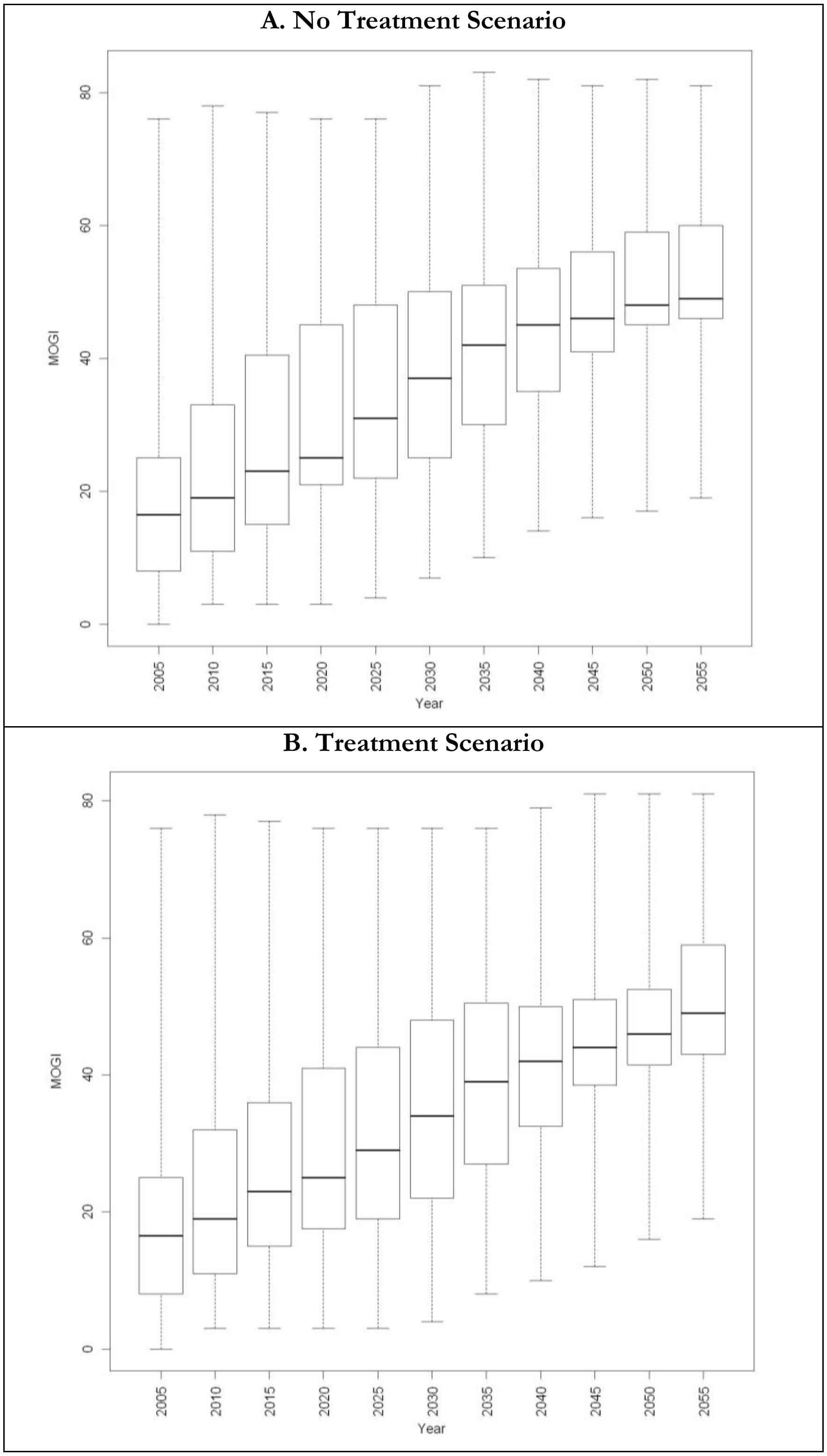
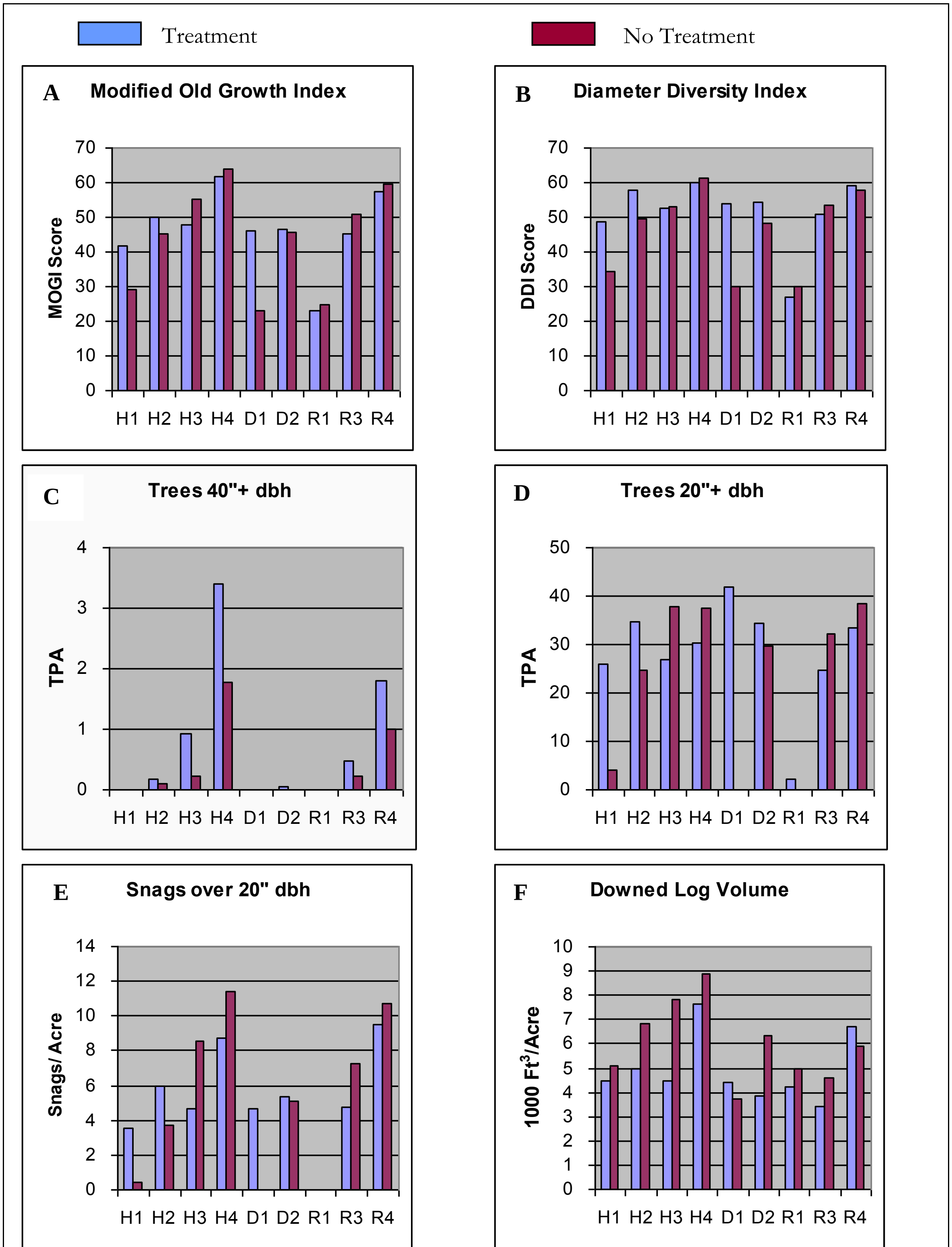


Figure 15: Modified Old Growth Index Scores (MOGI) for all stands within the SWBCA landscape for both no-thinning and thinning scenarios. The median value is represented by the solid line in each box and the upper and lower edges of the boxes are the 25% and 75% percentile values. The top and bottom of each "whisker" or vertical line show the upper and lower quartile of the data and the end of each whisker is the maximum and minimum value.



Notes: H1: WH/SS/RC 1-14 yrs; H2: WH/SS/RC 15-30 yrs; H3: WH/SS/RC 30-60 yrs; H4 WH/SS/RC 60-100 yrs; D1: DF 1-14 yrs; D2 15-30 yrs; R1: RA 1-14 yrs; R3 RA 30-60 yrs; R4 60-100 yrs

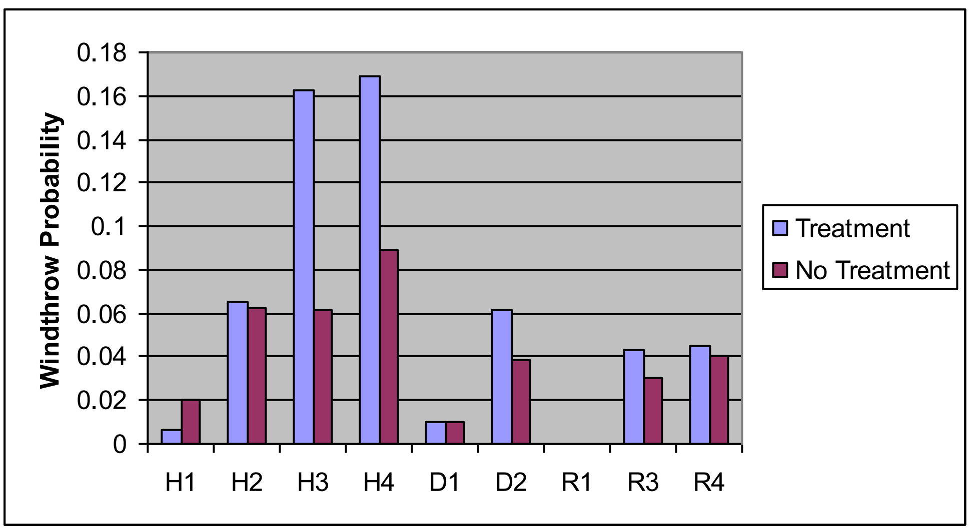
Figure 16: Overall Modified Old Growth Index scores (MOGI) and different MOGI components in 2055 by stand type. Data is from 87 stands that have full inventory data and are slated to receive treatment entries.

In order to tease out these factors, MOGI scores in the year 2055 were analyzed for stands that receive treatment entries and have actual inventory data (Figures 16). When overall MOGI scores are broken down by stand type (Figure 16A), it becomes clear that stands treated at a young age (under 15 yrs: H1, D1) show the biggest gains from thinning treatments in the model. This is due to the fact that increased diameter growth following thinning sends the number of trees per acre over 20 inches dbh significantly higher. While the tpa of trees over 20 inchesdbh is not one of the 4 main components of the MOGI, it improves the diameter diversity index component (Figure 16B) and the number of snags over 20 inches dbh per acre component (Figure 16E). As more live trees over 20 inches dbh exist, more are available to become snags. In addition to a greater number of trees over 20 inches dbh, the diameter diversity index was improved by additions to the lower diameter classes from planting and faster movement of trees through all diameter classes. The downed log volume component is not significantly affected by thinning at this early age (Figure 16F). Similar to the large snags, the increase in tree size leads to larger downed wood that decays more slowly. This offsets the higher total amount of dead wood recruitment in the untreated stands that is smaller in diameter and thus decays more quickly. Also, additional 2nd entry biomass removal treatments are light thinnings from below that do not remove many trees in the co-dominant and dominant crown classes. The number of trees over 40 inches dbh is not affected in these younger stands as the dominant trees do not reach this size in the 50 year modeling timeframe. While FVS was calibrated based on field data to model diameter growth increases from thinning for this model run, it likely is still underestimating diameter growth. It is possible that at least some dominant trees in stands on high productivity sites will be over 40 inches dbh when they reach ages 60-65.

Stands in the 15-30 year age class showed slight increases in overall MOGI scores. Similar to the very young stands, increased diameter growth in treated stands pushed up the diameter diversity index, tpa of trees over 40 inches dbh, and snags/acre over 20 inches dbh. However, roughly half of these stands received the marbled murrelet biomass removal treatment that removed a significant portion of trees in the co-dominant and dominant crown classes, leading to a significant decline in downed wood volume compared to the no-treatment scenario. Despite the calibration of FVS to address its typical overestimation of mortality, especially in un-thinned stands, it is likely that downed log recruitment is still being over-estimated in un-thinned stands. Also, while competition mortality kills the most trees in young stands, exogenous mortality (windthrow, pathogens, insects, etc) is often responsible for a majority of the total volume of downed wood as it typically kills larger trees in a stand (Lutz and Halpern 2006). Predicting mortality from stochastic events such as windthrow is very challenging and is not well modeled in FVS mortality functions. As thinning increases both windthrow and spread of annosum root rot, treated stands will likely experience significant recruitment of larger downed wood that is not accounted for in this modeling scenario. Also, the downed wood component of the MOGI does not distinguish between different sizes of logs. While many wildlife species use smaller down logs, large logs are critical for many species (Marcot et al. 2002) and a defining element of old growth forests (Harmon et al. 1986). Thus in terms of habitat value, the loss of smaller diameter dead wood from thinning vs. no-treatment may be offset by higher recruitment levels of large dead wood in thinned stands that results from increased diameter growth and elevated exogenous mortality of large trees.

The older conifer stands (H3, H4) and all the red alder stands experienced small declines in MOGI scores following treatment. While the increased diameter growth from treatment pushes up the tpa of trees over 40 inches dbh, the removal of a significant portion of trees in the co-dominant and dominant crown classes depresses all the other MOGI components relative to the no-treatment scenario. The diameter diversity index is also lower in the treated scenario as thinning moves trees out of the lower diameter classes faster than under the no-treatment scenario. Natural regeneration, which is stimulated by thinning, is not accounted for in FVS and thus replenishment of trees in the lower diameter classes is not occurring in the model. Similar to 15-30 year old stands, the large difference in downed log levels between treated and untreated stands is likely overestimated. However, the model clearly demonstrates that relatively heavy thinning from the "middle" and the resulting removal of dominant and co-dominant trees reduces the pool of mid and larger sized trees from which snags and downed logs can be recruited. While windthrow will likely create more snags and downed logs in thinned stands over time, it will also reduce the pool of live trees that will develop into large, old growth trees. In stands where windthrow is not too high, the total amount of dead wood recruitment is likely to be lower in treated stands in the medium term (50-100 yrs). Where high windthrow leads to high mortality and dead wood recruitment, stands may not have sufficient overstory canopy left to meet late seral canopy cover thresholds (50-70% canopy cover from the overstory). Downed wood could also be created by dropping, girdling, or topping trees, although one of the goals of management in the SWBCA is to restore natural processes of decadence formation.

In order to gauge the effects of thinning on windthrow , treated and untreated stands were run through the windthrow probability model that was built into LMS (Scott and Mitchell 2005) (Figure 17). While the effect of treatment is negligible in most stand types, it roughly doubles in the older conifer stand types (H3 & H4). This is the result of the relatively heavy biomass removal treatment in these mostly dense stands that have high height to diameter ratios. It confirms that recruitment of larger dead wood is likely in thinned stands. Also, the model assumes that stands remain closed throughout the 50 year period and does not factor in creation and expansion of windthrow pockets over time and the resulting exponential increase in pocket area. As heavy thinning will significantly open up these older stands, it is likely to accelerate the break up of stands compared to the no-treatment scenario, especially on exposed sites. The group selection approach to high risk stands was not included as FVS cannot model group selection. Group selection leaves most of a stand intact and thus windthrow is likely to be lower overall and concentrated on the edges of gaps. In younger stands, the decreases in height to diameter ratios and increases in crown ratios from thinning appear to make up for the lower density and inter-tree sheltering. The higher resilience of western red cedar to windthrow is not accounted for by the model.



Notes: H1: WH/SS/RC 1-14 yrs; H2: WH/SS/RC 15-30 yrs; H3: WH/SS/RC 30-60 yrs; H4 WH/SS/RC 60-100 yrs; D1: DF 1-14 yrs; D2 15-30 yrs; R1: RA 1-14 yrs; R3 RA 30-60 yrs; R4 60-100 yrs

Figure 17: Windthrow probability in 2055 by stand type. Data is from 87 stands that have full inventory data and are slated to received treatment entries.

Overall, the modeling exercise illustrates the key tradeoffs from thinning vs. no-treatment. Thinning increases diameter growth of residual trees which leads to earlier recruitment of larger dead wood as well as "bigger trees faster". It also moves small and medium sized trees through the diameter class distribution faster, which translates into accelerated development of mid-story layers. However, by reducing overall stand biomass it may reduce overall dead wood recruitment, at least in a 50 year time horizon. If prescriptions are heavy and remove significant number of trees in the upper half of the diameter distribution, numbers of medium to large sized live trees will be reduced which will shrink the recruitment pool for similar sized snags and downed logs. Exogenous disturbance agents, primarily wind in this case, are likely to compensate for the reduction in competition mortality driven dead wood recruitment. Heavy thinning, however, is likely to result in high levels of windthrow in a short timeframe that may reduce overstory canopy cover beyond levels typically associated with late seral forests for a significant period of time.

These tradeoffs explain why MOGI scores were essentially unchanged across the SWBCA landscape by the treatment scenario compared to no-treatment. In 50 years, the model shows that roughly half of the landscape will have a MOGI score above 50, with the older managed stands nearing 60, compared to the current average old growth score of 62. This does not mean that the managed stands will be fully functional old growth, however. The overestimation of downed wood recruitment by LMS is likely inflating scores. There is also a large degree of variance in FVS's predictions of stand conditions 50 years in the future, especially in older stands. Most important, the MOGI only considers 4 variables, whereas the structure of old growth forests is much more complex. What the high MOGI scores do suggest, however, is that these stands will begin displaying many of the components of current old growth forests within 50 years and, therefore, may also begin to support some old growth dependent species.

Modeling results also suggest that thinning can generate an economic return without compromising desired structural development objectives. Beyond this minimum threshold, results indicate that thinning can accelerate the development of at least some components of old growth structure, especially when thinning is done early in stand development. Thinning prescriptions must be light enough to ensure than sufficient biomass remains for dead wood recruitment and to avoid excessive windthrow, yet heavy enough to promote diameter growth, under and midstory development, and encourage some windthrow. The individualized LMS prescriptions created for a 70 year old stand earlier in this document came close to achieving this balance and increased the overall MOGI score relative to no-treatment. Similar individualized prescriptions could be designed and re-run through the LMS model for all stands and would likely increase the treatment effect on landscape level MOGI scores.

The objective of this modeling exercise, however, was to examine the relative effects of thinning vs. no-thinning on different components of forest structure, not to show that thinning could achieve higher MOGI scores. This type of modeling exercise cannot incorporate all of the real-world details required to develop site-specific prescriptions. These modeling results do provide a preliminary test of the use of thinning to accelerate the development of late-successional forest conditions, and offer a foundation from which site specific prescriptions can be developed. Creating such prescriptions will take time, careful thought, and trial and error. Over time, they will provide an opportunity to empirically test the hypothesis that thinning can accelerate the development of late-seral structure and refine our understanding and models of forest development.

3. ***Projected Volume and Revenue Outputs***

A preliminary economic analysis of the planned treatments over the next 20 years was performed to obtain a crude estimate of volume production and revenue flow. The TNC and WNWR ownerships within the SWBCA were grouped together for this analysis. In order to provide an accurate estimate that accounts for different log sort and species prices, volume per acre outputs for different stand types, and ground based vs. cable yarding costs, a forecasting spreadsheet was designed. The spreadsheet can be adjusted over time as prices and costs change. Log prices were based on October 2006 prices (Table 9). Logging costs were assumed to be $225/mbf for cable yarding, $175/mbf for ground based yarding (processer/forwarder combination), and $40/mbf for hauling. Each stand slated for a biomass removal treatment was evaluated to determine the extent of ground based vs. cable yarding required. The number of ground based and cable acres of each forest type for each time period where biomass removal treatments will occur was then calculated. The total acreage for each stand was reduced by 20% to account for buffers and skips. Volume produced per acre for different stand types was determined in LMS by growing them forward until their planned thinning date, running several different thinning treatments, and then adjusting for overestimation of volume by LMS. Adjustments were based on stand volumes from actual forest inventory data vs. LMS volume, and professional experience from thinning similar stands. The values are conservative by design and range from 7 mbf/acre for thinning in 25-35 year old stands to 13 mbf/acre for 60+ year old stands. Actual volume per acre outputs may be higher, especially within older stands.

The total volumes by species, sort, and time period were then calculated (Table 14 – also see Table 12 for acreage figures) for the analysis. The estimated total harvest volume is 65 million board feet over 20 years, which equates to an average of 3.25 million board feet per year; however, annual volume production will fluctuate over this time period. As the ecological need and economic viability of planned 2nd entries in years 2017-2026 will be not known for some time, thinning acreages and volume production may be lower than projected, especially towards the end of the planning period..

While logging costs are subtracted for this analysis, estimated revenue generation by species, sort and time period (Table 15) do not reflect the costs of forest or road management. To account for inflation, totals for each time period were discounted by 5%. For time periods 2010-2016 and 2017-2026, midpoint years were used for discounting. The total net present value is $6.5 million, which equates to an annual revenue stream of $325,000. This number will of course fluctuate based on prices, costs, and annual volume production.

Table 14: Volume production by species, sort, and time period. All numbers are Scribner volumes in thousand board feet (mbf).

Species	Sort	2007	2008	2009	2010-2016	2017-2026	Total
WH-SS	#4	0	1896	1630	15208	11461	30195
	#3	0	1437	1158	9873	4550	17019
	#1-2	0	392	303	2446	1471	4612
DF	#4	0	262	249	2828	4819	8157
	#3	0	0	0	891	3225	4117
	#1-2	0	0	0	0	0	0
RA	#4	0	0	0	217	67	284
	#3	0	0	0	433	134	567
	#1-2	0	0	0	325	100	425
Total		0	3,987	3,341	32,221	25,828	65,376
Annual Volume Production		0	3,987	3,341	4,603	2,583	
Total Thinning Acres[1]		0	327	276	2836	3005	6443
Average Mbf/Acre		0	12.2	12.1	11.4	8.6	10.1

[1:] This total assumes that 20% of the Biomass removal acres listed in table 12 will be left in skips or buffer.

Table 15: Revenue generation by species, sort, and time period.

Species	Sort	Price/ mbf	2007	2008	2009	2010-2016	2017-2026
WH	#4	$315	$0	$597,258	$513,402	$4,790,470	$3,610,251
	#3	$410	$0	$589,151	$474,960	$4,048,129	$1,865,396
	#1-2	$440	$0	$172,330	$133,358	$1,076,335	$647,424
DF	#4	$445	$0	$116,578	$110,885	$1,258,313	$2,144,258
	#3	$500	$0	$0	$0	$445,566	$1,612,746
	#1-2	$575	$0	$0	$0	$0	$0
RA	#4	$625	$0	$0	$0	$135,364	$41,835
	#3	$730	$0	$0	$0	$316,210	$97,727
	#1-2	$830	$0	$0	$0	$269,645	$83,335
Gross Total			$0	$1,475,318	$1,232,606	$12,340,034	$10,102,973
Total Logging Costs			$0	$983,761	$838,530	$7,279,661	$6,194,767
Net Revenue			$0	$491,557	$394,076	$5,060,372	$3,908,206
Net Revenue per Acre			$0	$1,504	$1,427	$1,785	$1,301
Net Present Value (5% Discount Rate)			$0	$468,150	$357,438	$3,776,128	$1,879,914
Total Net Present Value			**$**6,481,630				
Annualized NPV Revenue Stream			**$**324,082				

C. MONITORING

Monitoring the success of restoration treatments and recovery of late-successional forest species is an important component of the management plan for the SWBCA; however, resources for monitoring are limited. Compliance and validation monitoring of specific road and forest management treatments is expected to occur as a regular component of such actions. Effectiveness monitoring of fish and wildlife populations, and habitat responses to management actions will occur as funding and resources allow. The Refuge is planning to continue limited breeding season surveys of marbled murrelets in select forest stands following standard protocols (Evans et al. 2003). Other ongoing monitoring includes chum salmon spawning counts along a reference stream reach in the Ellsworth Creek drainage conducted annually by the WDFW. The foundation for monitoring the effectiveness of forest management and restoration within the SWBCA, however, will rely on an extensive experimental adaptive management study within the Ellsworth Creek watershed. This adaptive management study is one of the most extensive studies concerning forest restoration at a landscape scale in the Pacific Northwest.

Taking measurements at one of 224 permanent forest plots.

1. *Adaptive Management*

A considerable amount of research has taken place in the Pacific Northwest concerning old-growth forest ecology, growth and yield in young-managed forests, stream ecology, and wildlife-habitat relationships and other topics; however, as outlined in this plan, debate continues over how young-managed forest landscapes should be managed for restoration (e.g., Young Stand Management Forum, Olympia Washington, April 2003). Hot topics in this debate concern the economic motives of forest thinning, within stand damage caused by thinning treatments, impacts of forest roads, and effects on aesthetic or spiritual values in forest landscapes. Findings from ongoing research do not resolve these issues, and leave managers with several management alternatives – many of which are equally scientifically and socially justifiable. Managing these forest landscapes through an adaptive management process (Walters and Holling 1990) offers a method to test alternative management practices simultaneously and improve our understanding of how these systems respond to various forms of management intervention. In the Siuslaw National Forest, the Five Rivers Landscape Management Project (USFS 2001) has recently been implemented specifically to address these management questions. In the SWBCA, the Ellsworth Creek watershed offers an additional site, time within the Sitka spruce Zone (Franklin and Dyrness 1988), where these questions can be addressed at a landscape scale.

To meet the mutual goals of restoring the Ellsworth Creek Preserve, and addressing the key scientific uncertainties that remain regarding restoration treatments, the Conservancy will follow an active adaptive management process. Furthermore, the Conservancy will work toward linking this project with other landscape restoration efforts throughout the Pacific Northwest to promote synergistic mechanisms for increasing our collective knowledge of ecosystem recovery within young-managed forest landscapes.

An active adaptive management system offers the best chance to rapidly increase our management knowledge because it takes an experimental approach to simultaneously testing multiple restoration treatments - all of which have equal validity given our current state of knowledge (Bormann et al. 1999, Taylor B. et al. 1997, Walters and Holling 1990). In contrast, more commonly applied reactive and passive adaptive management systems (Figure 18) inhibit rapid learning because they apply only a single management regime to a problem (reactive and passive), or do not include monitoring as a key element of the design (reactive) (Bormann et al. 1996). Due to its landscape-scale size, topographical and geomorphological layout (i.e., multiple westward flowing tributary basins), single ownership, and the Conservancy's flexibility toward implementing a range of management regimes, the Ellsworth Creek watershed is an ideal setting to implement an active adaptive approach to restoration.

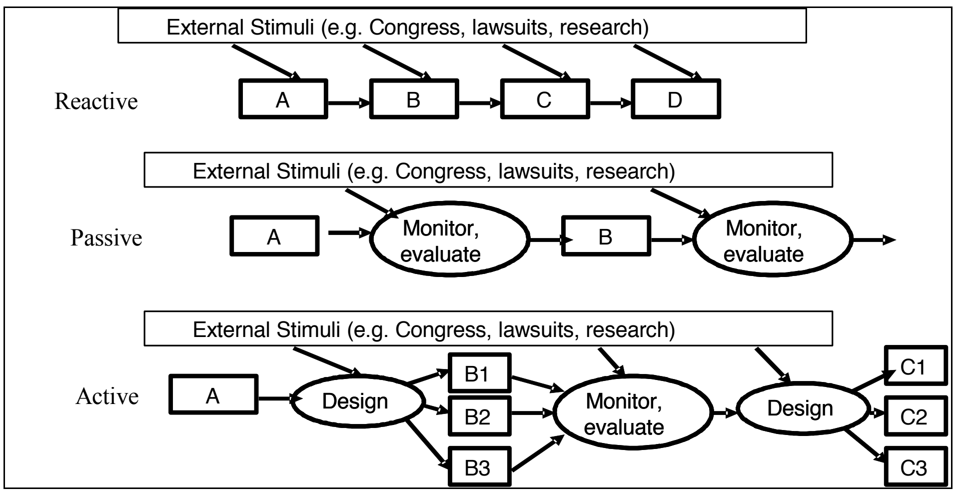


Figure 18. The flow of knowledge and modification of management regimes (A, B, C, D) under reactive, passive, and active adaptive management strategies. In an active adaptive management strategy, equally appropriate management treatments (B_1, B_2, B_3) are simultaneously applied and tested using an experimental design (*Adapted from*: Bormann et al. 1996).

The Conservancy worked with an external science review panel to develop a study design (Rolph and Beggs 2006) (that will simultaneously test rates of ecosystem recovery and cost effectiveness using three different restoration pathways (Map – Ellsworth Creek Experimental Basins). Each pathway is equally justifiable given our current understanding of forest restoration.

1. *Road Removal* – forest stands will be left to develop without management intervention and all roads will be permanently abandoned (unless constrained by management or legal restrictions).
   - Advantages – very low cost of forest management, quickly eliminates signs of human management (e.g., roads, new stumps), forest stands may develop different characteristics than thinned stands, reduces forest fragmentation and sediment delivery from roads.
   - Disadvantages – high initial financial costs for road abandonment, forest growth models predict stagnation within the stem exclusion stage, windthrow may be high due to increasing stem-diameter ratios, lack of access for management.
2. *Vegetation Management* – forest stands will be actively thinned during the initial treatment period (first 10 years) and at recurring intervals to promote forest growth and the development of structural complexity. Roads will be maintained to allow for harvest and other management operations.
   - Advantages – the time period for forest stands to obtain characteristics typical of late-successional forests should shorten: tree growth rates should increase, stands should quickly develop structural and compositional complexity, understory vegetation diversity should increase, large wood delivery

should increase in shorter timeframe. Some revenue generation from sale of commercially thinned trees.

- Disadvantages – increased ground disturbance and potential for invasive species introductions, higher sediment production and delivery to streams, higher forest fragmentation from roads, windthrow may be high in areas with high stem/diameter ratios and along road corridors, continued cost of road maintenance, signs of human management will be evident.

3. *Control* – forest stands will remain unthinned during the initial treatment period (first 10 years) and all roads will be maintained or repaired as needed. This management pathway will be re-evaluated in 10 years in an adaptive management context.
    - Advantages –lowest initial cost of management, sign of human management is reduced within forest stands, forest stands may develop different characteristics than thinned forests over time.
    - Disadvantages – moderate potential for introduction of invasive species along road corridors, continuing threat of sediment delivery from roads, ongoing costs of road maintenance, ongoing stand fragmentation from roads, future management options within forest stands may decline as young stands develop with high stem densities.

The Conservancy began implementing the experimental adaptive management study in 2005. Baseline data is currently being collected on a variety of indicator variables and will continue through the winter of 2007-2008. Indicator variables include:

- Stream hydrology
- Physical stream habitat
- Hydrologic connectivity of roads and streams
- Forest structure and composition
- Forest bird abundance
- Headwater stream amphibians abundance
- Spawning populations of coho salmon
- Stream macroinvertebrate composition
- LiDAR data

In general, no active management will occur within the adaptive management study area during the baseline data collection period. Two exceptions to this rule include: a) roads rated as high hazards for failure or showing imminent signs of failure will be treated uniformly throughout the study area, and b) thinning for restoration purposes within young-managed forest stands (less than 20 yrs of age) may occur within the study area, but only outside of the 8 designated experimental tributary basins.

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APPENDIX A: ECOLOGY OF SPRUCE-HEMLOCK FORESTS

By: Andrew Larsen and Derek Churchill

Natural Disturbances

Disturbances play important roles in structuring the coniferous forests of western North America (Agee 1993, Franklin et al. 2002, Veblen et al. 1994). Their variation in type, extent, intensity and frequency lead to unique post-disturbance conditions and forest developmental pathways. Stand replacing disturbances initiate the forest development sequence while chronic, small-scale disturbances are important agents of tree mortality and pattern formation within the development sequence. Wind is the primary disturbance in coastal Sitka spruce Zone forests. Storms with hurricane force winds—potential stand replacing events—have swept the western Washington coast approximately once every 20 years in the last 200 years (Henderson et al. 1989). Of these events, the "21 Blow" of 1921 and the Columbus Day Storm of 1962 were the most significant, with estimated 7 and 11 billion board feet of timber volume blow down in the storms, respectively. In addition, smaller windstorms blow down or damage individual trees or groups of trees on a much more frequent basis. Additional complexity is introduced by feedbacks between wind-created edges along canopy gaps and blowdown areas, which expose additional trees to wind disturbance (Greene et al. 1992). As a consequence, wind disturbance become chronic, and blowdown patches can be seen to grow and migrate across coastal forest landscapes at annual to decadal time scales in complex wave and partial wave patterns (Harcombe et al. 2004). The net effect of this variable-intensity wind disturbance regime is a complex landscape mosaic of different patch types and sizes, often with high within-patch heterogeneity.

Fires, while rare, also perturb coastal Sitka spruce Zone forests. The incidence of fire in these forests is low because ignition sources are infrequent and ignitions rarely coincide with fuel moisture levels conducive to carrying wildfire. The limited available fire history data for Sitka spruce forests indicates that stand replacement fires occur only during extreme weather conditions associated with dry east winds (Agee 1993). Long and Whitlock (2002) estimated a fire return interval of 240 ± 30 years over the past 2700 years at a site just south of the project area in northwest Oregon. In the Sitka spruce Zone forests of the Olympic Peninsula fires have burned with a return interval of approximately 900 years (Henderson et al. 1989). A major stand-replacing fire event—the Nestucca Fire— burned Sitka spruce Zone forests at what is now the Cascade Head Experimental Forest in northwest Oregon sometime between 1845 and 1849 (Morris 1934, Munger 1944). The Nestucca fire started in the Willamette Valley and was pushed over the Coast Range by strong east winds. It is unknown if this significant fire was of natural or human origin. In any case, stand replacement fire events are certainly possible in the Sitka spruce Zone, although the probability of occurrence is quite low.

Reconnaissance in the largest old-growth patch on Long Island revealed occasional isolated fire-scarred western redcedar snags, confirming that fire has been present to some degree in recent centuries. As the old-growth patch has no evidence of a recent stand-replacement event, these solitary fire-scarred snags likely represent trees that were struck by lightening and subsequently smoldered and charred, with the fire remaining small in extent. Recent lightening strikes in 2005 on Long Island and within the Ellsworth Creek watershed provide circumstantial evidence in support of this idea.

Landslides are another major disturbance type that affects coastal forests, (Powell et al. 2003, Skaugset et al. 2002, Wegmann 2004). Shallow, rapid translational landslides appear to comprise the bulk of soil mass movements in the Ellsworth Creek watershed, although deep-seated landslides are also apparent (Wegmann 2004). They can be categorized as either debris slides, where the debris is deposited at the foot of the failure scarp, or debris flows, in which material has a high water content, is mobilized down slope, and enters the stream channel network (Skaugset et al. 2002). By creating sites with exposed mineral soil in the terrestrial uplands, landslides create opportunities for early successional species to establish and thus maintain diversity in upland forest plant communities. Another important function of landslides, specifically debris flows, is to transport sediment and large woody debris from terrestrial uplands to the stream network. They reconfigure aquatic ecosystems (Montgomery D.R. and Buffington 1998) and deliver pulses of the basic habitat elements required for streams to develop optimal habitat function (Reeves et al. 1995).

Forest Development Pathways

Old-growth Sitka spruce Zone forests are structurally similar to old-growth Douglas-fir forests (Franklin et al. 2005). The well studied structural development of Douglas-fir forests (Franklin et al. 2002, Zenner 2005) is helpful in understanding structural development in Sitka spruce forests, especially in managed stands as historic clear-cutting was typically a high severity disturbance that placed new stands on an even-aged trajectory similar to Douglas-fir stands after a high severity fire. However, the dominant disturbance in natural Sitka spruce Zone forests—wind—differs from that of Douglas-fir forests, which are influenced relatively more by fire. The silvics of the major species are also different. Thus, while reviewing the developmental sequence of Douglas-fir forests, we will also identify the key differences of Sitka spruce Zone forests.

Franklin et al. (2002) present an eight stage conceptual model for Douglas-fir forest development following stand-replacing disturbance. Each structural stage is named for the dominant structural development processes at that point in development. Many developmental processes operate at any one time in stand structural development, however; forests do not develop in an orderly fashion. General trends are certainly identifiable, but high variability in natural forests is the rule rather than the exception.

The developmental sequence is initiated in the disturbance and legacy creation stage. The type and intensity of the stand replacing disturbance create the substrate and biological legacies (living organisms, dead organic matter, and biologically-derived spatial patterns that persist following a disturbance) that set the stage for stand development. Stand replacement windstorms create a complex substrate of overturned rootwads with depressions of exposed mineral soil, downed logs, and intact pre-disturbance forest soils that is very different from the predominance of exposed mineral soil after a high intensity fire. In addition a larger number of live trees tend to persist through windstorms as opposed to high intensity fire. Much recent research on biological legacies has focused on residual live green trees, including their distribution (Keeton and Franklin 2004, Keeton and Franklin 2005) affects on stand volume growth (Acker et al. 1998, Zenner et al. 1998), influence on spatial patterns of regenerating trees (Goslin 1997), contribution to stand structural complexity (Zenner 2000), and influence on rates of forest succession (Keeton and Franklin 2005). In all these examples, the influence of the stand-initiating disturbance, and especially the biological legacies, is apparent decades or even centuries later in stand development.

Following disturbance and legacy creation, stands enter the cohort establishment stage. This stage is characterized by the establishment of a new cohort of conifer tree seedlings that is highly variable in time and space. The establishment of tree populations is limited or facilitated by five broad factors: seed availability and dispersal; environmental conditions; competition with non-tree vegetation; seed and seedling loss to herbivory and pathogens; and repeat disturbance prior to the sexual maturity of the new cohort. The first three factors operate in serial progression. Environmental conditions only limit tree regeneration after viable seed reaches the site, and competing non-tree vegetation only becomes limiting after tree species germinants have survived the initial environmental filter. The last two factors operate more-or-less throughout the tree establishment process.

In the moderate, moist Sitka spruce Zone cohort establishment is typically a relatively rapid process. Both spruce and hemlock are prolific seed producers (Ruth and Harris 1979) and seedlings typically establish at very high densities. Western redcedar also establishes, but at lower densities. The growing conditions are also quite favorable for competing non-tree vegetation however; if seed source is limiting immediately following fire a dense shrub layer may establish, limiting further tree seedling recruitment (Tappeiner et al.

2002). Because the dominant disturbance in the Sitka spruce Zone is wind, advanced regeneration often survives in its relatively sheltered position in the understory and can dominate the new cohort. Cohort establishment thus precedes the disturbance and legacy creation stage.

The next structural development stage following cohort establishment is distinguished by closure of the tree canopy. Canopy closure brings about extremely rapid shifts in the environmental conditions at the site. Understory light levels shift from nearly full sun to quite dark. Temperature and moisture regimes become moderated by the tree canopy, as well as understory wind speeds. Community composition begins to change following canopy closure. Shade intolerant, early successional herb and shrub species begin to be excluded from the site and successful establishment of additional tree seedlings ceases.

With the development of a closed, interlocking canopy forest development enters a developmental period marked by intense competition and biomass accumulation. At extreme levels, competition results in the mortality of those plants unable to capture enough resources to compensate for respiration costs. Competition in the moist Sitka spruce Zone forests is assumed to be primarily competition for light, which is generally thought of as a one-sided process (Cannell and Grace 1993, Cannell et al. 1984, Ford 1975, Ford and Diggle 1981) . In one-sided (asymmetrical) competition for light, a tall plant does not compete with a short plant, at least not above the level of the highest foliage on the shorter plant, while short plants compete directly with adjacent taller plants.. Alternately, two-sided or symmetrical competition occurs when plants share scarce resources in proportion to their size. If symmetrical competition is occurring even small plants will adversely affect the growth of large plants, as in the ponderosa pine/grand fir (*Pinus ponderosa/Abies grandis*) stands studied by McDowell and colleagues (2003), where water use by young grand fir limited growth of old-growth ponderosa pine. Competition for belowground resources is generally thought of as a two-sided process; the ability of a plant to extract limited belowground resources is proportional to the size of its root system. In reality, both one-sided and two-sided competition likely occurs in Sitka spruce Zone forests. However, stand structural development is likely influenced more strongly by one-sided competition for light than by two-sided below ground competition.

Competition related tree mortality prevails during the competitive exclusion/biomass accumulation stage. Growth rates and early canopy differentiation determine the "winners". Slower growing species such as western redcedar are often out-competed and decline in relative abundance. The spatial outcome of competitive tree mortality is an overall homogenization of the forest stand structure. Subordinate trees and plants die, and recruitment of additional tree seedlings is excluded (Harcombe 1986) resulting in a canopy structure characterized by a single uniform layer of foliage (Van Pelt and Nadkarni 2004). Dense clumps of trees self-thin, reducing within-stand variation in tree density. Trees surviving competitive mortality tend to be distributed in a spatially regular pattern (Kenkel 1988). While competition related mortality dominates tree demography, ecologically significant competition-independent tree mortality due to disturbance typically occurs during the competitive exclusion/biomass accumulation stage. For example, in a young Cascadian Douglas-fir-hemlock forest (Lutz and Halpern 2006) found that while the frequency of suppression mortality of trees was 2.5 times greater than that of mortality due to disturbance, nearly four times more biomass was lost to disturbance mortality.

Gradually, the developing stand transitions from the competitive exclusion/biomass accumulation stage into the maturation stage. Maturation is marked by the attainment of maximum height and crown spread. As overstory trees slow their crown expansion the intensity of competition for light lessens. Consequently, the dominant agents of tree mortality shift from competition related processes to density-independent processes, such as small scale disturbance, pathogens and insects. Understory light levels increase, allowing the development and re-establishment of understory plants and shade-tolerant tree species in the lower canopy. However, this process can be very slow in mature stands with a strong western hemlock component—a common scenario in the Sitka spruce Zone. Working in mid-elevation forests in the Oregon Cascades Stewart (1986, 1988) found that shade tolerant tree regeneration was delayed and understory plant community development was limited in stands with hemlock-dominated overstories , relative to Douglas-fir dominated stands. The denser hemlock canopy likely transmits less light, restricting understory development. By extension, Sitka spruce Zone forests that established with a high initial western hemlock overstory component my experience delays in maturation relative to stands that established with a relatively large Sitka spruce overstory component.

Once understory trees have established, further small-scale canopy disturbances create opportunities for growth of shade-tolerant trees into the middle and overstory strata (Winter et al. 2002), resulting in a vertically continuous canopy and a diversity of live tree sizes. This stage is termed vertical diversification. As overstory trees which have grown to substantial size at this developmental stage succumb to mortality, woody debris loads increase from the low levels typical of the early maturation stage to those typical of old-growth forests. In coastal forests, much of the overstory tree mortality at this stage arises due to interactions between pathogens (root and butt rots) and wind. Large branch systems develop during vertical diversification, as does decadence in live trees (e.g. stem rot, cavities, bark scarring, broken tops, etc.), creating diverse canopy habitat for animals and epiphytes.

The horizontal diversification stage follows vertical diversification and describes the process by which a forest stand develops a spatially heterogeneous structure in a horizontal plane. Horizontal diversification subsumes many tree birth, death and growth processes, of which the net effect is to transform the homogenous young stand (i.e. a stand in the competitive exclusion/biomass accumulation stage) into a spatially heterogeneous forest. Horizontal heterogeneity, defined as the presence of multiple patches within a forest stand which together form a fine scale structural mosaic, is considered an emergent property of old-growth forests (Franklin and Van Pelt 2004) and is thought to originate primarily from a combination of spatially-aggregated tree mortality and competitive interactions between different subpopulations of trees (Franklin et al. 2002, Larson and Franklin 2006).

The final developmental stage identified by Franklin et al (2002) is pioneer cohort loss, which is simply the loss of the last members of the original stand initiation cohort. In the Douglas-fir forests described by Franklin et al. (2002) this represents a potential loss of forest structure and function since Douglas-fir generally does not regenerate in canopy gaps. The analogue for Sitka spruce Zone forests would be the loss of large, dominant spruce. However, in spruce forests the pioneer cohort loss stage does not have the same consequences for forest structure, composition and function as in Douglas-fir forests because spruce is capable of regenerating in canopy gaps (Taylor 1990), thereby maintaining a spruce component over time spans greater than the longevity of the original spruce cohort.

Two major stand development pathways exist in coastal spruce-hemlock-cedar forests and arise from variation in severity of the dominant disturbance, wind (Figure: 1). Sites with greater exposure to wind tend to experience high severity disturbance and stand development follows a catastrophic pathway (i.e., Franklin et al. 2002). Due to their prolific seed production and rapid early growth, western hemlock, and to much a lesser extent, Sitka spruce tend to be the dominant species in this pathway. Relatively less exposed sites experience chronic, low severity wind disturbance, which manifests as small scale, canopy-thinning disturbances (Winter et al. 2002). The chronic disturbance pathway tends to select for wind resistant, western redcedar and leads to relatively open, cedar dominated stands that are increasingly resistant to wind disturbance over time (Weetman and Prescott 2001). At the landscape scale, topographic heterogeneity create a mosaic of young, even aged stands developing along the catastrophic pathway following high severity wind disturbance and old-growth, all aged stands maintained by low and moderate severity wind disturbance (Kramer et al. 2001, Weetman and Prescott 2001).

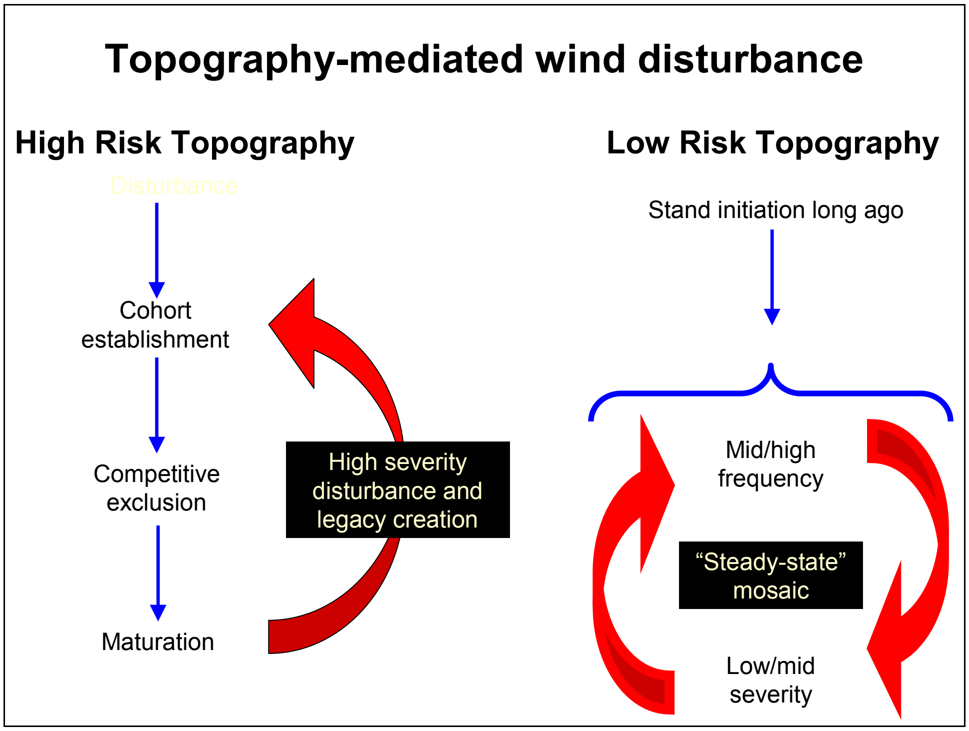

Figure 1: The effects of topography on wind disturbance and forest development

Long term studies of forest development following stand replacement fire at Cascade Head Experimental Forest provide additional insight into forest structural development in the Sitka spruce Zone. Stand replacement fire burned the Northern Oregon Coast Range in circa 1845 (Morris 1934, Munger 1944), including the area now designated as the Cascade Head Experimental Forest. Following fire, stand structural development proceeded along the sequence described by Franklin et al. (2002) up to the end of the competitive exclusion stage and beginning of the maturation stage (Harcombe 1986). Permanent plot studies then demonstrate accelerating mortality and biomass loss in maturing forests (Acker et al. 2000, Greene et al. 1992, Harcombe et al. 1990) from a complex pattern of wind disturbance (blowdown). Harcombe et al. (2004) used aerial photographs to characterize this wave like pattern as it advanced through Cascade Head over a 40 year period.

Susceptibility of a forest stand to windthrow increases with stand age in coastal forests (Harmon et al. 2004, Harris 1989, Jane 1986, Rebertus et al. 1997, Wimberly and Spies 2001) (Figure 2). As trees grow taller they become less able to withstand the physical forces of high velocity winds, leading to increases incidence of mechanical failure either by uprooting or stem breakage. Stem, butt and root rots in older (larger) trees also increase the likelihood of windthrow (Edmonds et al. 2000). Also, once gaps in the canopy have been created, the remaining trees are more exposed and susceptible. Topography interacts with prevailing wind directions (storm tracks) such that different locations will have greater or lower susceptibility to windthrow (Kramer et al. 2001). On sites predisposed to catastrophic windthrow by the local topographic context, forest structural development will be truncated, seldom reaching the later stages (i.e. vertical and horizontal diversification) of forest structural development.

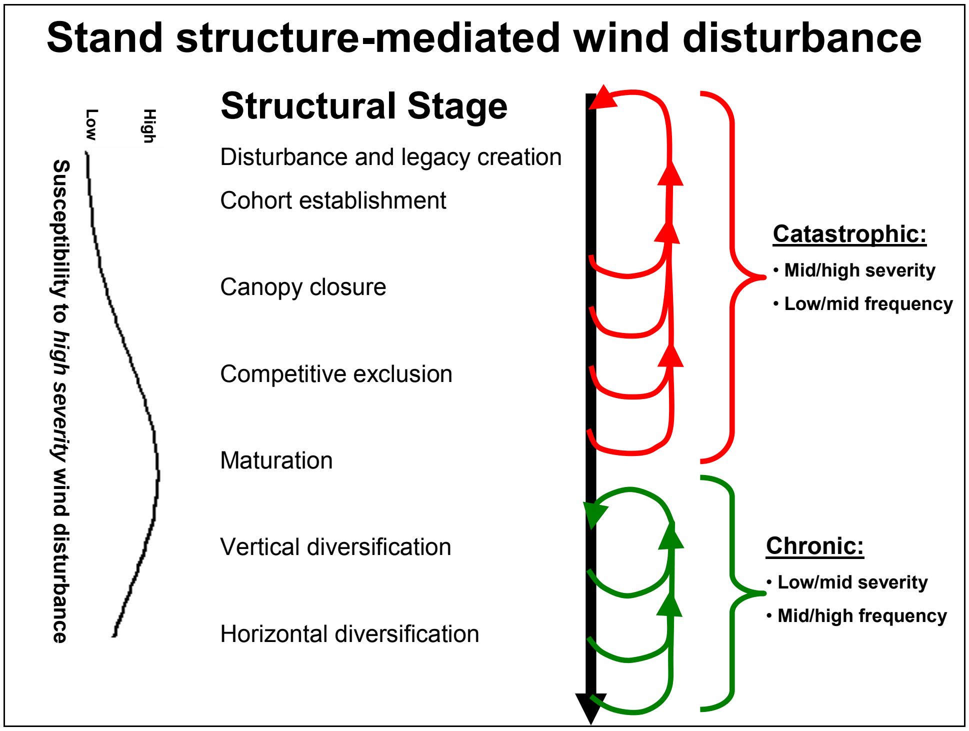

Figure 2: The influence of stand structure and wind disturbance on forest developmental pathways.

In the case of the Cascade Head, both topographic position and decreased resistance to wind disturbance due to unstable, single cohort stand structure dominated by tall, slender trees have contributed to the observed pattern of partial blowdown waves (Harcombe et al. 2004). These waves initiated from discreet canopy gaps that have slowly spread and coalesced through time. A similar phenomenon has been observed in other coastal, wind-disturbed forests (Rebertus and Veblen 1993, Rebertus et al. 1997). Thus, the implication is that conversion of wind resistant cedar dominated old-growth stands (*sensu* Weetman and Prescott 2001) to even aged hemlock dominated stands has decreased the resistance to wind disturbance, particularly on sites with only moderate topographic protection from storm tracks.

Red alder aggressively invades many sites in the Sitka spruce Zone following disturbances. Consequently, pure stands of red alder, or mixed alder - conifer stands often develop following logging or natural disturbance (Deal et al. 2004). Red alder is a short lived species; two major successional pathways are possible in maturing alder stands. Spruce, hemlock and cedar are all able to persist in the understory of alder stands. Thus, a common successional sequence is a gradual transition from alder to conifer dominance. Beach and Halpern (2001) found that distance to seed source was the most important explanatory variable for patterns of conifer seedling abundance in alder dominated riparian forests. Substrate (woody debris) was positively related to hemlock and spruce seedling abundance, while conifer seedling abundance declined with increasing herb and shrub cover. The same study found no relationship between conifer seedling abundance and overstory cover, suggesting that alder does not competitively exclude conifer seedlings from the understory. If conifer seed is not available, or if conifer seedling establishment is otherwise limited (e.g. by competition with understory plants or herbivory), shrubs may increase in dominance as the alder component senesces, further excluding conifer establishment and maintaining a stable shrub community (Spies et al. 2002). Having some portion of the landscape maintained in brushfields is not necessarily undesirable; the condition likely occurred naturally. However, management action (e.g. planting conifer seedlings) may need to be taken on some sites if past harvesting has removed local conifer seed sources.

Mixed alder - conifer stands have the potential to develop heterogeneous stand structures with multiple canopy layers and large diameter conifers (Deal et al. 2004). Rapid initial height growth by alder leads to canopy stratification, with understory conifers persisting under an overstory of alder. Alder is a short lived species however and mortality of overstory trees facilitates the eventual recruitment of suppressed conifers into the overstory of mixed alder – conifer stands. Sitka spruce appears to be particularly adept at responding to release from overstory alder competition (Deal et al. 2004).

Stream Geomorphology, Disturbances, and Habitat, including Riparian Areas

Stream geomorphology can be characterized at multiple spatial scales ranging from geomorphic provinces to channel reaches. Three basic types of channel reaches exist: (Montgomery D.R. and Buffington 1998).

- Colluvial reaches: These are typified by low volume, ephemeral flows and poor sediment sorting, as debris flows are the primary sediment transport process in colluvial reaches.
- Bedrock reaches: These occur where sediment transport capacity exceeds sediment supply, preventing the accumulation an alluvial sediment bed.
- Alluvial reaches: These occur where alluvial sediments accumulate and assume several different morphologies (cascade, step-pool, plane-bed, pool-riffle, and dune-ripple) depending on the ratio of sediment supply to transport capacity. These five types tend to arrange themselves within the channel network according to stream gradient, with cascades morphologies typically found in steeper areas and pool-riffle and dune-ripple reaches occupying low gradient locations. However, in-channel large woody debris alters sediment delivery-transport relationships, forcing channel reaches to assume different morphologies than would be expected in the absence of large wood in the stream channel. In-channel woody debris can create suitable aquatic habitat in stream reaches that would otherwise be of low habitat quality.

Disturbance regimes and processes change throughout the stream network (Montgomery D. R. 1999). As stream channels increase in size, dominant disturbance processes transition from landslides and debris flows to floods and channel migration/avulsion events. The frequency and magnitude of stream disturbance regimes shifts from infrequent and high magnitude disturbances in small streams to higher frequency and more moderate intensity in larger channels. Debris flows are primarily responsible for delivery of large woody debris in high gradient headwater channels; while downstream transport, bank erosion, and stand mortality are the primary causes of recruitment in low gradient, larger channels. Also, habitat heterogeneity within channel networks is hypothesized to be strongly influenced by large deposits of large woody debris in tributary junctions (Benda et al. 2004).

Riparian vegetation influences instream microenvironmental conditions, nutrient inputs and the quality and quantity of allotochonous organic inputs (Naiman et al. 2000, Naiman et al. 1998, Spies et al. 2002). Aquatic biota respond to changes in the quantity and quality of allotochonous inputs from riparian forests (Bisson and Bilby 1998). Riparian forests represent an important habitat resource in their own right: 29% of wildlife

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Appendix B: Process and Guidelines for Developing Stand Level Prescriptions

By: Derek Churchill, Andrew Larson, & Kevin Cedar

Numerous land management agencies in western Washington such as the Washington State DNR (Holmberg et al. 2006), the Olympic National Forest (Shoal 2002), the Cedar River Watershed (Erckmamn and others 2000), Fort Lewis Military Reservation (Public Forestry Foundation 2001), and the Pinchot Partners (Churchill et al. 2005) have translated the theoretical ideas of accelerating the development of old growth structure into operational thinning prescriptions. Various scientists have also provided operational level recommendations (Carey, pers. comm., Franklin pers. comm.). However, these recommendations are geared towards creating old growth structure suitable for spotted owl habitat in mostly Douglas-fir dominated forests. They also do not clearly articulate a thought process for determining the amount, scale, and distribution of variability that should be introduced at different stages of stand development in different forest types.

Applying these concepts and implementation strategies to the Sitka spruce forests of Willapa Bay, where wind disturbance and prolific hemlock regeneration are defining attributes, is likely to lead to unintended consequences. The following process was thus developed to guide managers in developing site-specific prescriptions that have a clearly defined rationale of how to meet distinct objectives for particular stands. It is an attempt to articulate and define the complete set of factors and thought processes that should be addressed when designing prescriptions for a mix of objectives. Many of the steps will be obvious to any land manager, while others may not be. It may seem at first glance to be overly complex, yet it is basically what experienced foresters do intuitively. By ensuring that the prescription development is done in a conscious, systematic fashion with a clear rationale can be explained, unintended consequences from cookie-cutter prescriptions that can develop over time are more likely to be avoided. Most of the information needed in the process has already been gathered, is presented in this plan, and can be further analyzed using the multiple GIS layers, inventory data, and LMS tools collected and developed for these ownerships. While this process is laid out in a linear fashion, prescription development is by nature an iterative process and will involve going back and forth between steps.

1. *Clearly Articulate Management Goals & Constraints*

While the overall management objectives and landscape level, desired future conditions for the Refuge and Conservancy ownerships have been laid out in this plan, it is critical that they be clearly fleshed out for the specific stand in question. Getting clear and being upfront about the balance of ecological, economic, and social needs and constraints of each particular project will continually refresh and allow for evolution of overall management goals, avoid overuse of boilerplate language, and guard against loss of public trust. Although this is an obvious and often repeated step, many land management agencies have been slow to change their goals, thinking, and strategies as social values, ecological conditions, and scientific knowledge have changed.

2. *Assess Stand*

- <u>Landscape context:</u> Several questions should be examined to get a clear picture of how the stand is connected with the surrounding landscape. What is the condition of the landscape around this stand in terms of stand structure, age class distribution, landscape heterogeneity, and habitat connectivity? What functions does this stand provide at the watershed and landscape scales? Are there riparian areas, streams, wetlands, unstable slopes, special habitats, rare species, or other features that are part of important landscape level processes or habitat for key wildlife species? If so, assess the condition of these areas relative to providing key functions. If treating several stands that are close together, much of this step can be done for multiple stands at once.

- Site characteristics: The key physical factors that affect the vegetation and potential vegetation on the site must be clearly understood by identifying the geological history, landform, topographic position, soil characteristics, site productivity, and susceptibility to disturbance (primarily wind) of the site where the stand is located. Also, identify the plant association group, its defining physiological and ecological characteristics (i.e. low or high drought and frost tolerance, light vs. moisture limited, etc), and the silvics of the tree species present (regeneration strategies, shade tolerance, lifespan, growth potential, etc).

- Stand development history: Summarize how the stand developed by listing all past management activities (i.e. clear cut harvest, broadcast burning, planting, pre-commercial thinning, etc) and key natural processes that also played a role (i.e. species colonization, windthrow, competitive interactions, disease, etc). Next, using the explanation of natural stand development for this forest type provided in appendix A, identify key differences between the developmental pathway of this stand and a theoretical natural stand of a similar age developing after natural disturbance on this particular site. While the natural pathway is not necessarily the ideal or target pathway, it is critical to understand what structures and processes are different because of past management (i.e. lack of legacy live trees, snags, and CWD; high proportion of Douglas-fir, reduced horizontal patchiness early in stand development, low crown class differentiation, low species diversity, etc). Finally, attempt to determine the fine scale distinctions in old growth development that exist in the specific plant association and topographic position of the particular stand. For example, sites on drier soils on exposed ridge tops appear more conducive to western redcedar dominated stands while protected riparian corridors favor Sitka spruce and western hemlock.

- Structure and composition of stand: Through both inventory data and thoroughly walking the stand, managers should have a firm grasp of the following items:
  - Stand density, diameter and height distribution, and species composition.
  - Live crown and height to diameter ratios
  - Live legacies
  - Size, decay class, and expected longevity of snags, CWD, and wildlife trees:
  - Horizontal patterning: patchiness
  - Understory plant community composition
  - Ongoing disturbances

- Developmental processes: As described in appendix A, Franklin et. al. (2002) built on the work of earlier efforts (Carey and Curtis 1996, Oliver and Larson 1996) to develop a series of structural stages that describe the development of old growth forests. Most land management agencies use these or similar systems to classify stands into structural stages and to prescribe treatment regimes. However, stand development is rarely a linear path and stands often have processes from multiple stages happening at once (Franklin et al. 2002). This is especially true in systems with chronic disturbance regimes. When designing prescriptions, it is much more important to understand the specific processes occurring in a stand and their relation to the development of the desired future conditions, than it is to define the specific structural stage. From a synthesis of the above authors and several others (Carey 2003, Spies and Franklin 1990, Spies et al. 2002a, Spies et al. 2002b), the 5 overarching components that lead to the development of old growth structure in westside Pacific Northwest forests have been broken down into the processes that drive them (table 1). These five overarching components are inherently interconnected and many of the processes are thus listed more than once. The processes are somewhat sequential, but not necessarily so. In order to better understand where the stand is at and where it is headed, the status of the overarching components should be observed in the field and analyzed. To do this, processes that are either in full swing, ramping up, declining, or about to begin should be identified using table 1.

Table 1: Stand development processes that lead to development of old growth structure in west side old growth forests in the Pacific Northwest.

Stand Development Processes
a). Overstory canopy development • Cohort establishment & early mortality from weather, herbivory, and shrub competition • Canopy closure • Crown class differentiation: • Competitive exclusion & mortality • Biomass accumulation: height growth, diameter growth, and stem form • Vertical crown development: height growth, crown lifting, & epicormic re-building • Horizontal crown expansion
b). Horizontal spatial patterning • Live and dead legacy carry over from previous stand • Early cohort establishment & mortality weather, herbivory, and shrub competition • Horizontal packing: canopy closure and competitive exclusion that leads to more homogenous spatial pattern. • Small and large gap creation • Patchy development of multiple canopy layers that creates "anti-gaps" (patches of dense mid and understory trees).
c). Vertical canopy development • Cohort establishment (early tree species colonization) • Competitive exclusion • Stratification • Understory tree species colonization • Recruitment and decomposition of dead wood: substrate for colonization. • Development of midstory • Patchy development of multiple canopy layers. Bottom loaded canopy where majority of foliage is in mid and understory tree layers.
d). Decadence formation • Legacy carry over from previous stand • Biomass accumulation • Competitive mortality • Exogenous mortality (pathogens, inserts, wind, fire, etc). • Damage to live trees: bole damage and crown damage • Decomposition: fungi, invertebrates, vertebrates, abiotic, etc.
e). Plant community development (shrubs, herbs, epiphytes, lichens, etc) • Live legacy carry over from previous stand • Early species colonization & mortality • Competitive exclusion & suppression. • Understory re-initiation: species colonization & growth • Gap formation • Recruitment and decomposition of dead wood: substrate for colonization. • Patchy development of multiple canopy layers where mid-understory tree layers create complex understory light environment • Crown colonization: epiphytes, lichens, etc.

<u>Operational assessment:</u> A rough assessment of the operational needs of different management options should be done (access, logging systems, landings, skid trails, etc) and the potential costs, revenues, and impacts estimated. The likelihood of a future entry and what type of future entry (MDL vs. BR) should also be determined as it will be a critical factor. Key potential impacts to be assessed include:
Soil compaction
Erosion and sediment delivery to aquatic systems
Invasive species
Loss of key ecological features: snags, tall shrubs, rare plant species.
Disturbance to sensitive wildlife & plant species.
Excessive shrub response or western hemlock regeneration
Social impacts: recreation, cultural sites, scenic value, etc.

3. *Design Prescription:*

- <u>Process analysis:</u> The information gathered the stand assessment should be used to answer the following questions:
  - Which processes are currently moving the stand towards DFC and which are moving the stand away from it?
  - Without any management intervention, what processes and structures will be missing or slow to develop with respect to DFC?
  - What processes could be manipulated to move the stand towards DFC?
  - What processes could be set back by a management entry?
  - Will stand benefit from treatment, factoring in the potential impacts? If not, consider alternative treatments or do not enter stand.

- <u>Specific treatment objectives:</u> While the management goals provide guidance, more detailed quantitative structural targets and a timeline should be clearly articulated for the particular stand given all of its site-specific conditions and landscape context. The general goal of developing late-seral structure should be broken down into the type of old growth forest that is desired and possible on the site. For example, some sites may be conducive to patchy, cathedral like, cedar-dominated old growth stands. On other sites, a more uniform, smaller diameter hemlock-spruce old growth forest may be the best option given habitat needs for Marbled Murrelets, the site, and the current structure of the stand. The intermediate structural stages should be spelled out by establishing quantitative targets of dominant tree size, height to diameter ratios, snag abundance, relative species composition, shrub cover, and spatial patterning within a 20-50 fifty year timeframe. The short to medium term effects of treating the stand should be balanced against the long term goals. Careful analysis of the stand inventory data and experimentation with different treatment scenarios in LMS will likely be necessary. The level of precision possible will vary for different metrics and a good deal of silvicultural judgement will be required. Maintaining future management options should also be factored in.

- <u>Sensitive areas and biodiversity hotspots:</u> From the stand assessment, identify what features and areas will need special management or protection. These may include large snags, legacy trees, hardwood patches, wildlife trees, midstory trees, riparian areas, wetlands, unstable slopes, rare plants, and habitat for endangered wildlife species. Based on landscape and stand level ecological conditions and regulatory requirements, determine if they should be managed with a no entry buffer, a drop and leave release treatment, or protected through specific marking or contract language protection.

- <u>Operational design:</u> If a biomass removal treatment is being considered, a logging systems analysis should be done at this stage. Costs and operational requirements should be calculated. The sensitive areas listed above will likely be a major factor to work with. For YDL, MDL, understory management, or decadence acceleration treatments, costs and opportunities for operational efficiencies should also be examined.

- Desired species composition: Determine what species will be retained and which will be targeted for removal.

- Understory management & decadence acceleration: Given the current species composition, snag and CWD levels, and what natural regeneration and blowdown is likely after a BR or MDL treatment, determine if these treatments are necessary and when.

- Baseline density and diameter targets: (for YDL, BR, and MDL treatments) The baseline density target can be considered the "average" or background thinning intensity that can be used to establish the range of variability desired in VDT treatments. Decades of silvicultural research provide guidance as to expected responses from different intensities of thinning (Marshall and Curtis 2002, Oliver and Larson 1996). While this research was conducted on plantations managed for wood production, it offers important knowledge and tools to achieve ecologically oriented structural goals.

  Density targets should be set in Stand Density Index (SDI) and can then be translated into trees per acre or basal area if necessary. The "Lower Management Zone" in stand density diagrams (Curtis 1982, Drew and Flewelling 1979, Long 1985, Reineke 1933) can be used as a starting point. This is 35% of maximum SDI or 50% of full stocking. It is the point where enough growing space is opened to allow residual trees to grow vigorously for a sustained period of time without losing excessive stand level volume growth (DeMars 2000, Drew and Flewelling 1979, Oliver and Larson 1996). Ecologically, it is a balance between growing large individual trees and maintaining biomass accumulation for future snag and CWD recruitment. It will typically result in a small to moderate pulse of understory development and tree regeneration that will slow down as the canopy re-closes. If additional understory or midstory development is desired or growing large trees is a primary goal, the density target should be lower, 25-35% of max SDI. In dense stands with high HD ratios or on wind prone sites, density targets may need to be set higher to avoid increasing windthrow risk. A general rule for these dense hemlock stands is to not lower density by more than 20% of max SDI (Holmberg et al. 2006). If a stand is at 70% of max SDI, then it should only be taken down to 50% of max SDI.

  Maximum SDI levels are 790 for western hemlock, 750 for Sitka Spruce and western redcedar, 590 for Douglas-fir, and 270 for red alder (Drew and Flewelling 1979, Farnden 2006, Hibbs and Carlton 1989, Long 1985, Puettmann et al. 1993, Smith N.J. 1989). Methods for determining maximum SDI levels for mixed species, multi-strata stands have only recently been developed (Woodall et al. 2005) and are still experimental. However, these stands are able to carry more stocking as different species and strata capture growing spacing differently and intra-specific competition is not as intense (Amoroso 2004, Long 1995, O'Hara and Gersonde 2004, Shaw 2000, Woodall et al. 2005). Thus maximum SDI levels in stands without a clearly dominant species (more than 60% of basal area) should use the highest SDI level of all the species in the stand, which will be 790 for western hemlock in most cases. Max SDI in stands dominated by Douglas-fir or red alder will need to be lower, and can be calculated using a weighted average based on the relative composition of the different species post-thinning. Field testing and experimentation through time will be needed to determine site specific maximum SDI levels for different mixtures of species and corresponding thinning targets. Also, in stands where individual tree or group selection approaches will be used to target specific features or areas of a stand, simple trees per acre targets may be more appropriate than using the SDI framework. Likewise, young drop and leave treatments are generally done in trees per acre targets. However, the same principles of stand density apply.

  In addition to the baseline density target, the decision as to what diameter classes to thin from must also be addressed. While thinning from below (removing the smallest diameter classes until the density target is reached) is the most common approach in thinning, it can reduce crown class differentiation, set back vertical canopy development, reduce species diversity, and generally simplify stand structure.

Given the goals of accelerating old growth development processes, removing some dominants and co-dominants is generally necessary and desirable. A proportional thin with lower and upper diameter caps can be used to achieve this. A stand table should be used to establish diameter caps

Finally, determining density and diameter targets requires clearly assessing a number of considerations. LMS can be used to experiment with different thinning intensities and to assess trade-offs. Density targets should then be field tested to ensure they make sense. Considerations include:

- Desired growth response of residual trees and time until canopy closure
- Post-thinning susceptibility to blow-down
- Effects on understory and midstory development
- Likelihood of future entries
- Volume removal and revenue potential
- Future snag and CWD recruitment potential

- <u>Introducing patchiness:</u> The amount, patch size, and distribution of horizontal patchiness to be introduced should be specified and supported by a clear rationale. Structural objectives, answers from the process analysis above, and existing patchiness, species composition, midstory condition, logging system requirements, access, topographical features, and special management areas should be all factored be in. Spatial information from nearby old growth stands can be used as a reference if it is available, although natural stand development processes that will shape the young stand over time must be factored in. The following items can be used to introduce patchiness and vary understory light levels.
    - No entry skips (in addition to those around sensitive features) to maintain dark areas in the understory, maintain snag creation from competitive mortality, provide refugia for soil fungi that can be negatively impacted from ground based thinning (Colgan et al. 1999, Smith J.E. et al. 2002), and set pockets up for future blowdown by maintaining high HD ratios.
    - Heavy release areas to release certain species or trees to achieve high growth rates and large crowns, as well as promoting understory development. Heavy release is generally 15-30% of max SDI. These can involve releasing single trees, clusters, or extend over multiple acres.
    - Gaps to promote understory development. Some trees can be left in larger gaps to either grow into large diameter trees or blow down to create snags and CWD. Often wind will create gaps naturally over time or expand ones that are created.
    - Varying the baseline density target in different parts of the stand to achieve the same goals as the first three items, but to a lesser degree.
    - Retain clustered or paired dominant trees, thickets of small trees, preserving fine scale heterogeneity. These features often are often lost in thinning treatments and are prominent features in old growth stands.
    - Retain all trees of a certain species, trees above or below specific diameter targets, or trees with specific features such as broken or forked tops. While this is an imprecise tool to create variability, it is easy to implement and can be effective at creating patchy stand structure post thinning or accelerating the development of a patchy midstory, which will create a variable understory light environment in the future.

There are no set maximum or minimum levels for these items. Objectives and site specific conditions must drive prescriptions. In stands that are already high in complexity, preserving and working with existing complexity when thinning may be all that is necessary. For example, in stands with a patchy component of midstory conifers, thinning the overstory more heavily around some midstory patches, leave some skips around areas with no midstory, and thinning the rest of the stand in a relatively even fashion will promote the patchy development of multiple canopy layers and lead to a range of small-scale vegetation patch types over time (dark sparse thickets, intermediate patches with low shrubs, "parked out" patches with large trees and a lush understory, and open shrubby gaps). On the other hand, in 60-80 year old stands where marbled murrelet habitat is a major goal or where post thinning blowdown is likely, a single density target, contract language to preserve fine scale heterogeneity, and a few skips may be all that is desired. In uniform 40 year old stands where growing large trees is a major goal and a future entry is likely, 20% of the stand in skips, heavy release in 30% of the stand favoring western redcedar where it exists, and a lighter thin around the rest of the residual trees may achieve the desired results. In 15-20 year old stands, a few areas of light thinning, retaining fine scale heterogeneity, and thinning the rest of the stand to a relatively even spacing while focusing on shifting relatively species composition may be all that is needed when future entries are likely. If maintaining early-seral habitat is a landscape scale need for certain species, then creating several large gaps in young stands where canopy closure has not excluded early-seral plant communities should be considered.

- Treatment Type: Make final decisions on what treatment or combinations of treatments to use in the stand: YDL, BR, MDL, UT, etc. For BR and MDL treatments, decide whether variable density thinning, individual tree selection, or group selection should be used. A combination of treatment approaches may often be used. At the operational level, these different approaches often blend together.

- Implementation and operational prescription: The final step is this process is to translate the management of sensitive sites, species selections, logging systems, desired variability, and density targets into an operational prescription that is simple and practical enough to be understood and implemented by marking crews and/or contractors in a cost effective manner. A number of implementation approaches have been used by other agencies implanting these types of prescriptions:
    - Marking: this is the most straightforward method and the easiest to fine tune. It can be costly, however, especially in young stands with high densities.
    - Designation by Description (DxD): This is a method of designating the specific trees that will be removed without actually marking. Any person following the prescription will select the same trees. It is simple and efficient to implement and can be adjusted with species and diameter targets. However, it can be challenging to achieve the desired level and type of variability with this method and it can overly homogenize stands.
    - Designation by Prescription (DxP): Known also as "operator's choice", the contractor selects which trees are actually removed using clear guidelines and spacing or basal area targets. It offers considerable options and flexibility when designing complex prescriptions and incorporates the knowledge and experience of the contractor, which can often reduce stand damage and create efficiencies. It requires skilled operators and an experienced sale administrator who knows how to work with contractors to avoid miscommunication and get the desired results.

  The method used will depend on the stand, treatment type, prescription, management resources, and available contractors. In many cases, a combination of some marking with a DxD or DxP prescription is ideal.

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Appendix L. Draft Predator Management Plan

Draft Predator Management Plan
Willapa National Wildlife Refuge
Leadbetter Point Unit

November 2010

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L.1 Purpose and Need for Action

L.1.1 Overview

Pursuant to its endangered species management responsibilities and in conjunction with other wildlife and habitat management activities, the U.S. Fish and Wildlife Service (Service) would implement, per available funding, a predator management program on the Willapa National Wildlife Refuge (Willapa NWR or Refuge). Species expected to directly benefit from this action is the federally threatened western snowy plover (*Charadrius alexandrinus nivosis*). The Federal candidate streaked horned lark (*Eremophila alpestris strigata*) would also benefit from these activities because they inhabit the sparsely vegetated sand beaches and dunes used by breeding plovers on refuge. Implementation of this program would maximize adult survival and juvenile recruitment of western snowy plover as identified in the western snowy plover Recovery Plan by reducing the threat posed by certain problem avian and mammalian predators. Predator management is identified in Objective 6.1 in Section 2.5 of the draft Willapa National Wildlife Refuge comprehensive conservation plan/environmental impact statement (CCP/EIS) as one of several actions to be implemented in support of listed species occurring on the Refuge.

This predator management plan has been developed as a comprehensive conservation strategy that addresses a range of management actions, from vegetation control and nesting habitat enhancement to non-lethal and lethal control, when necessary. The most effective, selective, and humane techniques available to deter or remove individual predators or species that threaten nesting, breeding, or foraging snowy plovers or horned larks will be implemented. Existing predator management plans for the conservation of plovers provided the framework for this document and forms the basis for methods used in this proposed plan (USDA 2002, 2005; USFWS 2002, 2006).

A number of species recognized as potential predators of snowy plover eggs, chicks, and adults are likely target predator species under this plan. They include crows, ravens, hawks, falcons, owls, coyote, fox, weasel, and mice (Liebezeit and George 2002; Powell et al. 2002; USFWS 2002, 2007). American and northwestern crows, common raven, northern harrier, merlin, American kestrel, peregrine falcon, coyote, and mice are currently suspected to be potential predators for western snowy plovers and streaked horned larks at the Leadbetter Point Unit of the Refuge. Elk are also implicated as having an impact on ground nesting birds at Leadbetter Point. (Refer to Objective 6.1, Section 2.5 the draft Willapa National Wildlife Refuge CCP/EIS for the proposed elk management strategy.) Those wildlife species requiring management because of conflicts with the recovery of listed species could be impacted by removal of a few problem individuals. The adverse effects of predator management on the local and range-wide population of the affected predator species would be insignificant.

L.1.2 Purpose

The Willapa NWR predator management program would aid the Refuge in accomplishing the following recovery actions:

- Maintain a five-year average population of 40 breeding pairs of western snowy plover on the Refuge.

- Maintain a five-year average productivity of at least 1.0 fledged western snowy plover chick per male on the Refuge.
- Fledge at least one young per western snowy plover pair per year on the Refuge.
- Reduce the number of problem predators utilizing the Leadbetter Point Unit. Problem predators are defined as individual wildlife of species known to prey on western snowy plover and streaked horned lark and that are exhibiting hunting behavior in plover and lark nesting areas.

The predator plan is being developed to support the Refuge's CCP management objectives of recovering and maintaining stable snowy plover populations. The 2009 Washington statewide western snowy plover nesting population as reported by Pearson et al. (2009) was 35 (95% CI = 26-44) and the 2009 Oregon nesting population was 145 (Lauten et al. 2009) for a total of 181 (Confidence Interval = 171-190) nesting adult plovers in Recovery Unit 1. The Federal recovery population objective is 250 breeding adults in Recovery Unit 1. The Willapa NWR predator management program is designed to integrate with existing refuge management efforts, including the Leadbetter Coastal Dune Habitat Restoration Project.

Developing a metapopulation model for streaked horned larks, determining the prevalence of site fidelity, and quantifying movement patterns between sites used for breeding and wintering, is currently underway. These are precursors to preparing a regional streaked horned lark conservation strategy. The streaked horned lark population is currently estimated around 750 birds. However, this estimate was derived from data collected from different survey efforts, using differing methods, over a period of several years (Pearson and Altman 2005). The 2004 Washington State breeding population was reported by Stinson (2005) to be 330 birds. A conservative 2009 estimate of 9 or 10 breeding pairs on the Refuge is based on available data. Pearson et al. (2008) predicted Washington's streaked horned lark population to be declining rapidly at an annual rate approaching 40%. Because predation is identified as a leading cause of streaked horned lark nest failure, minimizing predation will be an important component of any future conservation strategy (Altman 1999; Pearson and Altman 2005; Pearson and Hopey 2005; Pearson et al. 2008). A regional and refuge-based conservation strategy would include criteria necessary to attain viable populations, similar to recovery actions for listed species.

L.1.3 Background

Predation is one of many mortality factors that influence wildlife populations. Predators often play critical roles in the composition and function of wildlife populations in ecosystems (Witmer et al. 1996). Normally, predation would be considered part of the function of a healthy ecosystem. However, major changes have occurred in the ecosystems of the Pacific coastal region. The effects of predation on birds can be detrimental to local populations or islands, especially when predator densities are high or when predators gain access to areas not historically occupied (Bailey 1993; Stoudt 1982). In general, ground-nesting birds suffer the highest predation rates, followed by cliff/burrow nesters. Tree nesters experience the lowest rates of depredation (DeVos and Smith 1995).

Predator removal has been conducted to increase survival of fledglings and to increase breeding populations of threatened or endangered wildlife, rare species, and species not traditionally hunted (Reynolds and Tapper 1996). Numerous studies have shown that nest predation accounts for the largest share of nest failures of neotropical migratory songbirds and contribute to low recruitment rates (Heske et al. 2001; Nelson 2001). Increased rates of nest predation are believed to be largely related to habitat fragmentation, habitat degradation, and other changes in related landscape features (Heske et al. 2001; Nelson 2001; Sovada et al. 2001). The impacts of predation vary geographically because of habitat composition and structure and species composition of predator communities (Nelson 2001; Sovada et al. 2001). Also, when implemented, the effectiveness of predator removal to protect these non-game species has varied due to compensatory mortality (predator species composition), predator removal strategies and methodologies used (i.e., human bias), and geographic location.

Predation by native and introduced species has been identified as a leading cause of reproductive failure of the western snowy plover (USFWS 2007). Pearson et al. (2009) reported that predation was the primary source (58%) of plover nest failure in Washington in 2009. Crows and ravens are recognized as important predators of eggs and juvenile plovers and larks (Liebezeit and George 2002; Powell et al. 2002; USFWS 2002; Wilson-Jacobs and Dorsey 1985). Based on studies in Oregon between 1990 and 2000, corvids (ravens and crows) caused at least 64 plover nest failures (USDA 2002). Predation was also the most frequent cause of streaked horned lark nest failure (69%) in Washington at sites in south Puget Sound in 2002-2004, while causing 46% of failures at two coastal and one river island sites in 2004 (Pearson and Hopey 2005). Liebezeit and George (2002) provide a detailed review of corvids importance as predators. The Western Snowy Plover Recovery Plan and annual survey and population monitoring reports offer additional data on plover predation (Lauten et al. 2009; Pearson et al. 2009; USFWS 2007).

L.1.4 Relevance to Refuge Purpose and Need for Action

The USFWS mission is to conserve natural resources for future generations, the goal being to conserve, protect, and enhance fish, wildlife, and plants and their habitats for the continuing benefit of the American people. Willapa NWR was established in 1937 to protect migrating and wintering populations of brant, waterfowl, shorebirds, and other migratory birds. The Refuge preserves a number of unique ecosystems including diverse salt marshes, rich tideflats, rain-drenched old-growth forest, and dynamic coastal dunes.

The Leadbetter Point Unit of Willapa NWR is 705 hectares (1,742 acres) or about 7.05 square kilometers (2.72 mi^2) in size. Despite the success in attracting western snowy plovers and streaked horned larks to the Refuge's Leadbetter Point habitat restoration area, the relationship between the size of the restoration area and the number of plover nests discovered within this area suggest that plovers are not currently habitat limited at Leadbetter Point. The number of nests within the restoration area initially increased in 2005 as the size of the area increased but has quickly reached a peak at around 20 nests (Pearson et al. 2009) despite the continued enlargement of the restoration area. This conclusion is further emphasized by the lack of use of the state habitat restoration areas by plovers in 2008 or 2009.

By taking no actions related to predator management, mammalian and avian predators would not be harassed or specifically deterred from traveling or flying through the Refuge or entering the nesting areas. Based on previously documented losses of listed species to predation elsewhere in Oregon and California (Lauten et al. 2008; USDA 2002; USFWS 2002, 2006, 2007), it is likely that the Refuge's population of western snowy plovers and streaked horned larks would not be able to achieve sustainability objectives for adult breeding population levels and fledging success. In addition, a dramatic reduction in nest productivity could cause snowy plovers and streaked horned larks to abandon the existing nesting areas on the Refuge. Because the Leadbetter Point site is one of only two currently active breeding sites in Washington State, a management strategy that excludes any form of predator management would place the viability of the Refuge's listed species at risk of extirpation, and would likely make it impossible to achieve the Recovery Unit and step-down, refuge-specific objectives. After implementing predator management in Oregon, the state's plover population has experienced an increasing population trend for the first time, and unlike the years prior to predator management, fledging success has been above 1.0 chicks fledged per male for each year (Lauten et al. 2006, 2007, 2009; Pearson et al. 2009).

The two action alternatives proposed in the CCP/EIS for lands managed by Willapa National Wildlife Refuge include some form of plover predator management beyond nest exclosures that are currently being used to protect nests. If Willapa NWR implements predator management at Leadbetter Point and the plover population increases, then the restored suitable habitat at Leadbetter would likely be needed by the growing population.

L.1.5 Existing Snowy Plover Conservation and Predator Management Efforts

Existing snowy plover conservation and predator management efforts at Willapa NWR will continue or be expanded through the proposed action. The Refuge and its cooperators will continue to monitor snowy plovers to determine hatch and fledge rates as well as adult survivorship and population size. A discussion of how impacts of this plan would be monitored can be found on page L-14. See Pearson et al. (2009) for details on plover population and demographic monitoring. Current management and conservation practices also include seasonal use of nest exclosures on some snowy plover and streaked horned lark nests, spreading of oystershell in the snowy plover habitat restoration area, invasive tree and beachgrass removal in and/or adjacent to nesting areas, and installation of perching deterrents in and around known nest locations.

L.1.6 Authority and Compliance

Based on agency mission and legislative mandates, the USFWS is the "lead agency" and "decision maker" for this EIS, and therefore responsible for the EIS's scope, content, and outcome. As cooperating agencies, the Washington Department of Fish and Wildlife (WDFW), Washington State Parks and Recreation Commission (WSPRC), and U.S. Department of Agriculture, Animal Plant Health Inspection Service-Wildlife Services (APHIS-WS) provided input to this EIS and will provide advice and recommendations to the lead agency on when, where, and how predator damage management could be conducted. APHIS-WS would be the Service's authorized agent for implementing removal actions on the Refuge.

Agency Authority for Endangered Species Management and Conservation

USFWS. The USFWS is scientific and management authority for implementation and enforcement of the Endangered Species Act of 1973 (ESA), as amended and with developing recovery plans for many federally listed species. The USFWS cooperated with the WDFW, APHIS-WS, and WSPRC by recommending measures to promote the recovery of threatened and endangered species. The USFWS also makes recommendations to avoid or minimize take of threatened and endangered species. The term “take” is defined by the ESA (Section 3(19)) as “harass, harm, pursue, hunt, shoot, wound, kill, trap, capture, collect, or to attempt to engage in any such conduct.” The terms “harass” and “harm” have been further defined by USFWS regulations (50 C.F.R. Section 17.3) as: 1) harass is the intentional or negligent act or omission which creates the likelihood of injury to wildlife by annoying it to such an extent as to significantly disrupt normal behavior patterns which include, but are not limited to, breeding, feeding, or sheltering; 2) harm is an act which actually kills or injures wildlife. Such acts may include significant habitat modification or degradation when it actually kills or injures wildlife by significantly impairing essential behavioral patterns including breeding, feeding, or sheltering.

APHIS-WS. APHIS-WS is subject to the ESA, which requires Federal agencies to use their authorities to conserve threatened and endangered species. The primary statutory authorities for the APHIS-WS program are the Animal Damage Control Act of 1931, and the Rural Development, Agriculture, and Related Agencies Appropriations Act of 1988, which authorize APHIS-WS to reduce damage caused by wildlife, in cooperation with other agencies.

WDFW. The WDFW has the responsibility to manage all protected and classified wildlife in Washington, regardless of the land class on which the animals are found (Revised Code of Washington [RCW] 77.12.020). The Washington State Department of Agriculture (WSDA) is authorized to cooperate with APHIS-WS and WDFW for controlling predatory birds (RCW 15.04.110). Washington State law authorizes the removal or killing of wildlife that is destroying or injuring property, or when it is necessary for wildlife management or research (RCW 77.12.240). The law, however, does require the person trapping or killing the wildlife to notify WDFW immediately. The department shall dispose of wildlife so taken within three days of receiving such a notification and in a manner determined by the director to be in the best interest of the state.

Compliance with Federal Regulations

Several Federal laws regulate wildlife damage management. The USFWS and APHIS-WS comply with these laws, and consult and cooperate with other agencies as appropriate. The following Federal laws are relevant to the actions considered in the CCP/EIS for this plan:

50 C.F.R. 31.14 Official Animal Control Operations.

(a) Animal species which are surplus or detrimental to the management program of a wildlife refuge area may be taken in accordance with Federal and state laws and regulations by Federal or state personnel or by permit issued to private individuals.
(b) Animal species which are damaging or destroying Federal property within a wildlife refuge area may be taken or destroyed by Federal personnel.

50 C.F.R. 31.2 Methods of surplus wildlife population control and disposal. Upon a determination that wildlife are surplus to a balanced conservation program on any wildlife refuge area, the surplus may be reduced or utilized in accordance with Federal and state law and regulation by:

(a) Donation or loan to public agencies and institutions.
(b) Sale to public or private agencies and institutions.
(c) Commercial harvest of fishery resources.
(d) Official wildlife control operations.
(e) Public hunting or fishing.
(f) Trapping.

42 U.S.C. 4321-4347 National Environmental Policy Act (NEPA). Environmental documents pursuant to NEPA must be completed before actions can be implemented. NEPA requires that Federal actions be evaluated for environmental impacts, that these impacts be considered by the decision maker(s) prior to implementation, and that the public be informed. This EIS has been prepared in compliance with NEPA (42 U.S.C. Section 4231, et seq.,); the Council on Environmental Quality Regulations(40 C.F.R. Section 1500-1508); Department of the Interior regulations (43 C.F.R. 46) and Fish and Wildlife Service NEPA procedures found in the Departmental Manual (DM) (516 DM 8).

16 U.S.C. 1531-1544 Endangered Species Act (ESA). It is Federal policy, under the ESA, that all Federal agencies shall seek to conserve endangered and threatened species and shall utilize their authorities in furtherance of the purposes of the ESA (Sec.2(c)). Section 7 consultations with the USFWS are conducted to use the expertise of the USFWS to ensure that "any action authorized, funded, or carried out by such an agency …is not likely to jeopardize the continued existence of any endangered or threatened species. Each agency shall use the best scientific and commercial data available" (Sec.7(a)(2)). The USFWS will complete consultation pursuant to Section 7 of the ESA regarding the effects of predator damage management on the Pacific coast population of the western snowy plover and other Federally listed species in the area. The full results of the evaluation will be contained in the final CCP/EIS.

7 U.S.C. 136-136y Federal Environmental Pesticide Control Act of 1972 (FIFRA). FIFRA requires the registration, classification, and regulation of all pesticides used in the United States. The Environmental Protection Agency (EPA) is responsible for implementing and enforcing FIFRA. All chemical methods integrated into any selected program as implemented by APHIS-WS or other cooperating agencies must be registered with and regulated by the EPA and the Oregon Department of Agriculture, and used in compliance with labeling procedures and requirements.

16 U.S.C. 703-712 Migratory Bird Treaty Act (MBTA). The Migratory Bird Treaty Act provides the USFWS with regulatory authority to protect species of birds that migrate outside the United States. Individuals of these species that do not migrate outside of the United States are also protected. All cooperating agencies coordinate with the USFWS on migratory bird issues. If migratory birds are found to be preying on plovers, the agencies would request a permit from USFWS under the MBTA to "take" these species, if lethal control is determined to be necessary. A depredation permit for crows "when found committing or about to commit depredations upon ornamental or shade trees, agricultural crops, livestock, or wildlife, or when concentrated in a manner as to constitute a health hazard" is not required (50 C.F.R. 21.43). The USFWS Office of

Migratory Bird Management, Pacific Regional Office, requires notification prior to use of chemical substances for control of migratory birds that are not covered by the depredation order.

7 U.S.C. 426-426c Animal Damage Control Act and the Rural Development, Agriculture, and Related Agencies Appropriations Act. The Acts authorize and direct APHIS-WS to reduce damage caused by wildlife in cooperation with other agencies.

16 U.S.C. 1451-1464 Coastal Zone Management Act of 1972. All federally conducted or supported activities directly affecting the coastal zone must be undertaken in a manner consistent to the maximum extent practicable with approved state coastal management programs.

Protection of Children from Environmental Health and Safety Risks (EO 13045). Children may suffer disproportionately from environmental health and safety risks for many reasons. Predator damage management as proposed in this EIS would only involve legally available and approved damage management methods in situations or under circumstances where it is highly unlikely that children would be adversely affected. Therefore, implementation of the proposed action would not increase environmental health or safety risks to children.

Invasive Species (EO 13112). The Invasive Species Executive Order directs Federal agencies to use their programs and authorities to prevent the spread or to control populations of invasive species that cause economic or environmental harm, or harm to human health.

Migratory Birds (EO 13186). Executive Order 13186 directs Federal agencies to use their programs and authorities to enter into a Memorandum of Understanding with the USFWS outlining how the agency will promote conservation of migratory birds. Other activities called for include incorporating bird conservation considerations into agency planning, including NEPA analyses, reporting annually on the level of take of migratory birds, and generally promoting the conservation of migratory birds without compromising the agency mission.

Relevant Washington State Regulations

RCW 77.12.240 Authority to take wildlife—Disposition. Authorizes the removal or killing of wildlife that is destroying or injuring property, or when it is necessary for wildlife management or research.

RCW 15.04.110 Control of predatory birds. The director of the state department of agriculture may control birds which he determines to be injurious to agriculture, and for this purpose enter into written agreements with the Federal and state governments, political subdivisions and agencies of such governments, political subdivisions and agencies of this state including counties, municipal corporations and associations and individuals, when such cooperation will implement the control of predatory birds injurious to agriculture.

L.1.7 Cooperators

The proposed predator management plan will be implemented in cooperation with the following agencies.

- Washington Department of Fish and Wildlife

- Washington State Parks and Recreation Commission
- U.S. Department of Agriculture, Animal Plant Health Inspection Service-Wildlife Services

L.2 Comprehensive Predator Management Plan

L.2.1 Comprehensive Predator Management Strategy (Preferred Alternative)

This plan will implement integrated predator management strategies on western snowy plovers and streaked horned lark nesting habitats of the Willapa NWR. Before implementing control actions, the initial step involves identifying individuals or groups of snowy plover and streaked horned lark predators. After identification, the most effective, selective, and humane tools available would be used to deter or remove the species that would impact nesting, breeding, or foraging adult and young snowy plovers and streaked horned larks within breeding areas. When plover and lark numbers increase and their populations stabilize, native wildlife would be allowed a more natural interaction with the local species of concern and active predator management would be de-emphasized.

Predator management is based on interagency relationships, which require close coordination and cooperation because of overlapping authorities and legal mandates. The Refuge, in consultation with WDFW, may request that APHIS-WS conduct direct predator management actions to protect the snowy plovers. The Refuge may also take action itself. Under the predator management plan, the Refuge and its cooperators will continue to monitor snowy plovers to determine hatch and fledge rates as well as adult survivorship and population size. In addition, avian predators on the Refuge and adjacent lands will be monitored; information recorded will include species observed and their behavior and habits.

Based on monitoring to identify specific predator(s) impacting nesting birds, agency personnel will evaluate the feasibility of particular strategies and methods to reach the desired goal in the context of their availability (legal and administrative) and suitability based on biological, economic, and social considerations. Following this evaluation, the methods deemed to be practical, effective, and most humane for the situation based upon professional judgment will form the basis of a management strategy. Monitoring will continue during and after the management strategy has been implemented, monitoring is conducted to assess the effectiveness of the strategy and to determine reproductive success. Records will be kept and data reported to the appropriate wildlife management agencies. This proposal would implement safe and practical methods for the prevention and control of damage caused by predators, based on local problem analysis, environmental and social factors, and the informed judgment of trained personnel.

An effective program requires that site-specific consideration of the many variables listed above be given to allow the wildlife specialist to select and implement the most appropriate technique to resolve each unique damage situation. Flexibility in the management approach is important because of the high variability found in the natural environment. An adaptive management approach will be used by the Refuge in implementing and refining this plan. In order to determine when to initiate as well as select management techniques for specific damage situations, consideration would be given to:

- Western Snowy Plover: Achieving breeding population (40 breeding pairs of snowy plover) of adults and production of chicks (greater than one chick/adult male) as identified in Western Snowy Plover Recovery Plan (see objective 2.4.6.1 in the CCP/EIS) Streaked Horned Lark: A refuge specific population objective is being developed by streaked horned lark working group.
- geographic extent of threat
- time of year
- life cycle of the snowy plover or streaked horned lark
- vulnerability to each predator species
- other land uses (such as proximity to recreational areas)
- feasibility of implementation of the various techniques
- movement patterns and life cycle of the predator
- status of target and non-target species (such as protected or endangered)
- local environmental conditions such as terrain, vegetation, and weather
- presence of refuge visitors and refuge staff
- presence of trash that could attract predators
- potential legal restrictions such as availability of tools or management methods
- humaneness of the available options[1]
- cost of control options (the cost of control in this proposal may be a secondary concern because of overriding environmental and legal considerations)

[1] The lead and cooperating agencies regard humane methods of predator damage management (including the use of lethal methods where allowed) to be those that cause the least pain, suffering, or injury to individual animals under the circumstances. Predator damage management would be accomplished only to the extent necessary to meet defined objectives, such as, aiding plover recovery by reducing predation.

Visual and auditory repellants are limited by several factors, including 1) unintentional hazing of protected species while attempting to haze predatory species; 2) reduced effectiveness over time as some predatory species become accustomed to particular stimuli and begin to ignore them; 3) difficulties in effectively deploying such repellents in the field; and 4) limited effectiveness of repellents on particular species.

Predator management priorities will take the following general approach:

1. non-native and feral species before native species
2. target offending individuals before predator species as a group
3. target family groups (e.g., corvids)
4. primary concern is addressing nest predation for increased hatch rates; predation of chicks is second in importance to increasing fledge rates, and third is minimizing predation on plover adults

Although typically adult survival is one of the most important demographic parameters to consider, adult predation is not currently thought to be a significant factor at Leadbetter Point. Upon positive determination of the predator species that threaten plovers in each case, the following tools would be available:

Non-lethal Control—Non-lethal control of predators involves implementing measures such as visual and auditory repellents and physical barriers. Increased or improved trash management to reduce the amount of available garbage is another form of non-lethal control. Current management and conservation practices at Willapa NWR include seasonal use of nest exclosures on some snowy plover and streaked horned lark nests, spreading of oystershell in the snowy plover habitat restoration area, and invasive tree removal adjacent to nesting areas. An inventory and mapping project of perching and nesting structures will be completed for the Leadbetter Unit of the Refuge. Complete removal of nonessential structures will be implemented to minimize perches available to avian predators in and adjacent to nesting habitat. Installation of perching deterrents will be undertaken on all necessary structures in and around known nest locations. Beachgrass removal to improve plover habitat on the refuge and increase the area available for nesting habitat should reduce predation pressure over time. Habitat restoration actions are discussed under Objectives 4.1 and 4.2 in Chapter 2 of the CCP/EIS.

Predator management tools could include any or all of the following depending upon the circumstances: nest or decoy trapping; relocation of live trapped animals; aversive methods that deter, harass or condition the behaviors of predators such as foul tasting eggs, pyrotechnics, electronic calls, repellants, or effigies; or electrified or non-electrified exclusionary nest site fencing and electric wired perches.

Use of physical barriers would be implemented, which should reduce the need for control of some mammals including feral dogs and cats and domestic, free-roaming pets. Increased enforcement of pet violations on refuge lands will also reduce some disturbance. However, physical barriers in the absence of the ability to remove a predator are ineffective in controlling avian predation, as well as some mammalian predation. The use of exclosures over nesting plovers has been effective in protecting eggs, but once the chicks leave the exclosure, they are once again vulnerable to predation. Although predation could be reduced to some extent through indirect control, the potential for loss, particularly from avian predators would remain high, therefore, this form of control alone is not considered adequate to achieve the goals and objectives of the Refuge for listed species.

Predator management that relies on the control of all predators using only non-lethal methods would not be adequate and could result in devastating impacts on the Refuge's snowy plover and streaked horned lark populations. This is particularly true in situations in which an avian predator learns to prey on the eggs or young of a listed species. Past experience elsewhere has demonstrated that once an individual predator successfully begins to forage within a nesting colony, significant losses to the colony can occur before the individual is successfully trapped or otherwise discouraged from returning to the colony. In the case of predation of breeding adults, the losses have an even greater effect on productivity because losses of breeding adults can have adverse effects on populations for several generations. Without the option to implement lethal control when deemed necessary to protect listed species, it may not be possible to support the recovery plan and achieve the Refuge goals and objectives for the protection of endangered and threatened species.

Lethal Control—Lethal control could include any or all of the following depending upon field circumstances: shooting; euthanasia in conjunction with cage traps; padded-jaw leg-hold traps;

nets; snares; gas cartridges; DRC-1339 (avicide); nest removal and egg destruction; snap traps; or zinc phosphide bait (rodenticide).

Service employees or their authorized agents could use mechanical/physical methods (including trapping) to control pests as a refuge management activity. Based on 50 C.F.R. 31.2, trapping can be used on a refuge to reduce surplus wildlife populations for a "balanced conservation program" in accordance with Federal or state laws and regulations. In some cases, non-lethally trapped animals would be relocated to off-refuge sites with prior approval from the state. A pest control proposal (see 7 RM 14.7A-D for required elements) is needed before initiation of trapping activities, except those operations identified in 7 RM 14.7E. In addition, a separate pest control proposal is not necessary if the required information can be incorporated into an EIS (or other appropriate NEPA document).

Targeted animals that are live trapped are euthanized by lethal injection (sodium phenobarbital), shot, or gassed using carbon monoxide or carbon dioxide gas. It is not likely that all methods will be used because site conditions would render some tools more appropriate than others. APHIS-WS and Refuge personnel can pre-determine for each unique situation what method or combination of methods is most practical and effective using the APHIS-WS Decision Model.

Monitoring—Since 2006, the Refuge and WDFW have completed intensive surveys for snowy plovers at nesting areas on the Long Beach Peninsula. The Refuge in coordination with the cooperating agencies will monitor any program that results from the CCP/EIS and report those results annually. Direct observation and still or video photography will be employed as methods to obtain information about the particular species of potential predators. Data on evidence or sign of potential predators adjacent to nesting areas will also be collected.

The impacts discussed in this plan will be monitored and used in two ways:

1) Determine if any additional information that arises subsequent to the NEPA decision would trigger the need for additional NEPA analysis compliance or possibly trigger other compliance requirements. The lead agency would review program results annually, or as needed, to ensure that the need for action, issues identified, alternatives, regulatory framework, and environmental consequences are consistent with the CCP/EIS.

2) If work plans need modification based on the findings of the program's effects on plover or other environmental issues, APHIS-WS, in coordination with the Refuge and WDFW, would monitor impacts on target predator populations through its Management Information System (MIS) database when APHIS-WS is involved in direct damage management. The MIS information would be used to assess the localized and cumulative impacts of the program on predator populations. Monitoring of the effectiveness of the actions would be done by the Refuge in coordination with WDFW and APHIS-WS to determine if the program is benefitting plovers or if changes are needed. The Refuge would use the results of monitoring to develop site specific work plans (annually or as needed) for the Leadbetter Point plover sites, in cooperation with WDFW and APHIS-WS.

L.2.2 Predator Damage Management Methods

A variety of methods are used by APHIS-WS personnel in predator damage management. APHIS-WS employs three general strategies to reduce wildlife damage: resource management, physical exclusion, and wildlife management. Each of these approaches is a general strategy or recommendation for addressing predator damage situations. Most predator damage management methods have recognized strengths and weaknesses relative to each damage situation. APHIS-WS personnel can determine for each unique situation what method or combination of methods is most appropriate and effective using the WS Decision Model (Slate et al. 1992).

All predator damage management methods have limitations which are defined by the circumstances associated with individual wildlife damage problems. APHIS-WS considers a wide range of limitations as they apply the decision-making process to determine what method(s) to use to resolve each damage problem (USDA 1997). Examples of limitations which must be considered and criteria to evaluate various methods are presented in USDA (1997) and in the following discussions.

Resource Management. Resource management includes a variety of practices that may be used by resource managers or owners to reduce the potential for predator damage. Implementation of these practices is appropriate when the potential for or actual damage can be reduced without significantly increasing a resource manager owner's costs or diminishing a person's ability to manage resources pursuant to their goals.

Habitat Management. Just as habitat management is an integral part of other wildlife management programs, it also plays an important role in predator damage management. The type, quality, and quantity of habitats are directly related to the animals attracted to an area and what the habitat can support. Therefore, habitat can be managed so that it does not produce or attract certain species or it repels them. Limitations of habitat management as a method of controlling wildlife damage are determined by the characteristics of the species involved, the nature of the damage, economic feasibility, and other factors.

Physical Exclusion. Physical exclusion methods restrict the access of wildlife to resources. Nest exclosures are used to protect nesting plovers from predation. The exclosures must encompass the sides and top of the structure, and be buried into the sand to help prevent burrowing, climbing and flying predators from entering the exclosures. These methods provide a means of appropriate and effective prevention of damage in some situations.

Wildlife Management. Reducing wildlife damage is achieved with many different techniques. The objective of this approach is to alter the behavior or population of the target animal, thereby eliminating or reducing the potential for loss or damage.

Frightening Devices. Frightening devices include distress calls, pyrotechnics, propane cannons, flags, and reflective tape. The success of frightening methods depends on the animal's fear of and subsequent a version to the stimuli. Once animals become habituated to a stimulus, they often resume their damaging activities. Persistent efforts are usually required to consistently apply frightening techniques and to vary them sufficiently to prolong their effectiveness. In many situations animals frightened from one location become a problem at another. Some frightening devices may have negative effects on non-target wildlife, including threatened and endangered species. Frightening devices will probably have severe limitations in protecting plovers since they may affect plovers as much as the target species. The use of some frightening devices and techniques in urban and suburban environments may be considered aesthetically displeasing such as netting over trees or a nuisance by some persons such as the noise from propane cannons. The continued success of these methods frequently requires reinforcement by limited shooting (see shooting).

Pyrotechnics. Pyrotechnics consist of a variety of noise making devices in the form of fireworks. Double shotgun shells, known as shell-crackers or scare cartridges, are 12-gauge shotgun shells containing a fire cracker that is projected up to 75 yards before exploding. Noise bombs, whistle bombs, racket bombs, and rocket bombs are fired from 15-millimeter flare pistols. They are used similarly to shell-crackers, but are projected for shorter distances. Noise bombs (also called bird bombs) are firecrackers that travel about 75 feet before exploding. Whistle bombs are similar to noise bombs, but whistle in flight and do not explode. They produce a noticeable response because of the trail of smoke and fire, as well as the whistling sound. Racket bombs make a screaming noise in flight and do not explode. Rocket bombs are similar to noise bombs but may travel up to 150 yards before exploding. These pyrotechnics are often used to frighten birds away from crops, roosting locations, or runways. The shells are fired so that they explode in front of, or underneath, flocks of birds attempting to enter crop fields, roosts, or the air operating area at an airport. The purpose is to produce an explosion between the birds and their objective. Birds already in a crop field or at an airport can be frightened away, but it is extremely difficult to disperse birds that have already settled in a roost.

A variety of other pyrotechnic devices, including firecrackers, rockets, and Roman candles, are used for dispersing animals. The discharge of pyrotechnics may be inappropriate and prohibited in some area such as urban and suburban communities. Pyrotechnic projectiles can start fires, ricochet off buildings, pose traffic hazards, cause some dogs to bark incessantly, and injure and annoy people. Pyrotechnics may cause fear or alarm in urban areas as the sound of discharge sometimes resembles gunfire.

Propane Exploders. Propane exploders operate on propane gas and are designed to produce loud explosions at controlled intervals. They are strategically located (elevated above the vegetation, if possible, and hidden) in areas of high wildlife use to frighten wildlife from the problem site. Because animals are known to habituate to sounds, exploders must be moved frequently and used in conjunction with other scare devices or reinforced with lethal methods. Exploders can be left in an area after dispersal is complete to discourage animals from returning. However, propane exploders are generally inappropriate for use in urban areas due to the repeated loud explosions which many people consider an unacceptable nuisance.

Scarecrows or Effigies. Since personnel are often limited, the use of scarecrows can be effective when people are not present at a field. The human effigy is still one of the best scarecrows available. These work best with eyes on both sides of the head and dressed in clothes similar to the clothes worn by people that are harassing the birds. Other scarecrows are available such as “scare-eye” balloons. As with other techniques, scarecrows work best when the number is varied, a variety of scarecrows are used, and they are moved often.

Flagging. Flags may have limited effectiveness in frightening birds. Anecdotal reports indicate black flagging may be effective at repelling some birds.

Bioacoustics. Distress and alarm calls of various animals have been used singly and in conjunction with other scarring devices to successfully scare or harass animals. Many of these sounds are available on records and tapes. Calls should be played back to the animals from either fixed or mobile equipment in the immediate or surrounding area of the problem. Animals react differently to distress calls; their use depends on the species and the problem. Calls may be played for short (few second) bursts, for longer periods, or even continually, depending on the severity of damage and relative effectiveness of different treatment or “playing” times.

Chemical Repellents. Chemical repellents are compounds that prevent the consumption of food items or use of an area. They operate by producing an undesirable taste, odor, feel, or behavior pattern. Effective and practical chemical repellents should be nonhazardous to wildlife; nontoxic to plants, seeds, and humans; resistant to weathering; easily applied; reasonably priced; and capable of providing good repellent qualities. The reaction of different animals to a single chemical formulation varies, and for any species there may be variations in repellency between different habitat types. Development of chemical repellents is expensive and cost prohibitive in many situations. Chemical repellents are strictly regulated, and suitable repellents are not available for many wildlife species or wildlife damage situations. Naphthalene (moth balls) has proven to be ineffective as a bird repellent (Dolbeer et al. 1988).

Aversive Agents. Methiocarb, active ingredient in Mesurol, can be useful as an aversive conditioning agent, used in eggs, in reducing raven predation of colonial waterbirds (Avery et al. 1995). Mesurol is an aversive conditioning egg treatment registered with the EPA to reduce predation on the eggs of protected, threatened or endangered species. Mesurol is only available for use under APHIS-WS program supervision. After pre-baiting, a limited number of treated eggs would be distributed within the nesting colony. To reduce risk to humans, non-target animals and pets, a blind would be established during treated egg baiting periods so treated egg sites can be observed. In addition, eggs would be wired to the ground so they cannot be removed from the site, and thus would be consumed on site. Treated eggs would be removed from bait sites when the observer is not present. When used according to label directions, methiocarb will not pose unreasonable risks or adverse effects to humans or the environment (USEPA 1994, see product label).

Relocation. Most damaging species are common and numerous throughout Washington, so they are rarely, if ever, relocated because habitats in other areas are generally already occupied. Relocation of damaging species to other areas following live capture generally would not be biologically sound, effective, or cost-effective. Relocation of wildlife often involves stress to the relocated animal, poor survival rates, and difficulties in adapting to new locations or habitats. Relocation of target predator animals of breeding western snowy plovers and streaked horned larks is usually not recommended according to state wildlife policy

Lethal Control Methods

Chemical Immobilizing and Euthanizing Agents. Most APHIS-WS Specialists in Washington are trained and certified to use drugs for capturing or euthanizing wildlife. Drugs such as sodium phenobarbital derivatives are used for euthanasia. Most drugs, an exception is alpha-chloralose, fall under restricted-use categories and must be used under the appropriate license from the U.S. Department of Justice, Drug Enforcement Agency. The drugs used by APHIS-WS are approved by a Drug Committee panel.

Euthanasia. Captured animals may be euthanized. The euthanasia method used is dependent on whether the animal is going to be processed for human consumption. Animals that are not going to be consumed can be euthanized with a sodium phenobarbital solution such as Beuthanasia-D® or other appropriate method such as cervical dislocation, decapitation, a shot to the brain, or asphyxiation. Carbon dioxide (CO_2) is sometimes used to euthanize animals which are captured in live traps and when relocation is not a feasible option.

Leg-hold Traps are used to capture animals such as coyotes, bobcats, fox, mink, raccoon and skunk. These traps are the most effective, versatile and widely used tool available to APHIS-WS for capturing many species. Traps placed in the travel lanes of the target animal, using location rather than attractants, are known as “blind sets.” More frequently, traps are placed as “baited” or “scented” sets. These trap sets use an attractant consisting of the animal’s preferred food or some other lure such as fetid meat, urine, or musk to attract the animal into the trap.

In some situations, a carcass or large piece of meat (i.e., a draw station) may be used to attract target animals to an area where traps are set. In this approach, single or multiple trap sets are placed at least 30 feet from the draw station. APHIS-WS program policy prohibits placement of traps or snares within 30 feet of a draw station to prevent the capture of non-target scavenging birds. There are only two exceptions to this policy. One is when setting leg-hold traps to capture cougars returning to a kill. In these cases the weight of the target animal allows pan-tension adjustments which preclude the taking of small non-target animals. The second exception is when leg-hold traps are set next to carcasses used to capture raptors under permit with the USFWS.

Two primary advantages of the leg-hold trap are that they can be set under a wide variety of conditions, and that pan-tension devices can be used to prevent smaller animals from springing the trap, thus allowing a degree of selectivity not available with many other methods. Effective trap placement by trained personnel greatly contributes to the leg-hold trap’s selectivity. Another advantage of leg-hold traps is that the live-capture of animals permits release if warranted.

Disadvantages of using leg-hold traps include the difficulty of keeping them in operation during rain, snow, or freezing weather. In addition, they lack selectivity where non-target species are of similar size to target species and are abundant. The selectivity of leg-hold traps is an important issue and has been shown to be a function of how they are used. The type of set and attractant used significantly influences both capture efficiency and the risk of catching non-target animals. The use of leg-hold traps in the APHIS-WS program is costly due to the amount of manpower and time involved; however, the technique is indispensable in selectively resolving many animal damage situations. APHIS-WS program guidelines require warning signs to be posted in the vicinity of control operations. Placement is generally confined to areas not visible to or frequently visited by the public. APHIS-WS personnel are the most vulnerable to hazard exposures (USDA 1997).

Snares. Snares, made of cable, are among the oldest existing wildlife damage management tools. Snares can be used to catch most species. They are used wherever a target animal moves through a restricted lane of travel (i.e., "crawls" under fences, trails through vegetation, den entrances, etc.) When an animal moves forward into the snare loop, the noose tightens and the animal is held. Snares offer the advantage of being much lighter than leg-hold traps and are not as affected by inclement weather.

Snares can be set as either lethal or live-capture devices. Snares set to capture an animal around the neck can be a lethal use of the device, whereas snares positioned to capture the animal around the body or leg can be a live-capture method. Careful attention to details in placement of snares and the use of slide stops can also allow for the live-capture of neck-snared animals.

The catch pole snare is used to capture or handle problem animals. Catch poles are primarily used to remove live animals from traps without injury to the animal or danger to the APHIS-WS Specialist. Human safety hazards associated with snares are similar to leg-hold traps. Risks are minimized by limiting or avoiding use where the public may be exposed, and by program guidelines that require warning signs to be posted in the vicinity of control operations (USDA 1997).

Cage Traps. Cage traps are frequently used to capture skunks, raccoons, cougars, and black bears. Cage traps can also be used to capture coyote pups, fox, and dogs. Cage traps capture the animal by mechanical closure of the entry way via the animal's actuation of a triggering device. Cage traps commonly used or recommended by APHIS-WS to capture skunks and raccoons are drop-door wire box traps. Live traps are generally baited with food items as attractants.

The use of cage traps allows the release of captured non-target animals or target animals that are to be relocated. Cage traps are frequently recommended to private individuals for capturing skunks and raccoons or used operationally by APHIS-WS personnel in situations where other methods may not be as safe. These devices pose minimal risk to the humans, pets, or non-target animals, and are easily monitored and maintained. However, some animals fight to escape from cage traps and become injured. However, live traps, as applied and used by APHIS-WS pose no danger to pets or the public and if a pet is accidentally captured in such traps, it can be released unharmed.

Shooting Birds. Shooting is more effective as a dispersal technique than as a way to reduce bird densities when large numbers of birds are present. Shooting is a very individual specific method and is normally used to remove a single off ending bird. Shooting to supplement harassment typically enhances the effectiveness of harassment techniques and can help prevent bird habituation to hazing methods (Kadlec 1968). In situations where the feeding instinct is strong, most birds quickly adapt to scaring and harassment efforts unless the control program is periodically supplemented by shooting.

Shooting can be relatively expensive because of the staff hours sometimes required (USDA 1997). It is selective for target species and may be used in conjunction with decoys and calling. Shooting with shotguns, air rifles, or rim and center fire rifles is sometimes used to manage bird damage when lethal methods are determined to be appropriate. The birds are killed as quickly and humanely as possible. APHIS-WS personnel follow all firearm safety precautions when conducting bird damage management and comply with all laws and regulations governing firearms use. Also see “Shooting Mammals” for human safety consideration.

Firearm use is very sensitive and a public concern from general safety issues relating to the public to misuse. To ensure safe use and awareness, APHIS-WS employees who use firearms to conduct official duties are required to attend an approved firearms safety and use training program within three months of their appointment and a refresher course every three years afterwards (WS Directive 2.615). WS employees who carry firearms as a condition of employment, are required to sign a form certifying that they meet the criteria as stated in the *Lautenberg Amendment* which prohibits firearm possession by anyone who has been convicted of a misdemeanor crime of domestic violence.

Shooting mammals. Shooting is selective for the target species but is relatively expensive due to the staff hours required. Shooting is, nevertheless, an essential wildlife damage management method. Removal of one or two problem animals can quickly stop extensive damage. Predator calling is an integral part of ground hunting. Even difficult-to-catch, trap-wise predators are vulnerable to calling. Shooting can be selective for offending individuals and has the advantage that it can be applied in specific damage situations.

The primary human health and safety hazard associated with shooting is related to firearms handling by the user, making APHIS-WS personnel the most vulnerable. Human health and safety risks are minimized by program safety practices which include extensive training and experience in safe and effective firearms use; frequent employee evaluations; and use of firearms only at safe distances from human habitations or other activities, and in safe directions only (USDA 1997).

Egg, Nest, and Hatchling Removal and Destruction. Egg and nest destruction is used mainly to reduce or limit the growth of a nesting population in a specific area through limiting reproduction of offspring or removal of nest to other locations. Egg and nest destruction is practiced by manual removal of the eggs or nest. This method is practical only during a relatively short time interval and requires skill to properly identify the eggs and hatchlings of target species.

Chemical Toxicants. All chemicals used by APHIS-WS are registered under FIFRA (administered by EPA and WSDA) or by the Food and Drug Administration. APHIS-WS personnel that use chemical methods are certified as pesticide applicators by WSDA and are required to adhere to all certification requirements set forth in FIFRA and Washington pesticide regulations. Chemicals are only used on private, public, or Tribal property sites with authorization from the property owner or manager.

Denning. Denning is the practice of seeking out the dens of depredating coyotes or red fox and eliminating the young, adults, or both to stop ongoing predation or prevent further depredations. The usefulness of denning as a damage management method is proven; however, since locating dens is difficult and time consuming, and den usage is restricted to about two to three months of the year, its use is limited to specific, appropriate situations that must be determined by a specialist.

Coyote and red fox depredations often increase in the spring and early summer due to the increased food requirements of rearing and feeding young. Removal of pups will often stop depredations even when the adults are not removed. When the adults are removed and the den site is known, the pups are killed to prevent their starvation. The pups are euthanized in the den with a registered fumigant. Denning is highly selective for the target species responsible for damage. Den hunting for adult coyotes and fox is often combined with other activities (calling and shooting, etc.)

Den fumigants, also called gas cartridges, are fumigants, or gases, used to manage wildlife. They are highly effective but are expensive and labor intensive to use. In the APHIS-WS program, fumigants are only used in predator dens. The APHIS-WS program manufactures and uses den cartridges specifically formulated for this purpose. These cartridges are hand placed in the active den, and the entrance is tightly sealed with soil. The burning cartridge causes death from a combination of oxygen depletion and carbon monoxide poisoning.

DRC-1339. DRC-1339 is a slow acting avicide that is registered with the EPA for use on a number of species (e.g., ravens, crows, pigeons, gulls, blackbirds, and starlings), on various bait carriers, such as grain, meat baits, sandwich bread, and cull French fries. DRC-1339 is only available for use under APHIS-WS program supervision. Under project conditions, DRC-1339 is available for authorized for use on corvids and gulls (see product label). DRC-1339 was marketed as an avicide because of its differential toxicity to mammals. DRC-1339 is highly toxic to sensitive species but only slightly toxic to non-sensitive birds, predatory birds, and mammals. Most bird species that are responsible for damage, including starlings, blackbirds, pigeons, crows, magpies, and ravens are highly sensitive to DRC-1339. Many other bird species such as raptors, sparrows, and eagles are classified as non-sensitive. Numerous studies show that DRC-1339 poses minimal risk of primary poisoning to non-target and threatened and endangered species (USDA 1997). Secondary poisoning has not been observed with DRC-1339 treated baits. This can be attributed to relatively low toxicity to species that might scavenge on birds killed by DRC-1339 and its tendency to be almost completely metabolized in the target birds which leaves little residue to be ingested by scavengers.

Secondary hazards of DRC-1339 are almost non-existent. DRC-1339 acts in a humane manner, producing a quiet and apparently painless death.

DRC-1339 is unstable in the environment and degrades rapidly when exposed to sunlight, heat, or ultraviolet radiation. DRC-1339 is highly soluble in water but does not hydrolyze, and degradation occurs rapidly in water. DRC-1339 tightly binds to soil and has low mobility. The half-life is about 25 hours, which means it is nearly 100% broken down within a week, and identified metabolites (i.e., degradation chemicals) have low toxicity. Aquatic and invertebrate toxicity is low (USDA 1997). USDA (1997) contains a thorough discussion and risk assessment of DRC-1339. That assessment concluded that no adverse effects are expected from use of DRC-1339.

Zinc Phosphide. Zinc phosphide pellets (2%) may be used only by certified applicators, or persons under their direct supervision, for Norway rats, roof rats, and house mice (see product label). In the project area, the bait must be placed in tamper-resistant bait stations or in burrows because non-target hazards exist to any granivorous birds or mammals that occur in areas where zinc phosphide grain bait is applied (USDA 1997). The Aleutian Canada goose would potentially be affected by zinc phosphide if allowed to consume treated grains. Zinc phosphide poses little secondary risk to non-target wildlife since it breaks down rapidly in the digestive tract of affected animals. Domestic dogs and cats are more susceptible than other animals (USDA 1997).

L.2.3 Direct Control of Predators—Species Specific Protocols

The direct control of predators has historically been implemented by APHIS-WS through an interagency agreement with the Service. It is likely that this arrangement would continue in the future, provided funds are available. Contracts would be issued annually and would include detailed descriptions of approved control methods, disposition procedures for captured predators, and species-specific protocols. Predator management would be implemented year-round, although the majority of the contracted activities would occur during the snowy plover breeding season. During the non-breeding season for endangered species, APHIS-WS may be contracted to control feral dogs and cats and mammalian predators such as skunks and opossums.

Corvids. The *Corvidae* family is composed of over 100 species of birds including crows and ravens. Corvids are widespread across North America and are found on all continents, except Antarctica. Prior to European colonization of North America, corvids likely occurred at lower densities than found in many areas today. The ability of crows and ravens to adapt and thrive in human-altered landscapes, both rural and urban/suburban, has led to dramatic increases in range and population sizes in western North America, including California (Johnston 2001; Liebezeit and George 2002; Marzluff et al. 2001; USFWS 2007). Because they are effective predators on the nests and young of some threatened and endangered species, including snowy plovers, there is concern among management agencies that increases in corvid populations are having negative impacts on populations of some listed species (Liebezeit and George 2002). Liebezeit and George (2002) provide detailed review of corvid life history, ecology, and importance as predators.

The American crow (*Corvus brachyrhynchos*), northwestern crow (*Corvus caurinus*), and common raven (*Corvus corax*) are land birds recognized as potential predators of eggs and juvenile plovers and larks (Liebezeit and George 2002; Powell et al. 2002; USFWS 2002; Wilson-Jacobs and Dorsey 1985). All three species are currently suspected to be potential predation risks at Leadbetter Point. Some corvids use the lodgepole pine (*Pinus contorta*) forests at Leadbetter Point for resting, foraging, and nesting.

Specific local population data for corvids are currently unavailable. An initial step in the predator management plan will be implementation of a monitoring program to ensure that any impacts to corvid populations and their behaviors and use patterns can be assessed more precisely. The Refuge monitoring program would also reveal more information on the extent of threats that corvids pose to plovers and larks at Leadbetter Point. Under the proposed predator management strategy, any individual corvid could be controlled when they pose a threat to endangered species, as determined by the Refuge Manager, Refuge Biologist, or a qualified predator control contractor (e.g., APHIS Wildlife Services) as needed to protect the breeding population and production (see section L.1.2) . Any actions affecting corvids would only occur after consulting with the Refuge Manager and the Refuge Biologist. Individuals of those species requiring management because of conflicts with endangered species could be lethally removal. The overall adverse effects of control actions on corvid species would be temporary and localized in nature. Specifically, the small number of individual problem corvids that would potentially be removed by this project each year would not significantly impact their local or range-wide populations. Other species such as the savanna sparrow (*Passerculus sandwichensis*) and several shorebird species such as the killdeer (*Charadrius vociferous*) would also benefit from reduce predation pressure.

Control of a problem raven or crow exhibiting hunting behavior in and around snowy plover or streaked horned lark nesting areas on the Refuge would be authorized. The most effective, selective, and humane tools available to deter, relocate, or in very limited circumstances if necessary, lethally remove that individual would be implemented. As plover and lark numbers increase and meet breeding population and recruitment criteria, resident corvids would be allowed a more natural interaction with the local species of concern and active predator management would be de-emphasized. Translocation of corvids to other areas may negatively impact wildlife or agriculture in those areas, and thus would not be considered as a management option for corvids. Additionally, territorial vacancies created by translocation would likely be of short duration, because some translocated birds and/or birds from surrounding areas would quickly move into the vacated territory.

Lethal removal of avian predators is most often employed when an individual problem predator has focused its foraging activities on a specific nesting area. In this case, an entire colony's or community's productivity or even survival can be jeopardized in a short time frame. One such example occurred in 1997. A pair of burrowing owls was observed preying on adult and chick California least terns at the Tijuana Estuary. Refuge staff determined that live trapping was the preferred method of control because of a concern for the sensitivity of the local burrowing owl population. Over about a 12-day period (the time it took to locate and live-capture the owls), this pair of owls had taken between 70 and 80 breeding adult least terns and an unknown number of chicks. This one event resulted in the loss of approximately 18% of all breeding individuals in the colony during that nesting season (Patton 1998). Under this plan, selective removal of individual problem predators would be permitted for all avian predators.

Gulls. Several gull species are recognized as potential predators of snowy plover eggs (Liebezeit and George 2002; Powell et al. 2002; USFWS 2002, 2007). All occur on the Refuge; however, none are currently suspected as posing a predation risk at Leadbetter Point. Specific local population data for gulls are currently unavailable but any adverse effects of predator management on the local and range-wide population of the affected gull species would be insignificant.

An initial step in the predator management plan could include a monitoring program to ensure that any impacts on gull populations can be assessed more precisely. The refuge monitoring program could also reveal more information on the magnitude and extent of threats that gulls pose to plovers and larks at Leadbetter Point. Under the proposed predator management plan, any individual gull could be controlled when it poses a threat to endangered species, as determined by the Refuge Manager, Refuge Biologist, or a qualified predator control contractor (e.g., USDA APHIS Wildlife Services). Actions affecting any gulls would only be taken after consulting with the Refuge Manager and the Refuge Biologist as needed to protect the breeding population and production (see section L.1.2)

Control of any wildlife, including gull species, that are known to prey on western snowy plovers or streaked horned larks and that exhibit hunting behavior in nesting areas could be authorized. The most effective, selective, and humane tools available to deter, relocate, or in very limited circumstances if necessary, lethally remove that individual would be implemented. As plover and lark numbers increase and their populations stabilize, resident gulls would be allowed a more natural interaction with the local species of concern and active predator management would be de-emphasized.

Coyote. The coyote is one of the most widely distributed carnivores in North America. Despite more than 100 years of intensive efforts to control coyotes and reduce coyote depredation on livestock, coyotes are abundant and have expanded their range (Litvaitis and Mautz 1980). Human activities have often unintentionally benefited coyotes. For example, coyotes thrived in the Cascades, but only after their habitat was altered by clear cutting, and wolves, which were their primary competitors, were extirpated (Toweill and Anthony 1988).

The coyote's social organization revolves around the mated pair. Each pair occupies a home range that it defends against other coyotes. However, pairs often accept the presence of one or more "associates." These are nonbreeding adults that share the home range and assist in pup rearing duties (Andelt 1985; Ryden 1989). Home range size and coyote density varies according to prey abundance, topography, and vegetative characteristics (Gese et al. 1988). Home ranges often occupy 10 to more than 40 square miles or more (Andelt and Gipson 1979; Gese et al. 1988; Litvaitis and Shaw 1980; Springer 1982), but home ranges may be considerably smaller when conditions are favorable. Gese et al. (1988) and Windberg and Knowlton (1988) reported home ranges as small as 2.59 square kilometers (1.0 mi^2). Densities may be higher than home range size would indicate (Hein and Andelt 1995). Ranges of adjacent pairs may overlap, at least at the peripheries (Litvaitis and Shaw 1980), and transient (unmated) individuals whose home ranges overlap those of mated pairs are usually present (Andelt 1985; Gese et al. 1989).

Densities and home ranges on the refuge are unknown, but coyotes are common throughout the year. Small mammals provide an abundant, year-round, prey base. The frequency with which coyotes are observed and heard by refuge staff suggests that two or three mated pairs may be occupying the area. Coyote mating on the Willapa NWR typically occurs during January or February, and five to 10 pups for each breeding pair typically are born during April or May (Burt and Grossenheider 1964). Pups are fed by the adults for several months, and then disperse from their parents' home range before reaching 1 year of age, but they may remain longer (Andelt 1985; Bowen 1982; Nellis and Keith 1976). Mortality of pups often exceeds 50% during their first year (Andelt 1985; Nellis and Keith 1976).

The typical adult coyote weighs 25 to 30 pounds, although there is some geographic variation and occasionally individuals may be larger (Berg and Chesness 1978). Coyotes are opportunistic, omnivorous foragers, where the diet is flexible based upon prey that is available. Diets can include large and small mammals such as mice, rats, rabbits, and hares; deer and other wild ungulates; livestock and domestic pets; and carrion, as well as reptiles, amphibians, fish, insects, fruits, and even farm crops such as corn (Bailey 1936; Gier 1957). Deer, especially fawns, are often a major food item for coyotes (Andelt 1985; MacCracken 1984; Toweill and Anthony 1988). During the breeding season, coyotes seek larger prey (e.g., deer fawns) to feed their young (Till and Knowlton 1983). Harrison and Harrison (1984) found that pups at a site in Maine were fed deer fawns almost exclusively during June and July. A medium-sized coyote requires about 4,800 mice or eight adult deer per year to meet its basic resting energy needs (Litvaitis and Mautz 1980).

Coyotes would only be targeted if field investigations indicate they pose a direct and immediate threat to specific plovers, streaked horned larks and their chicks (see section L.1.2). Under the proposed action, about 15 to 70 coyotes could be removed, if they are found to be a threat to plovers. APHIS-WS estimated that total take of coyotes in 1998, which included fur harvest from hunting and trapping and depredation take, amounted to 3% of the population in northwest Oregon and 9% in southwest Oregon (unpublished monitoring reports of environmental assessments on predator damage management, APHIS-WS).

It is not expected that taking coyotes to protect plovers would add notably to the cumulative take of coyotes. Take is expected to remain well below the established USDA (1995) 70% allowable harvest for coyote. Cumulative mortality of coyotes from coastal counties included 775 coyotes taken from hunting, trapping, and depredation (ODFW 1999-2000 hunting and trapping and USDA MIS for FY 1999). Negligible impacts on the coyote population are expected as a result of plover protection.

Live trapping may include the use of box type mammal traps, bal-chatri traps (a type of baited monofilament line leg-hold/cage trap), scent baited padded leg-hold traps and perch pole traps, or cage traps. Manual capture methods may also be employed using hand held capture poles or other manual techniques. Traps are inspected in accordance with State Fish and Wildlife Code and Service policy. Specifically, traps set out overnight for mammalian predators are checked within two hours of sunrise and traps left out during daylight hours are monitored regularly and checked a minimum of four times per day. The use and monitoring of pole traps will be conducted in accordance with Service policy.

Targeted animals that are live trapped are euthanized by lethal injection (sodium phenobarbital), shot, or gassed using carbon monoxide or carbon dioxide gas. Lethal methods will be implemented as humanely and selectively as possible. It is not likely that all methods will be used because site conditions would render some tools more appropriate than others. APHIS-WS and refuge personnel can determine for each unique situation what method or combination of methods is most appropriate and effective using the APHIS-WS Decision Model. Shooting will be conducted only by government personnel trained and certified in firearm safety. In order to avoid human safety hazards, shooting will take place only when members of the public are not in the area.

Small Mammals. Small mammals such as raccoons, opossums, weasels, skunks, mice, and rats may pose a low level of nest predation risk to plovers and larks, although the likelihood of actual predation at Leadbetter Point is thought to be rare. In California, red fox predation on snowy plovers was a major reason for the plovers decline on the central coast (USFWS 1993) and is one of the major threats to the survival of the California least tern and light-footed clapper rail (USFWS and U.S. Navy 1990). The USFWS concluded that red fox are a major factor in snowy plover chick losses in California, based on numerous studies and on comparisons between areas with and without red fox. By reducing the number of red fox in the vicinity of plover breeding areas, the reproductive success of plovers may be dramatically improved (USFWS 1993). Red fox are not currently known to occur at Willapa NWR.

Selective control of problem mammalian predators will involve trapping and euthanizing by approved humane methods as described for coyote. Target and non-target predators that are injured during trapping will be treated on a case-by-case basis. These animals may be euthanized or taken to an approved rehabilitation or veterinary care facility depending on species and extent of injuries. Any non-target wildlife (an animal determined not to be a threat to listed species) that is captured unharmed would be immediately released near the capture site or at a suitable location.

All free-roaming domestic dogs and cats, when feasible, would be taken to an approved shelter facility operated by a cooperating local unit of government, humane society, or a veterinary care facility.

Raptors. Birds of prey, or raptors, are meat eaters that use their feet, instead of their beak, to capture prey. They have exceptionally good vision, a sharp, hooked beak, and powerful feet with curved, sharp talons. Raptor feeding strategies vary, but most are somewhat opportunistic, taking advantage of easily captured prey by using whatever means possible (Sibley 2000). Raptors primarily pursue small to medium sized birds and small mammals, or feed on carrion.

The northern harrier (*Circus cyaneus*), merlin (*Falco columbarius*), peregrine falcon (*Falco peregrinus*), and American kestrel (*Falco sparverius*) are recognized potential predators of both juvenile and adult plovers and larks (Liebezeit and George 2002; Powell et al. 2002; USFWS 2002). All occur at the Leadbetter Point Unit of Willapa NWR, but only the northern harrier and merlin are currently suspected to be potential predation risks at Leadbetter Point. Although not known to be predators at Leadbetter Point, snowy owls (*Nyctea scandiaca*) and short-eared owls (*Asio flammeus*) may opportunistically feed on shorebirds or land birds on an infrequent basis.

Specific local population data for raptors are currently unavailable. An initial step in the predator management plan will be implementation of a monitoring program to ensure that any impacts on raptor populations can be assessed more precisely. The refuge monitoring program would also reveal more information on the magnitude and extent of threats that raptors pose to plovers and larks at Leadbetter Point.

Under the proposed predator management plan, any individual problem raptor that poses a threat to endangered species, as determined by the Refuge Biologist or a qualified predator control agent for the Service (e.g., USDA APHIS Wildlife Services), could be considered for control actions. Actions affecting raptors would only be taken after consulting with the Refuge Manager and the Refuge Biologist as needed to protect the breeding population and production (see section L.1.2). If direct avian predator management is determined to be necessary, it could occur year-round but would be concentrated immediately prior to and during the snowy plover and streaked horned lark breeding season (March to September). If an individual non-corvid predator is evaluated as posing a threat to snowy plovers at the Refuge, it may be trapped and/or relocated as needed to protect the breeding population and production (see section L.1.2). The determination that relocation is necessary will be made by refuge staff in consultation with WDFW biologists. The Refuge Biological Resources Program staff will be responsible for monitoring and managing avian predators in cooperation with WDFW, APHIS-WS, and WSPRC.

Direct control of any raptor species would only focus on problem predators, which are defined in this context as individuals that belong to species that are known to prey on western snowy plovers or streaked horned larks and that exhibit hunting behavior in nesting areas. For most predatory species, direct management will be accomplished primarily by intentional hazing (scaring off) or live-capture, holding and/or translocation of individual predators from nesting areas. Hazing or trapping will be used only on extremely rare occasions when it is demonstrably necessary, for example, when there is an immediate threat to snowy plover chicks. The decision to haze an avian predator will be determined on a case-by-case basis, and will be based on the degree of threat, the breeding phase of snowy plovers and streaked horned larks, professional judgment of the situation, and as needed to protect the breeding population and production (see section L.1.2). Any traps set for avian predators would be regularly monitored.

Only licensed and authorized agencies or individuals will implement predator management actions. Management actions will be carried out by APHIS-WS, or other such qualified agencies or individuals. Refuge personnel and their cooperators may assist with capture efforts. All activities will be conducted using the most humane methods available, under the direction of the Refuge Biologist. Only non-lethal techniques will be used for problem raptors. A combination of live-trapping techniques will be used, including bal-chatri traps, dho gaza nets, bow nets, noose mats, net launchers with bait, and lures. Knowledge of the avian predator’s habits will determine which trapping technique to employ. Efforts will be made to avoid and minimize losses of non-target native wildlife and all uninjured non-target species inadvertently captured will be immediately released near the site of capture or at a suitable location at the discretion of the Refuge Manager in consultation with the Refuge Biologist.

Live captured raptors would be removed from the site and held in a licensed and permitted rehabilitation or holding center until they can be released back into the wild. Release would occur after the endangered species nesting season is completed and an appropriate release site has been approved by the Refuge Biologist. All translocated birds will be released in an area with suitable habitat. Raptors would be banded prior to release. As plover and lark numbers increase and their populations stabilize, raptors would be allowed a more natural interaction with the local species of concern and active predator management would be de-emphasized.

The Refuge and its cooperators will continue to research avian predator management alternatives that will protect the snowy plover while minimizing disturbance to avian predators. There is particular interest in developing management techniques that would permit problem predators to remain on the Refuge but would prevent them from hunting in snowy plover nesting areas.

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Appendix M. Hunting Plan

Table of Contents

M.1 Introduction

The Willapa National Wildlife Refuge (Refuge) is located on Willapa Bay in southwest Washington. The Refuge was established in early 1937 by President Franklin Roosevelt in order to preserve and manage the important habitats and wildlife of Willapa Bay. The Refuge currently manages approximately 16,000 acres including sand dunes, sand beaches, intertidal mudflats, saltwater and freshwater marshes, grassland, open water, and forested lands.

The Refuge's wetland habitats support wintering populations of waterfowl such as black brant, trumpeter swans, Canada geese, scaup, canvasback, bufflehead, scoters, and American wigeon. The Refuge also hosts some of the largest concentrations of shorebirds on the Pacific Coast during their spring and fall migrations. These large concentrations of migrating shorebirds and the habitats that support them are now recognized as globally significant. The western snowy plover, listed as threatened under the Endangered Species Act, nests along the Refuge beaches. Marbled murrelet, black bear, black-tailed deer, Roosevelt elk, bats, bobcats, and grouse can be found in the forests and upland habitats. The cool, wet climate of the Willapa hills makes the area a "hotspot" of amphibian diversity in Washington. Habitats on the Refuge support up to 13 of the 24 native amphibians that occur in the state. Coastal rivers and streams on the Refuge provide habitat for western brook lamprey; western pearlshell mussels; Chinook, coho, and chum salmon; steelhead; and sea-run cutthroat trout.

The purpose of the Hunt Plan is to outline how the hunting program will be managed on the Willapa Refuge. The Hunt Plan documents how the Refuge will provide safe, quality hunting opportunities, while minimizing conflicts with other priority wildlife-dependent recreational uses (Service Manual 605 FW 2). The Hunt Plan will discuss the following topics: compatibility, the effect of hunting on Refuge objectives, assessment of target species, description of the hunting areas, avoiding biological and public conflicts, and the procedures to conduct the daily hunt.

The Refuge would maintain current hunting opportunities and expand the wildlife-dependent recreational hunting opportunities as identified in this plan and the draft comprehensive conservation plan and environmental impact statement (CCP/EIS).

The goals of Willapa Refuge as developed for the long term management of the Refuge in the draft CCP/EIS are:

- Goal 1. Protect, maintain and restore ecologically functional late-successional forest habitats (mature and old-growth forest) characteristic of the low-elevation temperate forests in the southwest Washington coastal region for the benefit of endangered and threatened species, migratory and resident birds, and a diverse assemblage of other native species.
- Goal 2. Protect, maintain, and restore estuarine habitats historically characteristic of the southwest Washington coastal region for the benefit of salmonids, Pacific brant, other waterfowl, shorebirds, seabirds, and a diverse assemblage of other native species.
- Goal 3. Protect, maintain, and restore freshwater habitats historically characteristic of the southwest Washington coastal region for the benefit of migratory birds, salmonids, amphibians, mussels, lamprey, and a diverse assemblage of other native species.

- Goal 4. Protect, maintain and restore coastal beach and dune habitats historically characteristic of the southwest Washington coastal region for the benefit of the western snowy plover, streaked horned lark, pink sandverbena, Oregon silverspot butterfly, and a diverse assemblage of other native species.
- Goal 5. Provide short-grass fields (improved pastures) and grasslands for the benefit of Canada geese, pacific jumping mouse and other grassland-dependent species and restore grasslands for the Oregon silverspot butterfly.
- Goal 6. Promote the recovery of federally threatened and endangered as well as Federal candidate and state-listed species.
- Goal 7. Gather scientific information (inventories, monitoring, research, studies) in support of adaptive management decisions on the Refuge under Goals 1-6.
- Goal 8. Foster a connection between refuge visitors and nature. Visitors will have the opportunity to participate in safe quality wildlife-dependent recreation activities located throughout Willapa NWR. These activities and programs include wildlife observation, hunting, fishing, interpretation/education, and photography.
- Goal 9. Protect and preserve the cultural resources of the Refuge for the benefit of present and future generations.
- Goal 10. Contribute to the protection of the long-term environmental health of the Willapa Bay ecosystem.
- Goal 11. Provide support for off-refuge conservation efforts in southwest Washington in partnership with private landowners, agencies, and nongovernmental organizations.

M.2 Conformance with Statutory Authorities

National wildlife refuges are guided by the mission and goals of the National Wildlife Refuge System (Refuge System) and the purposes for which individual refuges were established, as well as other policies, laws, and international treaties. Relevant guidance includes the National Wildlife Refuge System Administration Act of 1966 (Administration Act), as amended by the National Wildlife Refuge System Improvement Act of 1997 (Improvement Act), the Refuge Recreation Act of 1962, and selected portions of the Code of Federal Regulations (C.F.R.) and Service Manual.

Refuge Recreation Act of 1962 (16 U.S.C. 460K) authorizes the Secretary of the Interior to administer refuges, hatcheries, and other conservation areas for recreational use. The Refuge Recreation Act requires that 1) any recreational use permitted will not interfere with the primary purpose for which the area was established; and 2) funds are available for the development, operation, and maintenance of the permitted forms of recreation.

Fundamental to the management of lands within the Refuge System is the Improvement Act, an amendment to the Refuge Administration Act of 1966. The Act provided a mission for the Refuge System, and clear standards for its management, use, planning, and growth. Its passage followed the promulgation of Executive Order 12996 (April 1996), Management of Public Uses on National Wildlife Refuges, reflecting the importance of conserving natural resources for the benefit of present and future generations of people.

The Improvement Act recognized that wildlife-dependent recreational uses involving hunting, fishing, wildlife observation and photography, and environmental education and interpretation, when determined to be compatible with the mission of the Refuge System and purposes of a refuge, are legitimate and appropriate public uses of the Refuge System. Compatible wildlife-dependent recreational uses are the priority general public uses of the Refuge System and shall receive priority consideration in planning and management.

The U.S. Fish and Wildlife Service (Service) has determined hunting of waterfowl, coot, snipe, elk, deer, bear, and grouse (ruffed and blue) to be a compatible wildlife-dependent recreational use on the Refuge (Waterfowl Hunting and Big Game and Upland Game Bird Compatibility Determinations, Appendix C of the draft CCP/EIS). Based upon biological impacts described in the Hunting Compatibility Determination (Appendix C, draft CCP/EIS), which are incorporated by reference, hunting on the Refuge is a compatible use and will not materially interfere with or detract from the purposes for which the Willapa Refuge was established. Stipulations within the Hunting CD to ensure compatibility include Refuge-specific regulations; monitoring of hunting activities, habitat conditions, public use activities, and wildlife population levels; and routine law enforcement patrols.

M.3 Statement of Objectives

In the draft CCP/EIS, the Service proposes maintaining existing waterfowl, upland game bird, and big game hunting and opening areas of the Refuge to elk and deer hunting. The objectives of the Hunt Plan directly support several of the Refuge's long-term management goals and Service mandates:

- National Wildlife Refuge System Improvement Act of 1997 states that refuges shall provide quality hunting opportunities wherever compatible.
- Foster a connection between Refuge visitors and nature. Visitors will have the opportunity to participate in safe quality wildlife-dependent recreation activities located throughout Willapa Refuge. These activities and programs include wildlife observation, hunting, fishing, interpretation/education, and photography.
- Protect, maintain, and restore coastal beach and dune habitats historically characteristic of the southwest Washington coastal region for the benefit of the western snowy plover, streaked horned lark, pink sandverbena, Oregon silverspot butterfly, and a diverse assemblage of other native species.
- Promote the recovery of federally threatened and endangered as well as Federal candidate and state-listed species.

This hunting program supports the mandate of the Improvement Act that refuges provide for priority public uses, including hunting, where compatible. A Compatibility Determination and Section 7 Endangered Species Consultation were completed for the existing and proposed waterfowl, upland game bird, and big game hunt (Appendices C and O, draft CCP/EIS). The current and expanded hunting program would be conducted to meet Refuge objectives for providing quality hunting opportunities, and assisting the Washington Department of Fish and Wildlife (WDFW) with achieving and maintaining state game population objectives.

M.4 Assessment

The hunting program would be thoroughly evaluated on an annual basis to determine if the Refuge is meeting its objectives. If there have been no unacceptable impacts to other wildlife populations or to other public use programs, the hunting program would be continued. At that time, the Service will also consider adding additional hunting areas if appropriate, including any newly acquired Refuge lands. Any reductions in or other changes to the hunt program would be made after evaluation of the program.

All existing and proposed hunting areas are located within Pacific County, Washington. Hunting of waterfowl, coot, snipe, elk, deer, bear, and grouse (ruffed and blue) would be allowed on the Refuge consistent and in accordance with all Washington State regulations except as specifically noted herein.

A. Are populations of waterfowl, coot, snipe, elk, deer, bear, or grouse (ruffed or blue) present in numbers that are sufficient to sustain an optimum population level for priority refuge objectives other than hunting?

Yes, target wildlife populations are present in sufficient numbers for priority refuge objectives for wildlife management and for the other priority wildlife-dependent recreational uses (wildlife observation, photography, environmental education, and interpretation). The Refuge has adopted harvest regulations set by the State, which uses concepts of density dependent compensatory mortality and adaptive harvest management to ensure sustained game species populations (See Section M.5.10, Species to be taken).

The Refuge was evaluated to determine the best public use strategy for providing high-quality wildlife-dependent public use opportunities. The Refuge would offer various public use opportunities on nearly the entire Refuge throughout various times of the year. Approximately 90 acres of the Refuge are closed to all public use. These areas include areas directly adjacent to buildings and are closed for safety purposes. Approximately 6,000 acres would be open for waterfowl, coot, and snipe hunting. There would be approximately 11,300 acres available for elk, deer, bear, and grouse (ruffed and blue) hunting. Hunting programs need to be based on healthy, sustainable populations of the species hunted. The number of elk that enter the Refuge may vary from year to year. For the Leadbetter Point Unit, reproduction continues to add to the estimated population of 40 to 60 animals. Outside recruitment to the herd may also add to this population annually.

Under this Hunting Plan, the elk and deer populations would be monitored and the continual expansion kept in check. According to WDFW Wildlife Biologists, the management of the elk and deer herds is necessary to maintain an overall healthy population that does not have negative impacts on the environment or create negative impacts for the community.

B. Is there competition for habitat between target species and other wildlife?

Possibly. While each species occupies a unique niche, there is a finite amount of space available to satisfy various habitat requirements of water, food, cover, breeding, and roosting areas.

Non-native beach grass is abundant on the Leadbetter Point Unit. However, it is unlikely that this is much of a food source for elk. Browse is in limited supply on this unit. Shore pine dominates much of the shrub/tree community, although willows and other shrubby plants do exist. Shrubs and trees occupy greater than 50% of the 1,742-acre unit and coupled with the large areas of predominantly beach grasses, it is not surprising that the native plants which are occurring in the dune habitat restoration area are being consumed or trampled.

Elk are large animals and require extensive amounts of food. A 700-pound elk will typically eat 14 pounds air dry weight (approximately 30 pounds fresh weight) of forage per day (Nelson and Leege 1982). A herd of 40 to 60 or more elk on the 1,742-acre unit exerts tremendous pressure on the native plant species that do occur and conflicts with the nesting wildlife that occupy those areas.

Elk compete with deer for food and cover. Elk are often classified as being primarily grazers (feeding on grasses and forbs), whereas deer are often classified as being browsers (feeding on the leaves and twigs of shrubs and trees). However, both elk and deer are generalist herbivores and seek out the highest quality forage available at any given time, whether it be grasses, forbs (herbs other than grasses), or browse (Nelson and Leege 1982; Verme and Ullrey 1984)

Black bears are omnivores and consume both plants and animal matter, including insects. Movement within a home range is associated with seasonal availability of food and breeding activities and dispersal. Habitat competition with other species of wildlife is negligible.

C. Are there unacceptable levels of predation by elk/deer/bear on other wildlife forms?

No, target species (waterfowl, coot, snipe, elk, deer, bear, and ruffed and blue grouse) generally do not prey on other species at unacceptable levels.

Although elk and deer are not predators and do not directly predate on other species, in large numbers they do create unacceptable levels of competition and habitat destruction (see above).

Predation levels on other species of wildlife have not been observed to be a problem with black bear on the Refuge.

M.5 Description of the Hunting Program

M.5.1 Areas of the Refuge that Support Populations of the Target Species

Target game species commonly occurring on the Refuge include waterfowl, coot, snipe, elk, deer, bear, and grouse (ruffed and blue). Descriptions of upland forest, estuarine open water, intertidal flat, salt marsh, riverine, wetlands, coastal dune and beach, and grassland habitats and their associated plant and wildlife species are described in further detail in Chapter 4 of the draft CCP/EIS. An overview of hunted target wildlife species is also described below in Section M.5.2.

M.5.2 Target Species

M.5.2.1 Migratory Game Birds

Status of Waterfowl, Coots, and Snipe on the Refuge
Willapa Bay is an important wintering ground for geese and ducks, many of which breed in Alaska and northern Canada. The Refuge's wetland habitats support wintering populations of waterfowl such as black brant, trumpeter swans, Canada geese, scaup, canvasback, bufflehead, scoters, and American wigeon. Up to 35 species of waterfowl can be observed.

The Pacific population of western Canada geese (*Branta canadensis moffitti*) nest in central and southern British Columbia, northwestern Alberta, northern and southwestern Idaho, western Montana, northwestern Nevada, northern California, and throughout Washington and Oregon. A large segment of this population is nonmigratory and resident throughout the year. In response to human activities, such as transplants and artificial nesting structures, the population has expanded its historic distribution. Agricultural practices, residential expansion, and park development has further expanded this population. In some urbanized areas, the geese have become acclimated to human interaction and reside in parks.

Willapa NWR and the fields and farm pastures adjoining Willapa Bay are the primary stopover habitat in Washington State for Aleutian cackling geese during the fall migration from September to late November. A peak count at Willapa during the mid-1990s averaged from 300 to 400 birds (Hays 1997; Kraege 2005). Winter goose survey numbers in Willapa Bay were much lower, comprising less than 1% of the geese examined from 2000 until 2004, when surveys were curtailed. Low numbers are typically seen during the northern migration in February and March each year. The highest number of spring migrating Aleutian cackling geese in Washington through the mid 1990s was 52 birds recorded in Willapa Bay by Pitkin and Lowe (1995). The 2008 calculated population index for Aleutian cackling geese in the Pacific Flyway was 193,321. The most recent three-year average population equals about 179,000, slightly below the Flyway objective of 250,000 birds set by the Pacific Flyway Council.

A primary rationale for creating Willapa NWR in 1937 was conservation of migratory and wintering populations of brant. Brant are one of the most abundant waterbird species passing through Willapa Bay during annual migrations. Brant utilize eel grass (*Zostera marina*) beds as a primary food source while in Willapa Bay, often numbering in the hundreds of birds. Use of the bay is greatest during the northern spring migration, with peak bird numbers observed from

March through May, with use typically highest in April. Brant also winter in the area from late October to early May. Total numbers of wintering birds are lower than in the spring, averaging several thousand, but overall there is a lesser degree of interannual variation (Wilson and Atkinson 1995). Historically the brant population was much higher than at present. Brant harvest in the Pacific Flyway states for 2007 was estimated at 2,800 birds, with Washington State comprising slightly less than 20% of the total rate of harvest. The 2008 population estimate based on an index derived from midwinter surveys totals 24,972.

M.5.2.2 Upland Game Birds

Status of Ruffed and Blue Grouse on the Refuge

Forest grouse in Washington include dusky blue grouse (*Dendragapus obscurus*), sooty blue grouse (*Dendragapus fuliginosus*), and ruffed grouse (*Bonsa umbellus*), which occur throughout the forested lands in Washington. Statewide biological surveys designed to estimate forest grouse populations have not been conducted in Washington (WDFW 2008). Forest grouse can be observed throughout the Refuge and adjacent lands

M.5.2.3 Big Game

Status of Roosevelt Elk on the Refuge

The Roosevelt elk (*Cervus elaphus roosevelti*) is one of six recognized subspecies of elk in North America (Bryant and Maser 1982). They are native to western Oregon and Washington, northwestern California, and Vancouver Island, British Columbia. Statewide elk populations are difficult to estimate but the statewide total ranges from approximately 55,000 to 60,000 elk (WDFW 2009). Southwest Washington and the Willapa Hills, which surround the Refuge, support one of the highest concentrations of elk in Washington State. Populations of elk in western Washington are variable, ranging from less than 1 elk/mi^2 to12 elk/mi^2 (USFWS 1978).

Elk can be observed throughout the Refuge and adjacent lands. Habitat on the Refuge includes open fields, fresh and saltwater marshes, forested areas, and clearings in forests. An estimate of the elk population in the late 1970s on Long Island was 40 to 45 animals.

Records indicate that elk were not present on Leadbetter Point when the area became part of Willapa Refuge in the 1960s. It is surmised that a small group of elk located to this area in late 1980s or early 1990s by travelling up the Long Beach Peninsula. There are also records of elk swimming from Long Island to the peninsula. Elk are found on the Mainland and Long Island Units of the Refuge on a year-round basis. The population of the mainland elk herds is kept in check because the surrounding private lands and portions of the Refuge are open to elk hunting annually.

Elk hunting is currently prohibited within the Leadbetter State Park and the Leadbetter Point Unit of the Refuge. Elk numbers have grown gradually and continuously since their establishment on the peninsula. In the spring and summer months of 2007, refuge biologists observed a herd of approximately 30 elk inside the western snowy plover nesting area. Reports of sightings in the area by WDFW and area residents confirm that the overall number of elk has increased and now may range from 40 to 60 animals.

Status of Black-tail Deer on the Refuge

WDFW conducts composition surveys from the air and the ground to index buck, doe, and fawn ratios (WDFW 2009). In western Washington, black-tailed deer (*Odocoileus hemionus*) surveys are coupled with hunter check station information and harvest data to model populations (WDFW 2009). In 2008, population estimates for deer in Game Management Units (GMU) 658, 660, 663, 672, 673, 681 (which includes the Refuge), and 684 was 25,797 (WDFW 2009).

Systematic surveys of black-tailed deer are not conducted on the Refuge. However, the Willapa Hills and the Long Beach Peninsula support healthy populations of black-tailed deer, and this species has been observed throughout the Refuge.

Status of Black Bear on the Refuge

The black bear (*Ursus americanus*) is the most common and widely distributed species of bear found in North America. In Washington, black bears inhabit 31 of 37 counties, occupying all forested habitats within western Washington, the Cascade Mountain Range, the Okanogan Region, and the Selkirk and Blue Mountains ranges (WDFW 2009). Although no formal statewide bear surveys are conducted in Washington, the black bear population is around 25,000 to 30,000 animals (WDFW 2009). Systematic surveys of black bear are not conducted on the Refuge. However, the Willapa Hills and the Long Beach Peninsula support healthy populations of black bear. This species has been observed throughout the Refuge. Although a population estimate does not exist for the entire Refuge, a study in 1973-1975 estimated the bear population on Long Island to be approximately 30 animals (Lindzey 1976).

Hunting pressure for bear on Long Island is limited.

M.5.3 Existing Areas Opened to the Public

The Refuge is opened for a variety of wildlife-dependent public uses and currently offers a waterfowl, upland game bird, and big game hunting programs:

M.5.4 Existing Waterfowl Hunting Opportunities

All hunters are required to use only federally approved nontoxic shot while waterfowl hunting. Use or possession of lead shot is prohibited while hunting waterfowl. Hunters may use dogs to aid in retrieval of birds, but dogs will need to be kept under control at all times. Hunters may set up temporary blinds along the shoreline which must be removed at the conclusion of each hunting period. Access to the waterfowl hunting areas will be by boat and/or foot access only.

M.5.4.1 Leadbetter Point

Portions of the Leadbetter Unit are open to free-roam duck and goose hunting seven days a week. Access is by Stackpole Road. Hunting is prohibited in the snowy plover closure area.

M.5.4.2 South Bay

Selected areas of the South Bay Unit: (Riekkola, Tarlatt, Porter Point, Potshot, North Potshot, and Stanley Peninsula) are open for waterfowl hunting from assigned blinds only. There are eight blinds including one that is accessible to people with disabilities. The Riekkola Unit is open to goose hunting only from blinds on Saturday and Wednesday. Hunters may not possess more than 25 shells per day. One blind is available for disabled hunters. Ducks, coots, and snipe may be taken only incidental to goose hunting. Access occurs off 67th Street in Long Beach. Blind selection is done by lottery early the morning of each hunt. Gates are open from 6 am to 5 pm. There is a small fee ($5.00) for use of the blinds. The user fee is $2.50 with a Golden Age or Golden Eagle passport. Funds from this fee go to help maintain the blinds.

Porter Point is open for free-roam waterfowl hunting on Sunday, Monday, and Thursday. The Porter Point Unit is suitable for car-top boats and small craft that can be easily moved. The freshwater wetland can be accessed by the Porter Point Unit levee or boating the wetland. No gas-operated engines are allowed in the freshwater wetland. The saltwater marsh of Willapa Bay can be reached from the existing footbridge on the east end of Porter Point Unit or by walking into the bay from the levee on the west end of the unit. Access occurs through the Riekkola Unit, off 67th Street in Long Beach.

M.5.4.3 Waterfowl Closure Areas

On November 7, 1940, the President issued another Proclamation (No. 2439), "Regulation Designating As Closed Area under the Migratory Bird Treaty Act Certain Lands and Waters Adjacent to and in the Vicinity of the Willapa National Wildlife Refuge Washington." As lands were acquired into the Refuge, with purposes derived from the earlier Executive Order it is also made clear in several Migratory Bird Conservation Commission Memorandum that "A Proclamation closes to hunting the water surrounding the island." That island refers to Long Island in south Willapa Bay. The Refuge maintains the Presidential Proclamation Boundary specifically prohibiting waterfowl hunting around Long Island.

Hunting was allowed on the Lewis Unit; however, access via Jeldness Road, a private road off U.S. Highway 101, was closed by property owners in 2008. This unit is now closed to hunting.

M.5.5 Proposed Waterfowl Hunting Opportunities

M.5.5.1 South Bay

The proposed expanded waterfowl hunt area identified in Alternative 2 (preferred alternative) of the draft CCP/EIS would include opening to waterfowl hunting all newly restored areas in the South Bay (Porter Point, Lewis, Riekkola, and Tarlett units). Hunting would be allowed seven days a week according to State regulations.

M.5.5.2 Waterfowl Closure Areas

The Refuge maintains the Presidential Proclamation Boundary specifically prohibiting waterfowl hunting around Long Island. The new headquarters office/visitor contact station would be located on the Tarlatt Unit necessitating closure to goose hunting for this unit.

M.5.6 Existing Upland Game Bird Hunting Opportunities

M.5.6.1 Long Island Unit

Archery hunters interested in a remote hunting experience find Long Island (State GMU 699) a challenging place to pursue ruffed and blue grouse. A Refuge hunting permit is required to hunt on Long Island but there is no fee for the permit. There are no firearms permitted on Long Island.

Visitors must provide their own boat transportation to and from Long Island. Access is best at a higher tide (6 foot or higher). Construction or use of permanent tree stands is prohibited. Camping is permitted only in designated campsites on the island.

M.5.7 Proposed Upland Game Bird Hunting Opportunities

No changes are proposed to the upland game bird hunting opportunities.

M.5.8 Existing Big Game Hunting Opportunities

Willapa Refuge currently provides several opportunities for big game hunters. Big game hunting occurs on both the mainland and Long Island. Existing big game hunting rules and regulations on the Refuge are consistent with the state regulations except as specifically noted herein. Hunting is permitted in some, but not all, of the management units. Specific species/numbers to be taken and hunting periods are set by the WDFW. (see Map 9, draft CCP/EIS)

M.5.8.1. Long Island Unit

The Long Island Unit (GMU 699) is annually open to archery elk, deer, and bear hunting. There are no firearms permitted on Long Island. Archery hunters interested in a remote hunting experience find Long Island a challenging place to pursue Roosevelt elk, black-tailed deer, and black bear. A Refuge hunting permit is required to hunt on Long Island but there is no fee for the permit. Many people who hunt on Long Island prefer to camp overnight since tides can make travel to and from the island challenging.

M.5.8.2. East Hills Units

Existing elk and deer hunting areas include designated portions of the East Hills Units (from the Bear River to Teal Slough) (GMU 681). Most of the Refuge lands on the mainland between Bear River and Teal Slough with the exception of the quarters (Q88) and headquarters area are open for those interested in hunting Roosevelt elk or black-tailed deer using modern firearms or archery. The East Hills Units are not open to bear hunting.

M.5.9 Proposed Big Game Hunting Opportunities

The proposed action identified in the preferred alternative (Alternative 2) of the draft CCP/EIS would open expanded elk and deer sport hunting opportunities in new areas of the Refuge in accordance with the State hunting regulations. No new bear hunting opportunities are proposed in this plan.

Proposed elk and deer hunting areas include the upland areas in the South Bay units (Lewis, Porter Point, Riekkola and a portion of the Tarlatt Unit); and a proposed regulated elk-only hunt on the Leadbetter Point Unit; and any additional lands acquired as identified in the draft CCP/EIS, would be considered for opening to elk and deer hunting. (See Map 9, draft CCP/EIS.)

M.5.9.1 South Bay Units

Deer and elk hunting are currently not open in the South Bay units due to existing facilities, refuge management activities and public use programs. It is proposed that elk and deer be opened on the upland areas of the South Bay Units once tidal restoration activities are complete in the South Bay subunits which include Lewis, Porter Point, Riekkola, and a portion of Tarlatt Slough. All of the existing South Bay subunits and any future acquisitions are located in the same muzzleloader zone as the Leadbetter Point Unit and therefore would typically be open for approximately five days in early October. Once tidal restoration is complete in South Bay, there will be no roads, trails, fences, equipment facilities, or cattle grazing for pasture management. The existing regulated goose hunt program and associated infrastructure will no longer exist, nor will the regulated waterfowl hunt. While these areas will be open to goose and waterfowl hunting in accordance with state season, the use will be along tidal channels and flats and waterfowl hunters will be much less concentrated. The birding public and those out to observe wildlife will have access to the South Bay units through the new office/visitor center and associated trail and observation tower. Therefore, it is not anticipated that any proposed elk or deer hunt will impact nor create a safety problem with other public uses. The South Bay units will not be open to bear hunting.

M.5.9.2 Nemah/Naselle Unit, East Hills Addition

Elk and deer hunting opportunities would expand upon acquisition of any new areas as identified in Alternative 2 of the draft CCP/EIS. Currently the land owners allow elk and deer hunting on these proposed refuge acquisition areas. The Refuge would continue this wildlife-dependent public use activity for any new acquisitions in the future. Elk and deer hunting opportunities would be considered upon acquisition of any new areas in the future and would resolve potential problems over the exact position of the refuge boundary and complement local hunting activities on adjacent lands. The Nemah/Naselle Unit and East Hills additions will not be open to bear hunting.

M.5.9.3 Leadbetter Point Unit

An early season muzzleloader elk only hunt and a special permit hunt are proposed on the Leadbetter Point Unit. The entire unit would be open to the early elk muzzleloader season, which typically lasts approximately five days in early October. The public would be notified that the entire unit would be closed to all other uses including hiking and waterfowl hunting. Public use of the trails during this time is minimal, due to the inclement weather and seasonal rains that regularly flood the trails. The proposed hunt falls outside the general tourist season. Since the waterfowl hunting season is much longer than the elk muzzleloader season, there would be little, if any, impact on this user group. In keeping with existing elk hunting regulations on adjacent private property and for safety purposes, the use of muzzleloader firearms will only be authorized. The Leadbetter Point Unit will not be open to deer or bear hunting.

A special permit elk hunt will be offered sometime between October and February on this unit only, if needed. If the elk are not found within the unit during the early muzzleloader hunt season, or the elk hunt proves unsuccessful due to weather or other uncontrollable influences, the special permit hunt could be implemented. Opening the special permit hunt would offer an opportunity to assist the State in management of the expanding elk herd. This additional hunt would draw from a pool of hunters who have applied for a muzzleloader permit through WDFW. The number of permits in this additional hunt would be determined after consultation with WDFW after the early season hunt.

Since big game hunting on the Leadbetter Point Unit is new and is not an expansion of hunting boundaries, more details on the elk and unit are provided below:

About the Leadbetter Point Unit

Historically, habitats along the Long Beach Peninsula consisted of low hummocky sand dune formations characterized by large areas of open sand with sparsely vegetated native dune plant species. Coastal marine and wind processes worked to maintain native plant communities in early successional stages on the outer prism of the beach. The dunes were more stable and blowouts less frequent; a mosaic of native prairie and dune grasslands, freshwater lakes, swamps, bogs, and spruce-dominated forests developed. High rainfall maintained high water tables favorable for plant growth.

The Leadbetter Point Unit encompasses 1,742 acres and is located at the northern tip of the Long Beach Peninsula, near the mouth of Willapa Bay. The coastal dune habitats consist of sand dunes in various stages of ecological succession including bare unstable sand; beachgrass-covered dunes; a transition zone composed of shrubs, small lodgepole pine (shore pine), and grass; lodgepole pine (shore pine); freshwater wetlands; and salt marsh.

At one time, the Columbia River provided the coastal shoreline with an extensive transport load of sediment; the ocean currents influenced by a long-shore drift deposited the sediment creating and maintaining the coastal sand beaches. Today, dams on Columbia River have altered sediment loads, and jetties at the river mouth and entrances to the bays have altered sediment transport along the coast. The beaches no longer have the natural processes depositing large amounts of sand and sediment necessary to maintain the sand beaches and dune habitats for a variety of native plants.

The habitat has changed in recent history with an accelerated plant succession that is also due to fire suppression efforts. These efforts have encouraged a plant successional progress away from the historic herbaceous beach grass, to a shrub (often invasive non-natives such as Scotch broom and common gorse) habitat leading to a pioneer lodgepole pine or climax Sitka spruce forest.

The west side of the unit is characterized by open wind-swept beaches backed by vegetated dunes. The extreme tip of the peninsula is largely barren sand, and the east side consists of a narrow beach with a few small, sheltered openings cut into the beachgrass by high water in winter. A small, isolated portion of beach exists to the east, on Willapa Bay, and is referred to as Grassy Island although it is attached to the peninsula.

The northern end of the Long Beach Peninsula was in a state of gradual northward accretion from 1965 to 1999. Invasion by non-native beach grasses has followed accretion, progressively filling in the dunes. In conjunction with slowed accretion in more recent years, the vegetation line has moved westward and the vegetation-to-water distance has decreased resulting in a narrower beach. Recent maps from the Washington State Department of Transportation show that the tip or northern portion of the unit has been gradually eroding since mapping efforts began in 1999. As the tip has eroded, the peninsula to the southwest has become wider.

American dunegrass (*Leymus mollis* or *Elymus mollis*), a native dunegrass, exists in small patches on the Refuge unit. Two invasive non-native beachgrass species, American beachgrass and European beachgrass (*Ammophila breviligulata* and *A. arenaria*), planted to stabilize dunes, have changed historical dune morphology and native plant communities. American beachgrass is the most abundant of the three grass species on the Long Beach Peninsula dunes, although all three species can be found growing together and there are patches of these species growing separately. The beachgrasses form a continuous band of vegetation parallel to the high tide mark along the outer ocean beach.

Non-native beachgrasses out-compete native vegetation, alter the dune ecosystem, and form dense stands that reduce the amount and quality of nesting habitat for native wildlife, including the federally threatened, state-endangered western snowy plover and a state-endangered, Federal candidate species, streaked horned lark. Non-native beachgrasses have rapidly taken over a majority of formerly open sand dunes that provide nesting habitat for these two species. Western snowy plover numbers have declined along the U.S. Pacific coast due to habitat degradation as well as impacts from the expanding predator populations. One of the most significant causes of habitat loss for coastal breeding population of western snowy plovers has been the encroachment of introduced beachgrasses.

The invasion of non-native beachgrasses has also caused a dramatic reduction of coastal native plants and is a primary threat to the state endangered pink sandverbena (*Abronia umbellata*) which is also a Federal species of concern. Pink sandverbena and other rare native dune plants like yellow sandverbena (*Abronia latifolia*), grey beach pea (*Lathyrus littoralis*) and beach morning glory (*Convolvulus soldanella*) are found along the sparsely vegetated sand beaches and coastal dunes.

In order to protect and encourage native plant growth the Refuge has implemented a Coastal Habitat Restoration Project. This ongoing project was initiated in 2002 and has continued each year with successful results. The mechanical and chemical removal and control of non-native beachgrass has resulted in over 120 acres of restored habitat that has successfully attracted nesting western snowy plovers and streaked horned larks. Oystershell was added to portions of the cleared area to provide camouflage for nests and reduce blowing sand to protect the bird nests. This habitat restoration area supports the only known population of pink sandverbena in Washington State; this plant species was thought to be extirpated in the state (Federal species of concern, Washington State endangered species). In 2006, it was able to re-establish itself, from a long-term seed bank, because beachgrass had been removed from the site. Thousands of plants now exist at the site due to transplantation of propagated individuals and broadcast seeding efforts as well as a high success rate due to natural seeding.

Leadbetter Point Research Natural Area (RNA) is located entirely in the Refuge and was put on the Washington Register of Natural Areas in 1989. The original designation included 1,705 acres of the peninsula tip, Grassy Island, and the marsh between the island and peninsula tip; however, the unit is now approximately 1,742 acres due to sand accretion at the peninsula tip. This area represents the highest quality habitat, largest coastal sand dune ecosystem in Washington State.

The natural elements protected include salt marsh, native dunegrass, lodgepole pine (shore pine) forest, shrub/lodgepole pine (shore pine), and open beach habitats. The bay side of the unit contains some of the most significant saltmarsh habitats remaining in Washington. It also contains high-quality examples of high salinity Virginia glasswort/inland saltgrass marsh, low salinity marsh, and transition zone wetlands. Flora associated with the marshes are of primary significance, as are the dune grassland and deflation plain habitat communities. Pockets of native plants within the secondary dune, deflation plains, and dune troughs are also significant ecological features and are of high quality compared to these remaining plant communities in Washington.

There have been over 200 species of plants have been documented at Leadbetter Point (Sayce 2001) and over 180 species of birds have been documented. Open water off the point supports large concentrations of waterfowl, including brant. Extensive mudflats at low tide support large populations of wintering and migrating shorebirds which also utilize the beach side in large numbers. It has been estimated that this unit hosts approximately seven percent of Willapa Bay shorebirds in the spring. Willapa Bay has some of the largest concentrations of shorebirds on the Pacific Coast during spring and fall migration. A key stopover site along the Pacific Flyway, it hosts hundreds of thousands of shorebirds, with dunlin and western sandpipers being the most numerous. Although it is not officially a designated site, Willapa Bay meets the criteria for status as a site of international significance in the Western Hemisphere Shorebird Reserve Network. Willapa Bay meets these criteria because it supports up to 15.5% of the Pacific Flyway population of wintering dunlin and an average of over 100,000 total shorebirds in the spring. Over 35 shorebird species have been documented.

This area is also considered an important staging site for passerine birds during spring migration. The unit also serves as a daytime roost site for brown pelicans and is an important loafing and resting area for this species (Cullinan 2001). A variety of raptors can be found here including bald eagles, peregrine falcons, and in some years, snowy owls.

This area of the Refuge is found within the northernmost breeding range for the western snowy plover along the Pacific Coast and is also the largest of the remaining nesting areas for the plover in Washington. The 374-acre nesting area for the endangered snowy plover is closed to all public entry from March through September, though the season can vary due to variation in the use by snowy plovers.

The primary public access occurs at the end of a narrow road near the northern end of peninsula. The Refuge provides parking, interpretive signs, vault toilets, hiking trails, and viewing platforms. Hiking trails allow visitors to walk through coastal woodlands, salt marshes, and beaches. These trails include 1.3-mile Bearberry Trail, 0.5-mile Beach Trail, and a 1.2-mile Bay Loop Trail which link to the adjacent Washington State Park trails. These trails are often flooded during the rainy season (October through May).

M.5.10 Species to be Taken and Hunting Periods

M.5.10.1 Hunting Season and Bag Limits Overview

Waterfowl populations throughout the United States are managed through an administrative process known as flyways, of which there are four (Pacific, Central, Mississippi, and Atlantic). The review of the policies, processes, and procedures for waterfowl hunting are covered in a number of documents identified below.

The National Environmental Policy Act (NEPA) considerations by the Service for hunted migratory game bird species are addressed by the programmatic document, ‘‘Final Supplemental Environmental Impact Statement: Issuance of Annual Regulations Permitting the Sport Hunting of Migratory Birds (FSES 88– 14),’’ filed with the Environmental Protection Agency on June 9,

1988. The Service published a Notice of Availability in the Federal Register on June 16, 1988 (53 FR 22582), and the Record of Decision on August 18, 1988 (53 FR 31341). Annual NEPA considerations for waterfowl hunting frameworks are covered under a separate Environmental Assessment and Finding of No Significant Impact. Further, in a notice published in the September 8, 2005 Federal Register (70 FR 53776), the Service announced its intent to develop a new Supplemental Environmental Impact Statement for the migratory bird hunting program. Public scoping meetings were held in the spring of 2006, as announced in a March 9, 2006 Federal Register notice (71 FR 12216).

Because the Migratory Bird Treaty Act stipulates that all hunting seasons for migratory game birds are closed unless specifically opened by the Secretary of the Interior, the Service annually promulgates regulations (50 C.F.R. Part 20) establishing the Migratory Bird Hunting Frameworks. The frameworks are essentially permissive in that hunting of migratory birds would not be permitted without them. Thus, in effect, Federal annual regulations both allow and limit the hunting of migratory birds.

The Migratory Bird Hunting Frameworks provide season dates, bag limits, and other options for the states to select that should result in the level of harvest determined to be appropriate based upon Service-prepared annual biological assessments detailing the status of migratory game bird populations. In North America, the process for establishing waterfowl hunting regulations is conducted annually. In the United States, the process involves a number of scheduled meetings (Flyway Study Committees, Flyway Councils, Service Regulations Committee, etc.) in which information regarding the status of waterfowl populations and their habitats is presented to individuals within the agencies responsible for setting hunting regulations. In addition, public hearings are held and the proposed regulations are published in the Federal Register to allow public comment.

For waterfowl, these annual assessments include the Breeding Population and Habitat Survey, which is conducted throughout portions of the United States and Canada, and is used to establish a Waterfowl Population Status Report annually. In addition, the number of waterfowl hunters and resulting harvest are closely monitored through both the Harvest Information Program and Parts Survey. Since 1995, such information has been used to support the adaptive harvest management (AHM) process for setting duck-hunting regulations. Under AHM, a number of decision-making protocols render the choice (package) of pre-determined regulations (appropriate levels of harvest) which comprise the framework offered to the states that year. The Washington Fish and Wildlife Commission then selects season dates, bag limits, shooting hours and other options from the Pacific Flyway package. Their selections can be more restrictive but cannot be more liberal than AHM allows. Thus, the level of hunting opportunity afforded each State increases or decreases each year in accordance with the annual status of waterfowl populations.

Each National Wildlife Refuge considers the cumulative impacts to hunted migratory species through the Migratory Bird Frameworks published annually in the Service's regulations on Migratory Bird Hunting. Season dates and bag limits for National Wildlife Refuges open to hunting are never longer or larger than the State regulations. In fact, based upon the findings of an environmental assessment developed when a refuge opens a new hunting activity, season dates and bag limits may be more restrictive than the state allows.

M.5.10.2. Refuge Hunt Seasons and Bag Limits

Hunting will be permitted in accordance with state and Federal regulations (Tables M.1 and M.2 give examples of annual state hunt seasons for areas within the Refuge) to ensure that it will not interfere with the conservation of fish and wildlife and their habitats. Therefore, the sport hunting of migratory and upland game birds and big game on the Refuge is in compliance with state regulations and seasons, the National Wildlife Refuge System Administration Act of 1966 as amended by the National Wildlife Refuge System Improvement Act of 1997 (16 U.S.C. 668dd-ee), and the Refuge Recreation Act of 1962 (16 U.S.C. 460k).

Table M.1. Willapa Refuge, Waterfowl and Upland Game Bird Hunting Season Bag Limit Summary for 2010-2011.

Species	Dates	Daily Bag Limits	Possession Limit
Ducks (youth hunt)	September 25-26	7 [A] 14	[A]
Ducks	October 16-20 & October 23-January 30 except scaup closed October 16-November 5	7 [A] 14	[A]
Geese (except brant) Mgmt. area 2B	8 am to 4 pm, Saturdays & Wednesdays only October 16-December 22 and January 5-15; December 26, 29; January 2	4 [B]	8[B]
Brant Pacific County	Jan. 15, 16, 18, 20, 22, 23, 25, 27, 29, 30	2	4
American coot	October 16-20 & October 23-January 30	25	25
Snipe	October 16-20 & October 23-January 30	8	16
Archery grouse (ruffed and blue) GMU 699	September 1-December 31	4 of any species	12 of any species

[A] **Daily bag limit:** to include not more than 2 hen mallard, 2 pintail, 3 scaup (see restricted dates above), 1 canvasback, and 2 redhead statewide; and to include not more than 1 harlequin, 2 scoter, 2 long-tailed duck, & 2 goldeneye in western Washington.
Possession limit: to include not more than 4 hen mallard, 4 pintail, 6 scaup (see restricted dates above), 2 canvasback, and 4 redhead statewide; and to include not more than 1 harlequin, 4 scoter, 4 long-tailed duck, and 4 goldeneye in western Washington.
Season limit: 1 harlequin in western Washington.

[B] **Daily bag limit:** to include not more than 1 dusky Canada goose & 2 cackling geese in Areas 2A & 2B; and to include not more than 1 Aleutian goose in Area 2B.
Possession limit: to include not more than 1 dusky Canada goose & 4 cackling geese in Areas 2A & 2B; and to include not more than 2 Aleutian geese in Area 2 B.
Season limit: 1 dusky Canada goose. A dusky Canada goose is defined as a dark breasted (Munsell 10YR, 5 or less) Canada goose with a culmen (bill) length of 40-50 mm. A cackling goose is defined as a goose with a culmen (bill) length of 32 mm or less.

Table M.2. Willapa Refuge, Big Game Hunting Season Bag Limit Summary for 2010.

Species	Dates	GMU	Legal
General deer (black-tailed)	October 16-31	681, 684	2 pt. min.
		684 A	ny buck
Late deer (black-tailed)	November 18-21	681, 684	2 pt. min.
		684 A	ny buck
Early archery deer (black-tailed)	September 1-24	681	2 pt. min. or antlerless
		684 A	ny
Late archery deer (black-tailed)	November 24-December 8	681	2 pt. min. or antlerless
	November 24-December 15	699	Any deer
Early muzzleloader (black-tailed)	September 25-October 3	684	Any buck
Late muzzleloader (black-tailed)	November 25-December 15	684	Any deer
General elk	November 6-16	681, 684	3 pt. min.
Early archery elk	September 7-19	681, 684, 699	3 pt. min. or antlerless
Late archery elk	November 24-December 15	681, 699	3 pt. min. or antlerless
Early muzzleloader (elk)	October 2-8	684	Any elk
Late muzzleloader (elk)	November 24-December 15	684	Any elk
Black bear	September 1-November 15	699	2/season

M.5.10.3 Justification for a Special Permit Elk Hunt on the Leadbetter Point Unit

The Refuge also proposes a special permit elk hunt to be offered sometime between October and February on this unit only. If the elk are not found within the unit during the early muzzleloader hunt season, or the elk hunt proves unsuccessful due to weather or other uncontrollable influences, the special permit hunt could then be implemented.

Opening the special permit hunt would offer an opportunity to assist the State in management of the expanding elk herd. This additional hunt would draw from a pool of hunters who have applied for a muzzleloader permit through WDFW. The number of permits in this additional hunt would be determined after consultation with WDFW after the early season hunt. Currently the registration process for big game hunting on the Refuge requires an orientation to refuge boundaries and hunting regulation review; this same process will be used for the elk hunt at the Leadbetter Point Unit.

By issuing the special permit for the muzzleloader elk hunt, it provides the refuge staff an opportunity to control the number and timing of hunters in a specific area thereby reducing potential hunter impacts to the resource and/or other Refuge users. Providing permits addresses the elk management issue by limiting the amount of animals taken or not taken in the area. Due to the size and shape of the unit and limited access points, the number of hunters will be regulated. There is the potential for elk hunters to disturb waterfowl and waterfowl hunters at certain times of the year. The permit system offers staff the opportunity to monitor take and potential impacts to resources while providing an opportunity for a quality and safe hunting experience.

M.5.10.4 Procedures for Consultation and Coordination with State

To ensure that hunted bird populations are sustainable, the WDFW annually reviews the population censuses to establish season lengths and harvest levels. In addition, refuge staff conducts habitat management reviews of each unit to evaluate wildlife population levels, habitat conditions, and public use activities.

Information on the Refuge's hunt program will be published in the state's regulations. If a special permit hunt is required at Leadbetter Point, the refuge staff will consult and coordinate with the WDFW regional biologists to determine the number and type of elk to be removed.

M.5.10.5 Methods of Control and Enforcement

The hunting program is managed in strict accordance with all applicable Federal laws (50 C.F.R. subchapter C) and to the extent practicable, consistent with applicable state laws.

Hunters will be required to obtain and hold a refuge permit from the refuge headquarters prior to hunting on specified units of the Refuge. Permitted hunters must report success/failure and any hit-but-not-retrieved animals when they turn in their refuge permit tag each day. Refuge and Washington State Fish and Wildlife enforcement officers will patrol and check hunters to ensure they are complying with all regulations.

M.5.10.6 Funding and Staffing Required for the Big Game Sport Hunting Program

It is estimated the following level of involvement by Refuge staff will be required to adequately monitor and manage the hunt program. The costs to administer the new program are found in Table M.3.

Table M.3. Willapa Refuge, Funding and Staffing for Big Game Sport Hunting Program

Position and GS/WG Level	Involvement	FTE	Cost
Project Leader/Deputy Project Leader (GS 12/13)	Oversight Coordination with Washington Department of Fish And Wildlife	.01 $	1000
Wildlife Biologist (GS-11)	Elk Monitoring, Reporting, Hunt Plan Updates	.05	$4200
Refuge Manager (GS -11)	Oversight of Hunt Program, Field Monitoring of Hunters	.04 $	3200
Visitor Services Manager (GS-11) / Refuge Law Enforcement Officer (GS-9)	Hunt Plan Orientation, Law Enforcement	.02	$1600
	Total Annual FTE's And Cost	.12	$9800

The expansion and continuation of big game hunting would not require any new infrastructure or personnel. Administration of the hunt and annual coordination with the State of Washington would be required as would some law enforcement patrols; however, refuge staff is in place and capable of conducting these duties. Revision and printing of the refuge brochure, updating the refuge website and other outreach information such as informational signage would be required at an estimated cost of $9,800. Base funding is available to cover these costs.

M.6 Measures Taken to Avoid Conflicts with Other Management Plans

M.6.1 Biological Conflicts/Impacts

M.6.1.1 Biological Environment

There are several minor impacts to the biological environment that would result from continuing the existing big game hunting program and expanding the hunt to areas as proposed.

Elk, deer, and bear are presently thriving in southwest Washington. There are open elk, deer, and bear hunting seasons for archery, modern firearms, and muzzleloaders. While the refuge hunt would reduce some elk, deer, or bear, the increased hunting opportunities on the Refuge would not have an impact on the overall populations. According to WDFW, controlling elk and deer numbers would help diminish the spread of diseases and parasites. It would also help maintain shrub habitat, which benefits the elk themselves as well as other wildlife such as many birds and small mammals that depend on understory vegetation for food, nests, etc.

Bear would continue to be hunted only on Long Island. A small number of bear are harvested annually due to the archery-only hunt, and impact on the existing population should continue to remain small. Disease and parasites are not an obvious problem with the bear population on Long Island.

Based on discussions with WDFW, there are approximately 40 to 60 elk currently accessing and utilizing the Leadbetter Point Unit. The population may fluctuate due to hunting pressure and disturbance on private property nearby. The number of elk utilizing this unit has steadily increased, and elk numbers are expected to further increase through migration and reproduction. This additional hunt area on the Refuge would provide an opportunity for a high-quality elk hunt and would assist the State with controlling the expanding elk population, while having the added benefit of protecting essential habitat for western snowy plovers, streaked horned larks, and pink sandverbena.

This existing and proposed hunting use would result in temporary displacement of migratory birds and resident wildlife in the hunt areas. Other species which may be temporarily displaced by the existing and proposed hunting program include bald eagles, great blue herons, and other birds that reside in and near refuge uplands.

Nearby resting and feeding areas would be available for use by waterfowl, migratory birds, and other resident wildlife species that are disturbed. These species would likely move to other areas of the Refuge which are less accessible to the hunters. The combination of limited duration of the proposed hunts and the ability of disturbed wildlife to move to secure habitat represents a minor disturbance to the above-mentioned species.

Due to the limited number of hunters and limited field time, no negative effects to vegetation are anticipated. In addition, no effects are expected to refuge fish populations because activities will not take place in environments used by fish.

M.6.1.2 Physical Environment
Hunting activities would not have an impact to the physical environment of the Refuge. The limited numbers of people who would be hunting for the short time frames hunting is allowed would not be enough to cause damage to features such as soils, air quality, and water quality.

M.6.1.3 Social and Economic Environment
There are several minor impacts to the social and economic environment that would result from continuing and/or expanding elk/deer hunting.

Effects to other public recreational uses are expected to be minimal due to the timing of the activities and limited duration of the hunt. The state elk/deer/bear hunting seasons occur when other public uses are at a minimum because they are outside the main tourist season and generally occur during the seasonal inclement weather. On the East Hills and South Bay units, many of the areas used for elk/deer hunting are not easily accessible to the general public. Access to the Long Island Unit requires a boat, and use of the island during fall's wet weather declines drastically for recreational uses other than hunting. The current headquarters area, where trails and visitor information kiosks exist, will remain closed to all hunting activity.

Maintaining and/or expanding hunting opportunities on the East Hills Units, South Bay Units, Nemah/Naselle Unit, and the Leadbetter Point Unit to hunting would complement some of the State permitted hunting activities locally. While hunting activity is not expected to increase according to surveys described in Chapter 5 of the CCP/EIS, expanding hunting opportunities may result in a slight increase in hunting visitation to the area. Having an expanded elk/deer hunt could result in slight increases to spending in the local economy.

Overall, by maintaining the existing elk/deer hunt program and expanding the elk hunt program to the Leadbetter Point Unit and future additions, this activity would provide increased opportunities for quality wildlife dependent recreation. The hunt activity on the Refuge would have minor positive benefits to local economy and reduce impacts to the agricultural community. The expanded elk hunt for the Leadbetter Point Unit would create a temporary closure to other public uses, but this impact would be temporary and short in duration and would occur outside the regular tourist season.

M.6.2 Public Use Conflicts

There are several minor public use conflicts that will result from continuing the existing elk/deer/bear hunt and expanding the elk/deer hunt to areas proposed in Alternative 2 of the draft CCP/EIS.

Effects to other public recreational uses are expected to be minimal due to the timing of the activities and limited duration of the hunt. The state elk/deer/bear hunting seasons occur when other public uses are at a minimum because they are outside the main tourist season and generally occur during the seasonal inclement weather. On the East Hills and South Bay units, many of the areas used for elk and deer hunting are not easily accessible to general public. Access to the Long Island Unit requires a boat, and use of the island during fall's wet weather declines drastically for recreational uses other than hunting. The current headquarters area (and proposed new headquarters area), where trails and visitor information kiosks exist, would remain closed to all hunting activity.

At the Leadbetter Point Unit, some noise from the muzzleloaders may be experienced from the public on the adjacent Washington State Parks lands, and the public may occasionally observe elk or other wildlife species flushed into the open due to hunter activity. The hiking trails and waterfowl hunting would be closed to other users during the short muzzleloader season. The closure would be for safety purposes and to reduce potential user conflicts, but this hunt is only for a limited time period and occurs when the trails are flooded due to seasonal rains. Again, due to the limited scope and timing of the existing and proposed elk hunt program, all effects are expected to be minor and of short duration.

Without elk hunting on the Refuge, the herd is expected to grow. As the herd increases and outgrows the available habitat on the Refuge, the elk and deer may move off the Refuge into the surrounding areas in search of food. The largest economic impacts of elk in particular are felt in the agriculture industries. Elk and deer may cause damage to local crops and residential landscaping. Other incidental negative economic impacts of elk/deer include elk/deer-vehicle collisions and damage to fences. Implementing this hunt is expected to reduce the negative impacts a larger population of elk/deer may have to the local community.

For the most part, although bears are known to cross the narrow channel between the island and the mainland, most Long Island bears generally remain confined to the island. Bear/human conflicts have occurred on the Long Beach Peninsula but have not been reported from Long Island.

To minimize any potential safety issues as well as potential conflicts with other refuge users, the following restrictions would apply.

M.6.2.1. Leadbetter Point Unit

- Participating hunters would be required to obtain a refuge hunting permit at the refuge headquarters. At this time a brief orientation will be given. Detailed maps showing roads, hiking trails, and open public use areas would be provided.
- During the hunt, the entire unit will be closed to other users including waterfowl hunters and hikers during the approximately five-day early elk muzzleloader season.
- Hiking trails would be closed to the non-hunting public on days when elk hunting is permitted.
- To limit the distance a missed shot would travel, only muzzleloader hunting would be permitted. (Archery is not a preferred option because of the likelihood of injured animals moving into public viewing areas, which would increase the likelihood of conflicts between hunters and other users. In addition, archery hunters generally have a lower success rate, which is less likely to take sufficient animals to reach management goals.)

M.6.2.2 Long Island Unit

- Participating hunters would be required to obtain a refuge hunting permit at the refuge headquarters. At this time a brief orientation will be given. Detailed maps showing roads, hiking trails, and open public use areas would be provided.
- Many people who hunt on Long Island prefer to camp overnight since tides can make travel to and from the island challenging. Camping permits are required during the early archery hunting season. Groups are limited to five people per campsite. Groups are limited to 14 consecutive nights camping on the island.
- There are no firearms permitted on Long Island.

M.6.2.3 South Bay Units

- All hunting regulations will be in accordance with WDFW state regulations.
- All public spaces will be closed to hunting including trails, quarters, and headquarters areas.

M.6.2.4. East Hills Units

- Hunting methods include modern firearms or archery.

- All hunting regulations will be in accordance with WDFW state regulations.
- All public spaces will be closed to hunting including trails, quarters, and headquarters areas.

M.6.3 Administrative Conflicts

At this time, no administrative conflicts are anticipated. The Refuge currently has successful big game hunting program.

M.7 Conduct of the Big Game Hunt

M.7.1 Refuge-specific Big Game Hunting Regulations

Willapa National Wildlife Refuge (50 C.F.R. Part 32.67)

A. Migratory Game Bird Hunting. We allow hunting of geese, ducks, coots, and snipe on designated areas of Riekkola, Lewis, Tarlatt Slough, and Leadbetter units in accordance with State hunting regulations and subject to the following conditions:

1. Prior to entering the hunt area at the Riekkola and Tarlatt Slough units, we require you to obtain a refuge permit, pay a recreation user fee, and obtain a blind assignment.

2. At the Riekkola and Tarlatt Slough units, you may take ducks and coots only coincidental to hunting geese.

3. We allow hunting on Wednesday and Saturday in the Riekkola and Tarlatt Slough units only from established blinds.

4. At the Lewis Unit, we prohibit hunting from the outer dike that separates the bay from the freshwater wetlands.

5. At the Riekkola and Tarlatt Slough Units, you may possess no more than 25 approved nontoxic shells per day while in the field.

6. At the Leadbetter Unit, you may possess only approved nontoxic shot.

7. You may not shoot or discharge any firearm from, across, or along a public highway, designated route of travel, road, road shoulder, road embankment, or designated parking area.

B. Upland Game Hunting. We allow hunting of blue and ruffed grouse on Long Island, subject to the following conditions:

1. We require you to obtain and carry a refuge permit and report game taken, as specified with the permit.

2. We allow only archery hunting.

3. We do not allow firearms on Long Island at any time.

4. We do not allow dogs on Long Island.

5. Condition A7 applies.

C. *Big Game Hunting.* We allow hunting of deer, elk, and bear on Long Island, and deer and elk only on designated areas of the Refuge north of the Bear River and east of Willapa Bay, in accordance with state regulations subject to the following conditions:

1. At Long Island you must possess a valid refuge permit and report game taken, as specified with the permit.

2. At Long Island we allow only archery hunting and prohibit firearms.

3. We prohibit bear hunting on any portion of the Refuge except Long Island.

4. We prohibit dogs on the refuge

5. You may not shoot or discharge any firearm from, across, or along a public highway, designated route of travel, road, road shoulder, road embankment, or designated parking area.

We allow hunting of waterfowl, coot, snipe, deer, elk, bear, and grouse (ruffed and blue) on specific designated units of the Refuge in accordance with state regulations subject to the following conditions:

- Law enforcement patrols to ensure compliance with regulations will be conducted. State Fish and Wildlife Officers also patrol the Refuge.
- Harvest and season lengths are established by the State of Washington.
- Hunters would be expected to comply with all current applicable State and Refuge regulations. This will be achieved through a combination of printed information, signage, outreach efforts, and enforcement of regulations by state and refuge law enforcement officers.
- Refuge staff and WDFW staff will consult on issues regarding law enforcement and any significant changes in the number or behavior of wildlife.
- Refuge regulations will be in accordance with state regulations.
- An Endangered Species Act Section 7 Consultation must be completed with a finding of either “No Effect” or a finding of “May Effect, Not Likely to Adversely Effect.
- Camping, overnight use, and fires are prohibited except in the designated campsites on Long Island.
- Additional help would be allowed to retrieve a downed elk.

<u>Leadbetter Point Unit</u>. The proposed elk hunt would be conducted using these guidelines:

- Refuge staff would, in advance, post signs and notify the public via media regarding the closure to all other activities on the unit during the elk hunt(s).

- Hunting would be limited to the state early muzzleloader elk season and the special elk hunt.
- All hunters participating in the elk hunt would be required to obtain a refuge permit from refuge headquarters and receive a brief orientation of boundaries and refuge regulations.
- Hunters would be required to park at the existing parking lot and would be required to walk into the unit; no motorized vehicles are allowed to assist.
- Only the use of muzzleloader firearms permitted.
- Hunters would be required to return their refuge hunt permit at the end of the day, reporting any success/failure and any hit-but-not-retrieved animals.

<u>Long Island Unit</u> hunting is conducted using set guidelines:

- Hunters must obtain a refuge hunt permit by visiting the refuge headquarters.
- Campers must register their campsite during the early hunt season at the parking lot kiosk prior to travelling to the island.
- Camping, overnight use, and fires are prohibited except in the designated campsites on Long Island.
- Camping is on a first-come, first-served basis.
- Use of archery equipment only.
- Elk/deer/bear/grouse hunters must report success/failure and any hit-but-not-retrieved animals when they turn in their refuge permit tag each trip.

<u>East Hills Units</u> (from the Bear River to Teal Slough) is conducted using set guidelines:

- Will be set by WDFW and will reflect the adjacent areas open to elk and deer hunting.
- Areas closed to hunter access include the current refuge headquarters and quarters area.

<u>South Bay Units</u> (Tarlatt, Riekkola, Porter Point, Lewis, Bear River, Teal Slough):

- Once estuarine restoration is completed, hunting of waterfowl, coot, and snipe in accordance with the state regulations would be expanded to include approximately 6,058 acres in South Bay.
- The upland portions would be opened to the public for elk/deer hunting.
- Areas closed include the proposed site of the new refuge headquarters and wildlife observation trail/overlook area.

M.7.2 Anticipated Public Reaction to the Hunting Program

Public reaction to hunting is expected to be mixed. There is a consistent desire among certain segments of the public to open more federally managed property, including the Refuge, to hunting. There are very few places in the State of Washington where elk hunters are encouraged in specified areas to take cows and small bulls. Limited hunting opportunities on the peninsula and in other areas should make the expansion of the hunt areas highly desirable among hunters, as hunters would not be crowded and should have an excellent chance at a successful hunt.

Other members of the public are expected to object to the hunting program on the grounds that a Refuge should be “a safe haven” for wildlife with no hunting permitted. One argument often made is to relocate the deer and elk. The WDFW has stated that they no longer conduct relocations for elk or deer. Across the State of Washington, elk are increasingly causing damage to private and commercial property including orchards and landscaping. In addition, elk relocation in the past has proven to be a very expensive option to implement annually and is not considered a feasible long-term solution to the problem; the Refuge is limited on how to manage the growing elk population. The bear population is not a problematic on Long Island. The population can withstand the small number of bear harvested annually due to the archery-only hunt and remain healthy. The impact of the archery hunt on the existing population should continue to remain small. Disease and parasites are not an obvious problem with the bear population on Long Island.

Some members of the public may object because they enjoy viewing and photographing the waterfowl, elk, deer, and bear. The hunters would be on the Refuge for a very limited time, and the waterfowl, elk, deer, and bear would be available to photograph in many other areas of the Refuge and throughout the year.

There may be some opposition to elk hunting on the Refuge by area cranberry growers as they may have concerns that the pursued elk may relocate to and impact their cranberry bogs.

M.7.3 Hunter Application and Registration Procedures

Hunters would apply through the WDFW state application processes and in addition obtain a refuge hunting permit from the refuge headquarters.

M.7.4 Description of Hunter Selection Process

The Refuge will be open to those with valid Washington State hunting license. If a special permit hunt is necessary, all permits will be issued according to WDFW regulations and application process.

M.7.5 Media Selection for Announcing and Publicizing Big Game Hunting

The hunting regulations specific to the Willapa Refuge will be published in the Washington State Big Game and Migratory Waterfowl & Upland Game pamphlets. Press releases would be issued by the Refuge to local newspapers including *The Daily News* in Longview, the *Wahkiakum Eagle*, the *Pacific County Press*, the *Daily Astorian*, and the *Chinook Observer* in Long Beach. The refuge website would be posted and updated with current hunting information.

M.7.6 Description of Hunter Orientation, Including Pre-hunt Scouting

Hunters will be required to obtain a refuge permit from the Refuge headquarters office. At this time a pre-hunt orientation of the Refuge will be given. The orientation will include:

- A review of refuge-specific regulations.
- Description of check-in and check-out procedures.
- Handout containing maps and/or aerial photographs of Refuge.
- Description of the access areas and location on the maps.

- A review of maps/aerial photographs of the Refuge to familiarize hunters with potential safety issues.
- Description of the current numbers and general location of the elk herd.
- Review areas (using maps/aerial photos) that have wildlife concentrations or sensitive wildlife. Request hunters avoid those areas has much as possible.
- Hunters will be able to scout the Refuge after receiving their maps/aerial photos prior to actual hunt days.

M.7.7 Requirements for Hunting

M.7.7.1 Age
Age restrictions will be in accord with WDFW regulations.

M.7.7.2 Allowable Equipment
- Hunters will only be allowed to use muzzleloaders for the Leadbetter Point and South Bay hunt units. Archery only hunting is allowed on Long Island. Hunting in the East Hills Units is in accordance with the State regulations.
- Weapons must comply with all Washington State weapon restrictions.
- Dogs, other than certified assistance dogs, are prohibited on the Refuge except while hunting waterfowl.
- Vehicles must remain on county or state roads or in the parking lot at all times.
- No motorized vehicles are permitted on the Refuge.
- All hunters are required to use only federally approved nontoxic shot while waterfowl hunting. Use or possession of lead shot is prohibited while hunting waterfowl.
- Hunters may set up temporary blinds along the shoreline, which must be removed at the conclusion of each hunting period.
- Access to the waterfowl hunting areas will be by boat and/or foot access only.

M.7.7.3 Use of Open Fires
All open fires are prohibited.

M.7.7.4 License and Permits
All hunters will need a valid Washington State hunting license. All deer/elk/bear/grouse hunters on Long Island and elk hunters on Leadbetter Unit will also need a refuge hunting permit. Currently, all waterfowl hunters at Porter Point and Riekkola units must have a refuge permit. Once the South Bay restoration is complete, no refuge permit will be needed for waterfowl.

M.7.7.5 Reporting Harvest
Hunters must report hunting success, failure, or any injured but not retrieved elk to refuge headquarters at the end of each day. Hunters must fulfill all WDFW reporting requirements.

M.7.7.6 Hunter Training and Safety
Hunters must fulfill all state requirements for training and hunter safety classes.

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Appendix O. Bear River Estuary Restoration Plan and Draft Biological Evaluation

BEAR RIVER ESTUARY RESTORATION PLAN and DRAFT BIOLOGICAL EVALUATION

Report

Prepared for:

Willapa Bay Regional Fisheries Enhancement Group

August 2, 2010

www.cherrycrk.com

Bear River Estuary Restoration
Draft Biological Evaluation

REPORT

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BEAR RIVER ESTUARY RESTORATION
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EXECUTIVE SUMMARY

The Willapa Bay Regional Fisheries Enhancement Group is applying for a permit from the U.S. Army Corps of Engineers (Corps) to restore 760 acres of intertidal area and obtaining the Corps permit will require compliance with the Endangered Species Act. The restoration will occur by removing about 5.74 miles of existing dike, 38 culverts, 2 fish ladders, 2 tide gates, and 2 foot bridges, and reconnect 18 estuary channels at the southern end of Willapa Bay, just west of the mouth of the Bear River. Increases in noise levels and increases in turbidity during construction have the potential to impact species listed under ESA, but best management practices would be used to reduce these impacts. Therefore, this biological evaluation reaches the following conclusions:

- may affect, not likely to adversely affect North American green sturgeon (*Acipenser medirostris*) or its designated critical habitat;
- may affect, not likely to adversely affect bull trout (*Salvelinus confluentus*) or its designated critical habitat;
- may affect, not likely to adversely affect marbled murrelets (*Brachyramphus marmoratus marmoratus*) or its designated critical habitat; and
- will have no effect on Western snowy plover (*Charadrius alexandrinus nivosus*).

1.0 INTRODUCTION

The Willapa Bay Regional Fisheries Enhancement Group (WBRFEG) is applying for a permit from the U.S. Army Corps of Engineers (Corps) to restore 760 acres of intertidal area. The restoration will occur by removing about 5.74 miles of existing dike, 38 culverts, 2 fish ladders, 2 tide gates, and 2 foot bridges, and reconnect 18 estuary channels at the southern end of Willapa Bay, just west of the mouth of the Bear River. Because this work requires a Section 10 permit from the Corps, it qualifies as an action by a federal agency, and must comply with Section 7 of the Endangered Species Act (ESA). Section 7 of the ESA requires that "actions" of federal agencies should be "not likely to jeopardize the continued existence of any [listed] species or result in the destruction or adverse modification of habitat of such species." Issuance of permits by federal agencies is considered an "action" and therefore falls under this requirement. Under ESA Section 7(c), the Corps is required to produce a biological evaluation (BE) of the potential influence of its action (issuing the permit) on listed species or their critical habitat. To help the Corps evaluate the potential effects of the proposed project on listed species, Cherry Creek Environmental (CCE), has prepared this BE on behave of WBRFEG.

To determine if listed species or their critical habitat are present in the vicinity of the proposed project, on June 28, 2010 CCE consulted the National Oceanic and Atmospheric Administration, National Marine Fisheries Service (NMFS 2010); and the U.S. Fish and Wildlife Service (USFWS 2010). Based on information from NMFS and USFWS (Appendix A), the following listed species may occur in the vicinity of the proposed project and are therefore addressed in this BE:

- North American green sturgeon (*Acipenser medirostris*);
- Bull trout (*Salvelinus confluentus*);
- Marbled murrelet (*Brachyramphus marmoratus marmoratus*); and
- Western snowy plover (*Charadrius alexandrinus nivosus*).

Streaked horned lark (*Eremophila alpestris strigata*), a candidate species, will also be addressed. Should the lark become listed during the life of the proposed project, this BE could be used to aid the Corps during any subsequent Section 7 consultation with USFWS.

Based on information from NMFS and USFWS (Appendix A), the following listed species may occur in Pacific County. Because the following species are found on the outer coast or their habitat requirements do not exist in the vicinity of the proposed project, they are not addressed in the BE:

- Columbia River smelt (*Thaleichthys pacificus*);
- southern resident killer whale (*Orcinus orca*)
- humpback whale (*Megaptera novaeangliae*)
- blue whale (*Balaenoptera musculus*)
- fin whale (*Balaenoptera physalus*)
- sei whale (*Balaenoptera borealis*)
- sperm whale (*Physeter macrocephalus*)
- Steller sea lion (*Eumetopias jubatus*);
- leatherback sea turtle *(Dermochelys coriacea)*
- green sea turtle (*Chelonia mydas)*
- olive ridley sea turtle (*Lepidochelys olivacea)*
- loggerhead sea turtle *(Caretta caretta)*
- brown pelican (*Pelecanus occidentalis*)
- northern spotted owl (*Strix occidentalis caurina*);
- Oregon silverspot butterfly (*Speyeria zerene hippolyta*); and
- short-tailed albatross (*Phoebastria albatrus*)

2.0 PROJECT DESCRIPTION

This section provides a brief description of the proposed project area and proposed action.

2.1 Project and Action Areas

The "project area" is within the Willapa National Wildlife Refuge (Refuge) in Pacific County, Washington at Township 10 North, Range 11 West, Sections 1, 6, 7, 11, and 12 and Township 10N, Range 10W, Section 6. The project area is within the Lewis, Porter Point, and Riekkola Units in the Refuge at the southern end of Willapa Bay, just west of the mouth of Bear River. Aerial photographs of the project area and design sheets are in Appendix B.

The "action area" for fish resources is defined as extending from mean higher high water out to the minus 30 feet mean lower low water (MLLW) depth contour, which is the elevation where open water channel depths begin (WNWR 2010). The action area for avian species is defined as a 1-mile radius around the project area.

2.2 Proposed Action Description

Historically, the project site was tidally connected to Willapa Bay. During the late 1940's and early 1950's a large portion of area's salt marsh habitat was eliminated by diking to create pasture lands and freshwater wetlands, believed to enhance overall waterfowl use of the refuge and increase land available for agricultural production. The dike was constructed by excavating a borrow ditch along the shoreward side of the dike. The dike has substantially reduced the amount of historical shoreline habitat and serves as a barrier, reducing nutrient input to the estuary and interrupting the physical, chemical and biological processes of the estuarine system. The conversion of estuarine wetlands to freshwater wetlands and pasture by diking has removed important natural habitat for waterfowl, waterbirds, shorebirds, and salmon as well as many other estuarine-dependent species. Construction of the dike also eliminated fish access to 3 small streams; Lewis Stream, Porter Point Stream and Dolman Creek to the estuary. In 2001, fish ladders were installed into the dikes to restore some fish passage to these creeks.

The proposed project would remove 5.74 miles of existing dike, 38 culverts, 2 fish ladders, 2 tide gates, and 2 foot bridges, and reconnect 18 estuary channels; resulting in up to 760 acres of restored estuarine habitat. Construction details are depicted in Appendix B. The resorted habitat includes reconnection of stream channels to the estuarine environment, open water, intertidal flats, and saltmarsh. The proposed project would provide unrestricted tidal exchange and channels currently isolated landward of the dike will be reconnected to the estuary. The proposed project will assist in improving and maximizing the current estuarine system and contribute to the health of the bay and associated habitats. In addition, the proposed project would reduce or eliminate the extent of a highly invasive exotic plant, reed canarygrass, which currently infests the refuge's freshwater impoundments. Similarly, tussock infestation will also be reduced. Other exotic species, including nutria and bullfrogs, which currently use the freshwater ponds landward of the dike will be eliminated by restoration of estuarine habitat. Juvenile salmon habitat will be restored and other expected benefits include increased waterfowl, waterbird, and shorebird use. Finally, protection and restoration of native estuarine and nearshore habitats is a major ecoregional and recovery goal in the Pacific Northwest Coast Ecoregional Assessment (TNC and WDFW 2006) and the Northern Pacific Coast Regional Shorebird Management Plan (Drut and Buchanan 2000).

2.2.1 Proposed Construction

The project would be accomplished by removal of dikes, culverts, fish ladders, and tide gates within the Lewis, Porter Point and Riekkola Units in the Refuge. Dikes will be removed completely to grade and material will be removed or used to fill in the associated borrow ditch. Approximately 114,812 cubic yards of fill from the dike will be placed back into the borrow ditch. Fish ladders and tide gates would be demolished and taken off-site for disposal and/or recycling. Heavy equipment utilized will include excavators, bulldozers, scrapers, and agricultural tractors. A detailed narrative of construction techniques and sequencing is in Appendix C. In summary, the first phase of construction would remove a portion of the dike fill, which will create a wider area for construction traffic than driving on the existing top of the dike. Construction would begin at the southern side of the project area, in the Lewis Unit and work northward/westward. In addition to removing the dike, the fish ladders and tide gates will be demolished. The demolished fish ladders and tide gates will be disposed of off-site at an approved location or recycled. Channels will be excavated as close as possible to their historic locations and have been sized so that tidal processes would accelerate the establishment of natural topography and vegetation.

Throughout the project, dewatering will need to occur. Dewatering techniques will be up to the contractor, but the recommended method (Appendix B) will be to create temporary culverts with tide gates. These would be placed in the constructed channels to allow construction traffic access during removal of the dikes and filling of the borrow ditch. This dewatering option would place the culvert and tide gate in the new channel location, Installation of riprap armoring may be necessary during construction, but would be removed when the temporary culvert and tide gate is removed.. As construction within weach unit is completed, these temporary culverts and tide gates would be removed and the channel enlarged to the required design. The advantage to this approach is that it is a passive and automatic approach that maintains the separation between the landward and waterward sides of the dike system.

2.2.2 Project Timeline

The proposed project would be constructed in phases, with each phase occurring during the in-water work window. Since there are three phase, the overall construction period is anticipated to last 3 years. Assuming all permits are received, the project would begin during the in-water work window of 2011. As stated above, work would begin at the southern end of the project area in the Lewis Unit. Removal of the dike and one of the fish ladders within the Lewis Unit would be finished by the end of the 2011 in-water work window. Construction would then stop until the beginning of the 2012 in-water work window. The cross-dike, located between the Lewis and Porter units would remain in place to serve as a sea dike until the 2012 in-water construction season. During 2012, work within the Porter Unit is expected to occur. That is, dike removal work would begin where it was left off during the 2011 construction season and second fish ladder would be removed with construction continuing to work northward/westward. Removal of the dike and one of the fish ladders within the Porter Unit would be finished by the end of the 201in-water work window. Construction would then stop until the beginning of the 2012 in-water work window. During 2013, work within the Riekkola Unit is expected to occur. That is, dike removal work would begin where it was left off during the 2012 construction season and the proposed project would be completed by 2013.

Prior to leaving the site at the end of each in-water work window, the active construction area would be stabilized to reduce erosion.

2.2.3 Conservation Measures

To avoid impacts to aquatic species, construction would occur during the in-water work window and occur in the dry as much as possible. Although work would occur below the ordinary high water mark, material would not likely be placed when tidal waters have inundated the project area. Additionally, WBRFEG proposes to monitor water quality and dike erosion during and following the first construction season. This information would be used in adaptive management for subsequent phases of construction (AMEC 2010).

Vehicles used in the project area will be routinely inspected for petroleum product or hydraulic fluid leaks, and defective equipment will be serviced before being allowed back into the project area.

3.0 EXISTING ENVIRONMENTAL CONDITIONS AND EFFECTS OF THE ACTION

Presented below are discussions of existing environmental conditions and temporary, permanent, direct, indirect, and net effects of project activities. This section addresses only environmental attributes and habitat qualities important to listed species that may be present in the action area and likely to be affected by the project in some way.

3.1 General

This section describes existing general environmental conditions and effects of the proposed action on the general environmental conditions of the action area.

3.1.1 Existing Conditions

The Bear River Estuary, located in Willapa Bay, is part of the Willapa National Wildlife Refuge. Willapa Bay is the second largest estuary on the Pacific Coast and is one of the most pristine estuaries in the United States. The refuge is over 15,000 acres of tidelands, temperate rainforest, ocean beaches and small streams. Within the project area the site can be divided into three areas; the Lewis Unit, the Porter's Point Unit, and the Riekkola Unit.

Freshwater impoundments were created behind the dike in the Lewis and Porter's Point units and their water levels are managed to provide freshwater foraging areas for migrating waterfowl, mostly ducks (USFWS 2010). Small seasonal freshwater wetlands are also maintained in the Riekkola Unit. Use of the freshwater impoundments by waterbirds other than waterfowl, include grebes, herons, bitterns, and rails. These shallow, vegetated wetlands provide breeding habitat for red-legged frogs, Pacific tree frogs, roughskin newts and northwestern salamanders. River otters and non-native nutria also use the freshwater impoundments.

Three small streams; Lewis Stream, Porter Point Stream and Dolman Creek flow from the foothills south of the project area to the estuary. However their historic connection was cut off and altered by the dike. To improve fish passage to these streams, fish ladders were installed in 2001. Although the fish ladders have improved fish passage, the conversion of estuarine wetlands to freshwater wetlands and pasture by diking has removed important natural transition habitat from freshwater streams and wetlands to estuaries.

The intertidal portion of the project area is dominated by mudflats and salt marsh. The mudflats consist of fine sediment combined with organic matter. Intertidal mudflats support an abundance of prey invertebrates including oysters, clams, mussels, amphipods, polychaete and oligochaete worms, insect larvae and nematodes. Foraging shorebirds follow the receding tide across the mudflats and fish and waterbirds frequent the mudflats when they are flooded to forage and find refuge (WNWR 2010).

The upper edges of the intertidal flats are ringed by salt tolerant plants which serve as sediment traps and add much organic matter to the estuarine system. Juvenile salmon and other fish find an abundance of food in the marshes, as well as shelter from strong currents and predators. Bald eagles, great blue herons, and other predators are attracted to the abundance of life. The productivity of the marshes is critical to the health of the estuary (WNWR 2010). It is estimated that Willapa Bay originally contained approximately 14,620 acres of saltwater wetlands, but only 5,277 acres remain, a 64% loss of estuarine wetlands (Coastal Resources Alliance 2007 as cited in (WNWR 2010).

No information on ambient noise levels in the Action Area was identified. A WSDOT noise assessment on the San Juan Islands identified a baseline of about 35 dBA, with regular noise intrusions from traffic and aircraft overflights ranging from 45 to 72 dBA (WSDOT 1994). Noise levels from breaking waves has been measured at levels ranging from 55 dBA to 80 dBA (Allan and Komar 2000; Bolin 2009; Tetra Tech 2005). For the purposes of evaluating ambient noise levels within the Project Area, it is assumed that background noise would likely be about 40 dBA.

3.1.2 Effects of the Action

Existing vegetation on the dikes will be permanently removed during the proposed action. Disturbed soils are expected to be colonized quickly by salt tolerant vegetation or converted to intertidal mudflats or stream channels. The streams will be directly reconnected to the estuary through reconstruction of stream channels where the dike was previously. The reconstructed stream channels are designed to provide efficient and unrestricted tidal exchange and effective low tide drainage. This will provide a vast improvement to fish passage in comparison to the existing conditions. Once the dike removal is complete, the proposed project would restore about 760 acres of land to estuarine open water, salt marsh, and intertidal flats.

A variety of construction equipment will likely be used in the project area, depending on the activity that is occurring. Based on average maximum noise levels of different construction equipment, noise levels associated with construction are likely to be around 80 dBA (WSDOT 2010). Based on existing site conditions, an estimated ambient noise level o f40 dBA, and a maximum construction noise level of 80 dBA, construction noise would attenuate to ambient levels at a distance of 15,811 feet. The increased noise level would be temporary and only occur during active construction). Terrestrial animals not used to the increased noise may avoid the immediate work area. Since the construction is occurring in the dry there will be no appreciable increases in underwater noise.

3.2 Water Quality

This section describes existing conditions and expected effects of the proposed action related to water quality in the action area.

3.2.1 Existing Conditions

No information on existing water quality in the action areas was identified. Dissolved oxygen and high temperatures have been determined to be limiting factors affecting the aquatic habitat and fish in the Willapa system (Ecology 2008a), although the action area is not on Ecology's 303d list for these or any other parameters (Ecology 2008b).

3.2.2 Effects of the Action

During active construction and shortly afterward, temporary increases in turbidity are likely to occur. Construction techniques (e.g. dewatering) would be implemented to reduce increases in turbidity. The increases in turbidity are not expected to persist long after construction. Construction activities are not expected to alter dissolved oxygen or temperature conditions in the Action Area. To ensure construction does not significantly impact water quality during construction, temperature, turbidity, and fecal coliform levels would likely be monitored as part of the Hydraulic Project Approval permit.

3.3 Sediment, Substrate, and Bathymetry

This section describes existing conditions and expected effects of the proposed action related to sediment, substrates, and bathymetry in the action area.

3.3.1 Existing Conditions

The dike was constructed mostly with site soils and some imported fill material. Landward of the dike, the substrate is likely fine grained with a high organic content because the area is cut off from tidal exchange and high flows, and is routinely planted with aquatic vegetation. Waterward of the dike, the area is tidal saltmarsh and mudflat. Since the project area was diked and drained, the surface has subsided by approximately 1-3 ft below the natural marsh elevation of mean higher high water (9 ft NAVD) (Vandever 2010).

3.3.1 Effects of the Action

The proposed project will remove the dike, changing surface elevations along the dike from upland to intertidal. Sediment transport will be restored to conditions similar to what existed prior to the construction of the dike. With the removal of the dike and reconnection of the stream channels, bathymetry will be restored to historic or near historic conditions. Removal of the dike will allow tidal exchange to be restored. It is anticipated that the removal of the dike and restoration of tidal exchange, over time, may return the salt marsh surface elevation to the natural elevations of the salt mash outside of the action area.

3.4 Access and Refugia

This section describes existing conditions and expected effects of the proposed action related to refugia and access in the action area.

3.4.1 Existing Conditions

The conversion of estuarine wetlands to freshwater wetlands and pasture following construction of the dikes has eliminated refuge habitat for waterfowl, waterbirds, shorebirds, and estuarine fish (e.g. juvenile salmon, juvenile flatfish, crabs). Three small streams, Lewis Stream, Porter Point Stream and Dolman Creek no longer had a direct connection to the estuary. In 2001, WBRFEG and the Refuge received grants funding to install the two fish ladders in the dikes. Installation of the fish ladders allowed salmonids to access and refuge habitat in the freshwater ponds landward of the dike, but their movements are still restricted from their historical spawning and rearing areas.

3.4.2 Effects of the Action

During construction the temporary culverts would allow access to the freshwater ponds and streams while the fish ladders are removed. Once the dike removal is complete, the proposed project would restore about 760 acres of land to estuarine open water, salt marsh, and intertidal flats available for access and refuge for fish and wildlife.

3.5 Slope, Shoreline Condition, and Habitat Diversity

This section describes existing conditions and expected effects of the proposed action related to habitat diversity, slopes, and shoreline conditions in the action area.

3.5.1 Existing Conditions

Construction of the dikes converted about 760 acres of land from estuarine open water, salt marsh, and intertidal flats to freshwater ponds, freshwater wetlands, and pasture. The conversion from estuarine habitats to freshwater/upland habitats reduced habitat diversity. Landward of the dikes, the site is currently infested with invasive plant species such as reed canarygrass and tussock and animal species such as nutria and bullfrogs. Waterward of the dike, beyond the dike footprint, the action area is relatively flat and consists of salt marsh, mudflats, and open water.

3.5.2 Effects of the Action

Removal of the dike will restore about 760 acres of land to estuarine open water, salt marsh, and intertidal flats, restore the unrestricted tidal exchange to the three small creeks, and reduce or eliminate non-salt tolerant invasive plants, such as reed canarygrass and tussock and animals, like bullfrogs and nutria within the action area. The proposed project does not include planting the area with native salt marsh vegetation. The Refuge has an existing spartina elimination program and will monitor the site for spartina infestation and eradicate any infestation.

3.6 Flow, Current Patterns, Saltwater–Freshwater Mixing

This section describes existing conditions and expected effects of the proposed action related to flow, current patterns, saltwater–freshwater mixing in the action area.

3.6.1 Existing Conditions

Construction of the dikes and installation of the tide gates altered and reduced the saltwater-freshwater mixing zone and altered current patterns. Currently, saltwater-freshwater mixing s limited within the project area to the areas waterward of the dikes.

3.6.2 Effects of the Action

The proposed project will result in the unrestricted tidal exchange within the project area currently isolated behind the dikes. The proposed project would assist in restoring the estuarine system, including historic current patterns and saltwater-freshwater mixing zones.

3.7 Vegetation

This section describes existing conditions relevant to vegetation and expected effects of the proposed action.

3.7.1 Existing Conditions

Two vegetation communities are dominant in the action area; freshwater wetlands and salt marsh. Freshwater wetland plants include bulrush, cattail, sedges, spikerush, bur-reed, beggarticks, juncus, smartweed, mannagrass, water pennywort, several species of pondweed and duckweed. Native emergent and submerged aquatic plants are present as are non-native invasive species including reed canarygrass, tussock and bog loosestrife.

Salt marsh vegetation include pickleweed, seashore salt grass, jaumea, alkali grass, sea arrow grass, sand-spurry, seaside plantain, and salt marsh wort. Tufted hairgrass, Pacific silverweed, salt marsh bulrush and Lyngbye's sedge are found in higher elevations within the salt marsh, in areas that are occasionally covered by tidal water.

3.7.2 Effects of the Action

The proposed project will eliminate all of the vegetation on the dikes and effectively drain the freshwater impoundments. Areas dominated by non-salt tolerant plant communities will shift to salt tolerant plant communities. The distinction between freshwater wetland and salt mash will no longer be a discrete line (i.e. the dike), but become a natural gradient likely similar to historic conditions. Disturbed soils are expected to revegetate quickly because of the abundant native vegetation in the immediate vicinity will provide a seed source.

3.8 Benthic Epifauna

This section describes existing conditions relevant to benthic epifauna and expected effects of the proposed action in the action area.

3.8.1 Existing Conditions

Currently benthic epifauna are limited to the areas waterward of the dike. Although no studies of species abundance or richness were identified, epibenthic species present within the project area are likely typical of those found in estuarine mudflats.

3.8.2 Effects of the Action

During construction, benthic epifauna living on the dikes will be eliminated during the dike removal process. Benthic epifauna are expected to colonize quickly because of the large area of undisturbed habitat within the action area providing recruitment. Removal of the dike will restore about 760 acres of land to estuarine area and restore the unrestricted tidal exchange to the three small creeks. Benthic epifauna will be able to colonize within areas where it was unable to prior to the dike removal.

3.9 Forage Fish

This section describes existing conditions relevant to forage fish and expected effects of the proposed action in the action area.

3.9.1 Existing Conditions

Forage fish are limited to estuarine areas of the action area (i.e. waterward of the dike) and are those typically found in estuaries.

3.9.2 Effects of the Action

During construction, forage fish would likely avoid the vicinity where active in-water construction is occurring. However, avoidance of the area is temporary and would not persist after construction. Removal of the dike will restore about 760 acres of land to estuarine area and restore the unrestricted tidal exchange to the three small creeks. Forage fish will be able to utilize newly restored estuarine areas within the action area where it was unable to prior to the dike removal.

4.0 EVALUATION OF EFFECTS ON LISTED SPECIES

This section discusses use by listed species of the action area, describes effects on listed species from project activities (Section 2.2), and provides an effect determination. This section discusses only attributes of listed species that are relevant to the project area and likely to be affected by the project. Life histories for the species discussed in this section are presented in Appendix D. Appendix E describes habitat for federally managed commercial fish species, potential project impacts, and proposed conservation measures.

4.1 North American Green Sturgeon

4.1.1 Stock Status and Critical Habitat

There are no good data on current stock sizes or population trends of the North American green sturgeon (NMFS 2009). NMFS has proposed designating critical habitat for the southern DPS green sturgeon in coastal U.S. marine waters within 110 meters (m) depth from Monterey Bay, California (including Monterey Bay), north to Cape Flattery, Washington, including certain coastal bays and estuaries in California, Oregon, and Washington, including Willapa Bay (73 FR 52084).

4.1.2 Use of the Action Area

The North American green sturgeon is present in Willapa Bay (Lindley, et al. 2010), but are not believed to spawn in any mainstem rivers in Willapa Bay (NMFS 2009). Since spawning is not expected to occur in the mainstem rivers of Willapa Bay, use of the bay by green sturgeon is likely limited to foraging and juvenile refuge.

4.1.1 Effects of the Action

During construction, the green sturgeon may avoid the vicinity where elevated turbidity occurs. However, avoidance of the area is temporary and would not persist after active construction. Removal of the dike would restore about 760 acres of land to estuarine area. Green sturgeon will be able to utilize newly restored estuarine areas within the action area.

4.1.2 Effect Determination

Because the proposed project would cause temporary increases in turbidity and restore about 760 acres of estuarine habitat that could be used by green sturgeon for foraging and refuge, this BE concludes that the proposed project may affect, not likely to adversely affect North American green sturgeon or its designated critical habitat.

4.2 *Bull Trout*

4.2.1 Stock Status and Critical Habitat

Willapa Bay does not have a breeding population of bull trout (WDFW 2000). Therefore, any bull trout in Willapa Bay are likely foraging. While bull trout critical habitat has been designated, no critical habitat for bull trout has been designated in Willapa Bay.

4.2.2 Use of the Action Area

Bull trout using Willapa Bay are believed to use the bay for occasional foraging. The nearest confirmed bull trout was caught in the Willapa River, the mouth of which is approximately 22 miles to the north of the action area. The single fish was caught by a Washington State Department of Fish and Wildlife technician near river mile 29, approximately one mile downstream of the Willapa/Forks Creek State Salmon Hatchery.

4.2.3 Effects of the Action

Bull trout are not expected to use the action area because bull trout are not frequent users of Willapa Bay. However, during construction, any bull trout in the area may avoid the vicinity where elevated turbidity occurs. However, avoidance of the area is temporary and would not persist after active construction. Removal of the dike would restore about 760 acres of land to estuarine area. Any bull trout in Willapa Bay would be able to utilize newly restored estuarine areas within the action area.

4.2.4 Effect Determination

Because the proposed project would cause temporary increases in turbidity and restore about 760 acres of estuarine habitat important that could be used by bull trout, this BE concludes that the proposed project may affect, not likely to adversely affect bull trout or its designated critical habitat.

4.3 Marbled Murrelet

4.3.1 Population Status and Critical Habitat

The estimated population size of marbled murrelets in North America is about 950,000 birds (Huff et al. 2006). Most of these birds occur in Alaska (about 860,000) and Canada (about 55,000 to 78,000). Huff et al (2006) conducted at sea surveys to estimate the marbled murrelet population in the Pacific Northwest (Washington, Oregon, and northern California). The population was estimated at about 22,000 birds, indicating only a small fraction of the total population (2 to 3%) uses the coast of the Pacific Northwest. The four year survey was not sufficient to detect population trends (declines or increases) (Huff et al 2006).

Critical habitat has been designated by USFWS, but there is no critical habitat within the action area (Appendix A). The closest WDFW Marbled Murrelet Detection Sections is about 0.5 mile to the south of the action area (WDFW 2010).

4.3.2 Use of the Action Area

No nesting habitat exists within the action area. Since marbled murrelets forage in nearshore waters, they may fly over the action area to reach foraging habitat near the action area

4.3.3 Effects of the Action

During active construction, increases in noise would occur. Behavioral effects from noise during marbled murrelet foraging occur at 70 dBA (WSDOT 2010). Construction noise would attenuate to the behavioral effects threshold of 70 dBA within 500 feet of the active construction area. However, since marbled murrelet use is likely limited to an occasional fly over, as the birds head out to open water to forage or return to their nests effects from construction noise are expected to be negligible.

4.3.4 Effect Determination

Although the proposed project would cause temporary increases in noise during active construction, marbled murrelet use of the action area is likely limited to occasional fly over's as they fly to and from their nesting sites to foraging sites. Thus, this BE concludes that the proposed project may affect, not likely to adversely affect marbled murrelets or its designated critical habitat.

4.4 *Western Snowy Plover*

4.4.1 Population Status and Critical Habitat

In Washington, snowy plovers formerly nested at five coastal locations but only three sites currently are known to be active (Pearson et al. 2009). The average number of breeding pairs over the four years reported in this study was approximately 25 pairs but the population is declining (Pearson et al. 2009). Critical habitat has been designated by USFWS, but there is no critical habitat within the action area (Appendix A).

4.4.2 Use of the Action Area

The Western snowy plover is found within the refuge in the Leadbetter Point Unit located approximately 15 miles away from the action area. The western snowy plover uses sparsely vegetated coastal dunes and beach, since this type of habitat does not exist within the action area, the Western snowy plover is not expected to be found within the action area.

4.4.3 Effects of the Action

During active construction, increases in noise would occur. However, the Western snowy plover is not expected to be within the action area because their preferred habitat (sparsely vegetated coastal dunes) does not exist in the action area.

4.4.4 Effect Determination

Because the Western snowy plover is not expected to be present in the action area, this BE concludes that the proposed project will have no effect on the Western snowy plover or its designated critical habitat.

4.5 *Streaked Horned Lark*

4.5.1 Population Status

Although no systematic range wide attempt has been made to estimate the total population of the streaked horned lark, results from winter and breeding surveys suggest that the entire population of this species is likely less than 1,000 birds (Pearson and Altman 2005).

4.5.2 Use of the Action Area

Results from these U.S. and Canadian surveys indicate that the streaked horned lark currently breeds on beaches and accreted lands near Grays Harbor and Willapa Bays (Pearson and Altman 2005). However, the streaked horned lark is not expected to be within the action area because their preferred habitat, sparsely vegetated coastal dunes, is not present there.

4.5.3 Effects of the Action

During active construction, increases in noise would occur. However, like the Western snowy plover, the streaked horned lark is not expected to be within the action area because their preferred habitat (sparsely vegetated coastal dunes) does not exist there.

4.5.4 Effect Determination

Because the streaked horned lark is not expected to be present in the action area, this BE concludes that the proposed project will not jeopardize the streaked horned lark or its habitat.

Should the streaked horned lark become listed as threatened or endangered under ESA during the construction of the proposed project, this BE would conclude that the proposed project would have no effect on the streaked horned lark or its designated critical habitat.

5.0 INTERRELATED AND INTERDEPENDENT ACTIONS AND CUMULATIVE EFFECTS

Cumulative effects are effects from state agency or private activities that are reasonably certain to occur within the area of the federal action subject to consultation (50 CFR 402.02 Definitions). The future construction of a trail and viewing platform on the 2,000 lineal feet of remaining dike in the Riekkola Unit would be considered a cumulative action. Federal actions unrelated to the proposed action are not considered in this section, because they require separate consultation pursuant to Section 7 of the Endangered Species Act. Interdependent actions are from actions with no independent utility apart from the proposed action. Interrelated actions include those that are part of a larger action and depend on the larger action for justification.

6.0 SUMMARY

The proposed project has the potential to adversely affect listed species or their habitat. Construction could temporarily increase noise and turbidity and possibly causes listed species to avoid the immediate work area, but best management practices would be used to reduce impacts. Therefore, this biological evaluation reaches the following conclusions:

- may affect, not likely to adversely affect North American green sturgeon or their designated critical habitat;
- may affect, not likely to adversely affect bull trout or their designated critical habitat;
- may affect, not likely to adversely affect marbled murrelets or their designated critical habitat; and

- will have no effect on Western snowy plover or their designated critical habitat.

Similarly, the proposed project will not jeopardize the streaked horned lark, a species proposed for listing. Should the streaked horned lark become listed during the proposed project, this BE reaches the conclusion that the proposed project may affect, not likely to adversely affect the streaked horned lark or their critical habitat.

7.0 CULTURAL RESOURCES ASSESSMENT

Section 106 of the National Historic Preservation Act requires any project receiving federal funds or a federal permit to undergo consultation with the "affected" Native American Tribe(s). To assist the WBRFEG with the Section 106 consultation, a cultural resources assessment was conducted. This assessment included a record search of the Washington State Department f Archaeology and Historic Preservation and a review of the ethnographic ad historical literature on Native American and early Euro-American use of the action area. The results of the review and record search are detailed in Appendix F. In summary, the cultural resources assessment identified two previously documented archaeological resources directly adjacent to the Project's Area of Potential Effects (APE). Sites 45PC125 and 45PC126 are pre-contact fish traps located within the mudflats adjacent to the Bear River channel. Radiocarbon (C-14) dates on the wooden stakes from 45PC126 dated the site to 1,000 Before Present (or approximately 1000 AD). It is anticipated other unknown fish weirs are located within the Bear River watershed due to the limited survey area covered during the original project which documented them.

There are no previously documented Traditional Cultural Properties (TCPs) identified within and/or directly adjacent to the APE. Ethnographic research does identify at least one place name associated with a former village (*nu?x*^{w}*as?nł* - "blackberry town") that was once located near the confluence of Bear River and Willapa Bay. The exact village location is unknown, but it may be closely associated with the previously documented fish traps in the area.

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Appendix A—
ESA listed Species

Endangered Species Act Status of West Coast Salmon & Steelhead

(Updated July 1, 2009)

Species[1]			*Current Endangered Species Act Listing Status*[2]	*ESA Listing Actions Under Review*
Sockeye Salmon (*Oncorhynchus nerka*)	1	Snake River	*Endangered*	
	2	Ozette Lake	*Threatened*	
	3	Baker River	*Not Warranted*	
	4	Okanogan River	*Not Warranted*	
	5	Lake Wenatchee	*Not Warranted*	
	6	Quinalt Lake	*Not Warranted*	
	7	Lake Pleasant	*Not Warranted*	
Chinook Salmon (*O. tshawytscha*)	8	Sacramento River Winter-run	*Endangered*	
	9	Upper Columbia River Spring-run	*Endangered*	
	10	Snake River Spring/Summer-run	*Threatened*	
	11	Snake River Fall-run	*Threatened*	
	12	Puget Sound	*Threatened*	
	13	Lower Columbia River	*Threatened*	
	14	Upper Willamette River	*Threatened*	
	15	Central Valley Spring-run	*Threatened*	
	16	California Coastal	*Threatened*	
	17	Central Valley Fall and Late Fall-run	*Species of Concern*	
	18	Upper Klamath-Trinity Rivers	*Not Warranted*	
	19	Oregon Coast	*Not Warranted*	
	20	Washington Coast	*Not Warranted*	
	21	Middle Columbia River spring-run	*Not Warranted*	
	22	Upper Columbia River summer/fall-run	*Not Warranted*	
	23	Southern Oregon and Northern California Coast	*Not Warranted*	
	24	Deschutes River summer/fall-run	*Not Warranted*	
Coho Salmon (*O. kisutch*)	25	Central California Coast	*Endangered*	
	26	Southern Oregon/Northern California	*Threatened*	
	27	Lower Columbia River	*Threatened*	• Critical habitat
	28	Oregon Coast	*Threatened*	
	29	Southwest Washington	*Undetermined*	
	30	Puget Sound/Strait of Georgia	*Species of Concern*	
	31	Olympic Peninsula	*Not Warranted*	
Chum Salmon (*O. keta*)	32	Hood Canal Summer-run	*Threatened*	
	33	Columbia River	*Threatened*	
	34	Puget Sound/Strait of Georgia	*Not Warranted*	
	35	Pacific Coast	*Not Warranted*	
Steelhead (*O. mykiss*)	36	Southern California	*Endangered*	
	37	Upper Columbia River	*Threatened*	
	38	Central California Coast	*Threatened*	
	39	South Central California Coast	*Threatened*	
	40	Snake River Basin	*Threatened*	
	41	Lower Columbia River	*Threatened*	
	42	California Central Valley	*Threatened*	
	43	Upper Willamette River	*Threatened*	
	44	Middle Columbia River	*Threatened*	
	45	Northern California	*Threatened*	
	46	Oregon Coast	*Species of Concern*	
	47	Southwest Washington	*Not Warranted*	
	48	Olympic Peninsula	*Not Warranted*	
	49	Puget Sound	*Threatened*	• Critical habitat
	50	Klamath Mountains Province	*Not Warranted*	
Pink Salmon (*O. gorbuscha*)	51	Even-year	*Not Warranted*	
	52	Odd-year	*Not Warranted*	

1 The ESA defines a "species" to include any distinct population segment of any species of vertebrate fish or wildlife. For Pacific salmon, NOAA Fisheries Service considers an evolutionarily significant unit, or "ESU," a "species" under the ESA. For Pacific steelhead, NOAA Fisheries Service has delineated distinct population segments (DPSs) for consideration as "species" under the ESA.

Page Title: ESA Other List
URL: http://www.nwr.noaa.gov/Other-Marine-Species/ESA-Other-List.cfm

Other ESA-Listed Species

Under the jurisdiction of NOAA Fisheries that may occur off Washington & Oregon:

- distinct population segment, or DPS, of bocaccio *(Sebastes paucispinis)* (E) in Puget Sound
- distinct population segment, or DPS, of canary rockfish *(Sebastes pinniger)* (T) in Puget Sound
- distinct population segment, or DPS, of yelloweye rockfish *(Sebastes ruberrimus)* (T) in Puget Sound
- southern distinct population segment, or DPS, of eulachon (Columbia River smelt) *(Thaleichthys pacificus)* (T)
- southern distinct population segment, or DPS, of north American green sturgeon (*Acipenser medirostris*) (T), listed in the NOAA Fisheries Southwest Region

(E) = Endangered
(T) = Threatened

Page last updated: 2010-06-15 10:22:36

Page Title: ESA MM List
URL: http://www.nwr.noaa.gov/Marine-Mammals/ESA-MM-List.cfm

ESA-Listed Marine Mammals

Under the jurisdiction of NOAA Fisheries that may occur:

off Washington & Oregon

- Southern Resident killer whale (*Orcinus orca*) (E); critical habitat
- humpback whale *(Megaptera novaeangliae)* (E)
- blue whale *(Balaenoptera musculus)* (E)
- fin whale (*Balaenoptera physalus)* (E)
- sei whale (*Balaenoptera borealis)* (E)
- sperm whale (*Physeter macrocephalus)* (E)
- Steller sea lion *(Eumetopias jubatus)* (T); critical habitat

in Puget Sound

- Southern Resident killer whale *(Orcinus orca*) (E); critical habitat
- humpback whale *(Megaptera novaeangliae)* (E)
- Steller sea lion *(Eumetopias jubatus)* (T); critical habitat

(E) = Endangered
(T) = Threatened

Page last updated: 2010-06-15 11:08:13

Page Title: ESA Turtle List
URL: http://www.nwr.noaa.gov/Other-Marine-Species/ESA-Turtle-List.cfm

ESA-Listed Marine Turtles

Under the jurisdiction of NOAA Fisheries that may occur off Washington & Oregon:

- leatherback sea turtle *(Dermochelys coriacea)* (E)
- green sea turtle (*Chelonia mydas)* (E)
- olive ridley sea turtle (*Lepidochelys olivacea)* (E)
- loggerhead sea turtle *(Caretta caretta)* (T)

Sightings and strandings of these animals are very rare, and there are no breeding beaches in the Northwest Region.

(E) = Endangered
(T) = Threatened

Feb. 19, 2010: NOAA Fisheries extended the comment period on the proposed revision to existing critical habitat for the leatherback turtle under the Endangered Species Act. See the *Federal Register* notice *(PDF 49KB)* for details.

Jan. 5, 2010: NOAA Fisheries proposed to revise and expand critical habitat for the leatherback turtle under the Endangered Species Act. Additional information about this proposal can be found in the links below and on NOAA Fisheries' Office of Protected Resources Website.

- News Release *(PDF 73KB -- links to NOAA Fisheries Website)*
- *Federal Register* notice *(PDF 711KB)*

Page last updated: 2010-06-17 23:03:52

LISTED AND PROPOSED ENDANGERED AND THREATENED SPECIES AND CRITICAL HABITAT; CANDIDATE SPECIES; AND SPECIES OF CONCERN

IN **PACIFIC COUNTY**

AS PREPARED BY

THE U.S. FISH AND WILDLIFE SERVICE

WESTERN WASHINGTON FISH AND WILDLIFE OFFICE

(Revised November 1, 2007)

LISTED

Brown pelican (*Pelecanus occidentalis*) [outer coast]

Bull trout (*Salvelinus confluentus*)

Marbled murrelet (*Brachyramphus marmoratus*)

Northern spotted owl (*Strix occidentalis caurina*)

Oregon silverspot butterfly (*Speyeria zerene hippolyta*)

Short-tailed albatross (*Phoebastria albatrus*) [outer coast]

Western snowy plover (*Charadrius alexandrinus nivosus*)

Major concerns that should be addressed in your Biological Assessment of project impacts to listed species include:

1. Level of use of the project area by listed species.

2. Effect of the project on listed species' primary food stocks, prey species, and foraging areas in all areas influenced by the project.

3. Impacts from project activities and implementation (e.g., increased noise levels, increased human activity and/or access, loss or degradation of habitat) that may result in disturbance to listed species and/or their avoidance of the project area.

DESIGNATED

Critical habitat for the marbled murrelet

Critical habitat for the western snowy plover

PROPOSED

None

CANDIDATE

Streaked horned lark (*Eremophila alpestris strigata*)

SPECIES OF CONCERN

Bald eagle (*Haliaeetus leucocephalus*)
Coastal cutthroat trout (*Oncorhynchus clarki clarki*) [southwest Washington DPS]
Columbia torrent salamander (*Rhyacotriton kezeri*)
Long-eared myotis (*Myotis evotis*)
Long-legged myotis (*Myotis volans*)
Makah=s copper (butterfly) (*Lycaena mariposa charlottensis*) [historic]
Newcomb's littorine snail (*Algamorda newcombiana*)
Northern goshawk (*Accipiter gentilis*)
Northern sea otter (*Enhydra lutris kenyoni*)

Olive-sided flycatcher (*Contopus cooperi*)

Pacific lamprey (*Lampetra tridentata*)

Pacific Townsend=s big-eared bat (*Corynorhinus townsendii townsendii*)

Peregrine falcon (*Falco peregrinus*)

River lamprey (*Lampetra ayresi*)

Tailed frog (*Ascaphus truei*)

Van Dyke=s salamander (*Plethodon vandykei*)

Western toad (*Bufo boreas*)

Abronia umbellata ssp. *acutalata* (pink sandverbena)

Dodecatheon austrofrigidum (frigid shootingstar)

Filipendula occidentalis (queen of the forest)

Sanicula arctopoides (footsteps of spring; bear=s-foot sanicle)

Endangered Species Act Section 7 Consultation Form
for
Estuarine Restoration

File #: R1-13552-2010-NS-004

Refuge Name: Willapa National Wildlife Refuge
Address: 3888 State Route 101, Ilwaco, WA 98624
Phone: 360-484-3482

Refuge Action: Restoration of historical estuarine habitat (currently managed pasture and managed freshwater impoundments) is being considered through the CCP (Comprehensive Conservation Plan) process. Estuarine restoration is planned to occur on portions of the Lewis, Porter Point and Riekkola Units within the Willapa National Wildlife Refuge in Pacific County, WA.

Part 1

I. Project Overview

1. Project Location

The proposed project is located at the Willapa National Wildlife Refuge in Pacific County, Washington. The specific project sites are the Lewis, Porter Point and Riekkola Units at the southern end of Willapa Bay. The legal location of the sites is Township 10 North, Range 11 West and Sections 11,12,7,1and 6.

2. Description of the Proposed Action

Historically, the project site was tidally connected to Willapa Bay and the Bear River. Prior actions by the refuge in the late 1940's and early 1950's contributed to loss of this estuarine habitat. At that time, a large portion of refuge salt marsh habitat was eliminated by diking to create pasture lands and freshwater wetlands, believed to enhance overall waterfowl use of the refuge and increase land available for agricultural production. The dikes have substantially reduced the amount of historical shoreline habitat and serve as a barrier, reducing nutrient input to the estuary and interrupting the physical, chemical and biological processes of the estuarine system. Small streams including Lewis stream, Porter Point stream and Dolman creek do not connect directly with the estuary. Although fish ladders were incorporated into two water control structures in the dike system in 2001, anadromous fish species, including salmon, are restricted in their movements to and from spawning and rearing areas. The conversion of estuarine wetlands to freshwater wetlands and pasture by diking has removed important natural habitat for waterfowl, waterbirds, shorebirds, and salmon as well as many other estuarine-dependent species.

The property which consists of managed non-tidal pasture and freshwater impoundments is currently of low quality. During this project up to 2760.2 acres will be restored to estuarine habitat (includes open water, intertidal flats and salt marsh). Unrestricted tidal exchange will be the goal and historic channels currently isolated within diked areas which are now removed from tidal influence will be reconnected to the Willapa Bay estuary. Such an action will assist in improving and maximizing the current estuarine system and contribute to the health of the bay and associated habitats. The project will be accomplished by removal of dikes and water control structures within the Lewis, Porter Point and Riekkola Units (In Alternative 3 of the CCP the Riekkola Unit will not be restored). Dikes will be removed completely to grade and material will be removed or used to fill in the associated borrow ditch. Partial removal or breaching of dikes will not be considered as problems may result, including restricted tidal penetration and circulation, ponding, and erosion (USFWS 2004). Heavy equipment utilized will include excavators, bulldozers, scrapers, and agricultural tractors. Concentration will be on restoration of functional processes including tidal influences, sediment delivery, native vegetative communities and channel networks. These processes will be instrumental to accomplish associated restoration of historical geomorphology and hydrodynamics. This action will also reduce or eliminate the extent of a highly invasive exotic plant, reed canarygrass, which currently infests the refuge's freshwater impoundments. Tussock infestation will also be reduced. Other exotic species, including nutria and bullfrogs, which currently use the freshwater impoundments will be eliminated by restoration of estuarine habitat. Juvenile salmon habitat will be restored and other expected benefits include increased waterfowl, waterbird, and shorebird use. Protection and restoration of native estuarine and nearshore habitats is a major ecoregional and recovery goal in the North Pacific Coast Ecoregion Plan (1995) and the Northern Pacific Coast Regional Shorebird Management Plan (Drut and Buchanan 2000).

3. Project Timeline

Work on the project will commence in 2011 after approval of the CCP for the Willapa National Wildlife Refuge. It is expected that work will occur in several stages and take several weeks per stage, depending on weather and tides.

4. Federally Listed Species and Critical Habitat

A. Listed species and/or their critical habitat:

Bull trout (*Salvelinus confluentus*) – Federally Threatened. Not found within the refuge or the action area.

Western Snowy Plover (*Charadrius alexandrinus nivosus*) – Federally Threatened. Found within the refuge but not within the action area. No officially designated critical habitat occurs on the refuge.

Marbled Murrelet (*Brachyramphus marmoratus*)– Federally Threatened. Found within the refuge but not within the action area. Occupied sites exist on the refuge but no officially designated critical habitat occurs on the refuge.

B. Proposed species and/or proposed critical habitat: None

C. Candidate species:

Streaked horned lark (*Eremophila alpestris strigata*) – Found within the refuge but not within the action area.

Part 2 – Informal Consultation

II. Effects Analysis

Species:

Bull trout (*Salvelinus confluentus*) – Federally Threatened. Not found within the refuge or the action area. NO EFFECT

Western Snowy Plover (*Charadrius alexandrinus nivosus*) – Federally Threatened. Found within the refuge but not within the action area. No officially designated critical habitat occurs on the refuge. NO EFFECT

Marbled Murrelet (*Brachyramphus marmoratus*)– Federally Threatened. Found within the refuge but not within the action area. Occupied sites exist but no officially designated critical habitat occurs on the refuge. NO EFFECT

Streaked Horned Lark (*Eremophila alpestris strigata*)- Found within the refuge but not within the action area. NO EFFECT

Bull Trout

The Bull Trout is a federally listed threatened species. Bull Trout have not been found in this portion of Willapa Bay. The nearest confirmed Bull Trout was caught in the Willapa River, the mouth of which is approximately 22 miles to the north of the project area. The single fish was caught by a Washington State Department of Fish and Wildlife technician near river mile 29, approximately one mile downstream of the Willapa/Forks Creek State Salmon Hatchery. There is not believed to be a breeding population in the Willapa River, or anywhere off Willapa Bay. Bull Trout are believed to use the Willapa River only for occasional foraging. Due to the distance from the sighting and the rarity of the sighting, we believe that this project will not have any impact on Bull Trout.

Western Snowy Plover

The Western Snowy Plover is a federally listed threatened species. Habitat consists of sparsely vegetated coastal dunes and beach. The Western Snowy Plover is found within the refuge in the Leadbetter Point Unit located approximately 15 miles away from the action area. It is not found within the action area. The project will have no effect on the Western Snowy Plover.

Marbled Murrelet

The Marbled Murrelet is a federally listed threatened species. Marbled Murrelets have been detected on the Long Beach Peninsula in low densities. The nearest terrestrial occupied habitat was documented by WDFW biologists about 2 miles southwest of the project site in T10N, R11W, Section 23. No potential Marbled Murrelet habitat exists at the project site. The project will have no effect on the Marbled Murrelet.

Streaked Horned Lark

The Streaked Horned Lark is a federal candidate species. Habitat consists of sparsely vegetated coastal dunes. The Streaked Horned Lark is found within the refuge in the Leadbetter Point Unit located approximately 15 miles away from the action area. It is not found within the action area. The project will have no effect on the Streaked Horned Lark.

III. Effects Determination and Response Requested:

Determination

A. no effect/no adverse modification
species:__Marbled Murrelet____________________ status:___Threatened
species:__Western Snowy Plover________________ status:____Threatened
species: Streaked Horned Lark status: Threatened
species: Bull Trout status: Threatened
critical habitat:____

B. may affect, but is not likely to adversely affect species/adversely modify critical habitat
species: status:
species status:

critical habitat:________________________

C. may affect, and is likely to adversely affect species/adversely modify critical habitat

species: ____________________________________ status:__________ *
species:____________________________________ status:__________ *
critical habitat:____ *

D. may affect, and is likely to adversely affect species/adversely modify critical habitat

species: ________________________________ status: Proposed **
species: ________________________________ status: Candidate **
proposed critical habitat:____________________________________ **

Marie Fernandez________________
Signature of Preparer

__6-28-2010______
Date

Evaluation by Project Leader:

1. *For A & B above:* Concurrence __X___ Non-concurrence _______
2. *For C above:* Formal consultation required _______
3. *For D above:* Conference required _______

____
Signature of Project Leader

6/30/10
Date

References:

Drut, M.S. and J.B. Buchanan. 2000. U.S. Shorebird Conservation Plan. Northern Pacific Coast Regional Shorebird Management Plan. U.S. Fish and Wildlife Service, Office of Migratory Bird Management, Portland, Oregon.

North Pacific Coast Ecoregion Plan (1995) Northern Pacific Coast Regional Shorebird Management Plan (Drut and Buchanan 2000).

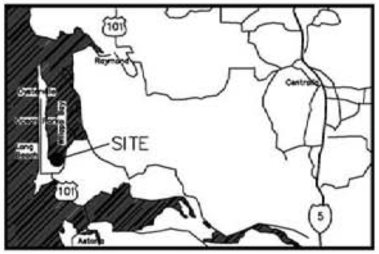
U.S. Fish and Wildlife Service. 2004. Nisqually National Wildlife Refuge. Final Comprehensive Conservation Plan and Environmental Impact Statement.

Appendix B—

Design Sheets (AMEC)

BEAR RIVER ESTUARY RESTORATION PROJECT

70% DESIGN
SOUTH WILLAPA BAY
PACIFIC COUNTY, WA



VICINITY MAP
(NOT TO SCALE)

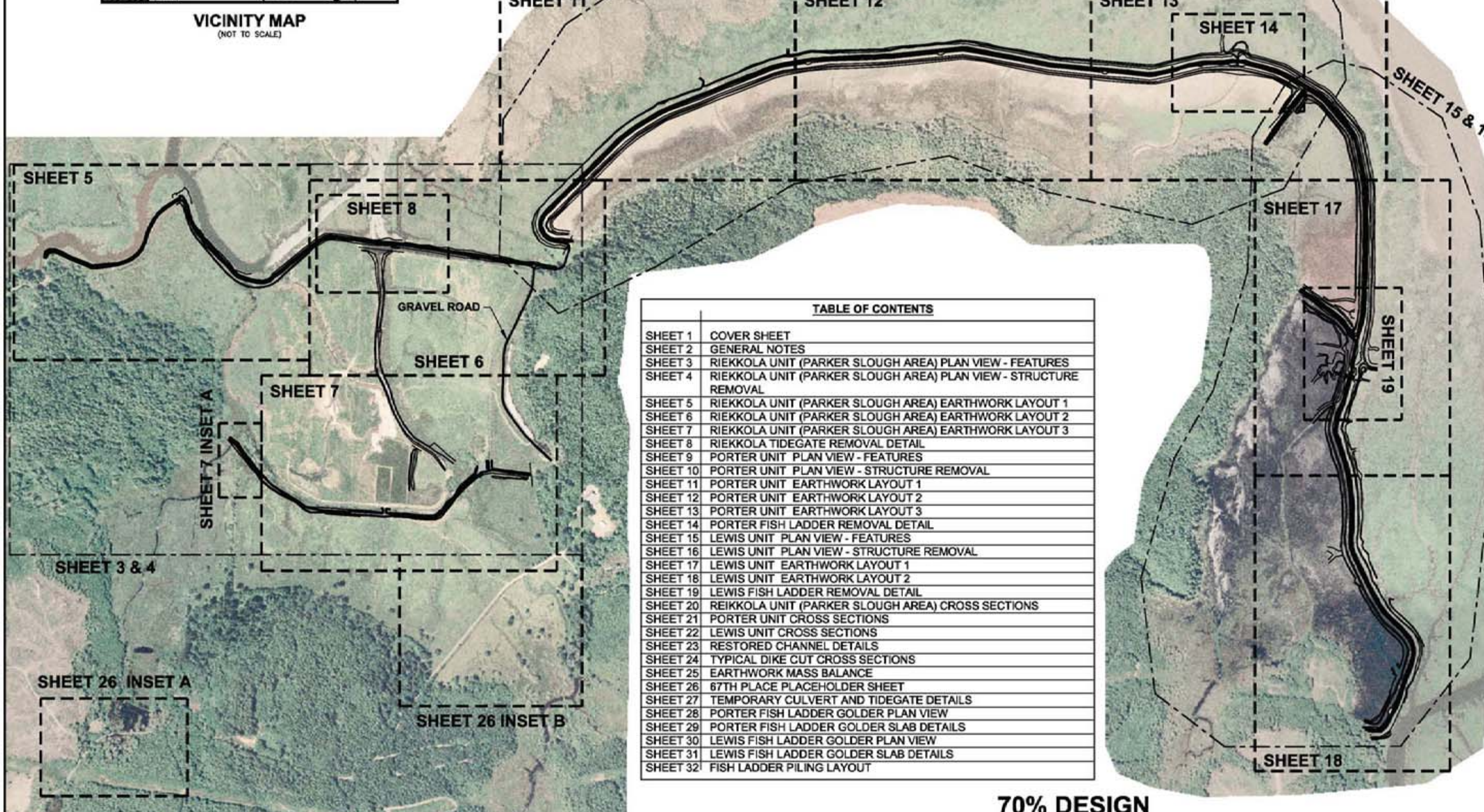


TABLE OF CONTENTS

70% DESIGN

REVISIONS			
NO.	DESCRIPTION	BY	DATE

PROJECT: BEAR RIVER ESTUARY RESTORATION

TITLE: COVER SHEET

Client: WILLAPA BAY REGIONAL FISHERIES ENHANCEMENT GROUP

amec

AMEC Earth & Environmental

BEAR RIVER ESTUARY RESTORATION

DATE: JULY 2010

1

SHEET NUMBER

GENERAL CONSTRUCTION NOTES

1. THE DRAWINGS INCLUDE LOCATION, PROFILES, SECTIONS, DETAILS AND NOTES NECESSARY TO DESCRIBE THE WORK AT THE LEVEL OF DETAIL DESIRED BY CLIENT.
2. ALL PERMITS, RIGHTS OF WAYS, AND/OR EASEMENTS THAT ARE APPLICABLE FOR THE CONSTRUCTION AND/OR OPERATION ARE THE RESPONSIBILITY OF THE LANDOWNER/OPERATOR AND SHALL BE AVAILABLE ON SITE DURING CONSTRUCTION.
3. THE CONTRACTOR IS RESPONSIBLE FOR COMPLIANCE WITH ALL LAWS, ORDINANCES, CODES, AND/OR REGULATIONS APPLICABLE FOR THE INSTALLATION.
4. DUE TO THE REMOTE NATURE OF THE PROJECT SITE, THE CONTRACTOR MUST HAVE ACTION PLANS IN PLACE FOR NORMAL OPERATIONS AND CONTINGENCY PLANS ACCOUNTING FOR SITUATIONS SUCH AS SPILLS, SOFT GROUND, STUCK EQUIPMENT, UNANTICIPATED FLOODING, AND OTHER SUCH EVENTS.
5. ALL PUBLIC ACCESS OR HAUL ROADS USED BY THE CONTRACTOR DURING CONSTRUCTION ACTIVITIES PROJECT SHALL BE SPRINKLED OR OTHERWISE TREATED TO FULLY SUPPRESS DUST.
6. ALL CONSTRUCTION EQUIPMENT SHALL BE STAGED IN A LOCATION AND MANNER TO MINIMIZE AIR, SOIL AND WATER POLLUTION.
7. ALL FUEL AND LUBRICANTS SHALL BE STORED IN CONTAINERS AND AREAS THAT ARE IN CONFORMANCE WITH APPLICABLE REGULATIONS.
8. ALL FUEL AND LUBRICANTS USED IN THE SERVICING OF CONSTRUCTION EQUIPMENT SHALL BE DONE IN A MANNER THAT AVOIDS SPILLS AND OVER FILLING.
9. ALL POLLUTION CONTROL MEASURES SHALL BE ADEQUATELY MAINTAINED IN A FUNCTIONAL CONDITION AS LONG AS NEEDED DURING THE CONSTRUCTION OPERATION. ALL TEMPORARY MEASURES SHALL BE REMOVED AND THE SITE RESTORED TO THE ORIGINAL CONDITIONS AS PRACTICABLE.

GENERAL DEMOLITION AND STRUCTURE REMOVAL NOTES

1. STRUCTURES SHALL BE REMOVED TO THE EXTENT AND DEPTH SHOWN ON THE DRAWINGS OR AS DESIGNATED BY THE TECHNICAL REPRESENTATIVE.
2. ALL HAZARDOUS MATERIALS SHALL BE IDENTIFIED PRIOR TO STRUCTURE REMOVAL BY A QUALIFIED INDIVIDUAL AND IDENTIFIED ACCORDINGLY IN A REPORT OR BY DRAWINGS.
3. ALL IDENTIFIED HAZARDOUS MATERIALS SHALL BE DISPOSED OF IN ACCORDANCE WITH APPLICABLE REGULATIONS.

GENERAL DEWATERING NOTES

1. PROTECTIVE MEASURES NEEDED TO DIVERT STREAMFLOW AND OTHER SURFACE WATER SHALL BE BUILT, MAINTAINED AND OPERATED DURING CONSTRUCTION.
2. THE CONSTRUCTION SITE SHALL BE DEWATERED AND KEPT FREE OF STANDING WATER OR EXCESSIVELY MUDDY CONDITIONS AS NEEDED FOR PROPER EXECUTION OF THE CONSTRUCTION WORK. DEWATERING SHALL INCLUDE FURNISHING, INSTALLING, OPERATING AND MAINTAINING ALL EQUIPMENT, SUCH AS PUMPS, AS NEEDED.
3. AFTER THE TEMPORARY WORKS HAVE SERVED THEIR PURPOSES, THEY SHALL BE REMOVED WITHOUT INTERFERING WITH PERMANENT DRAINAGE SYSTEMS OR STREAM FLOWS.
4. ALL TEMPORARY WORKS SHALL BE ACCOMPLISHED IN SUCH A MANNER THAT EROSION AND THE TRANSMISSION OF SEDIMENT AND OTHER POLLUTANTS ARE MINIMIZED.

GENERAL FILL NOTES

1. ALL EARTH CUT AND FILL QUANTITIES LISTED ARE BASED ON IN-PLACE VOLUMES.
2. ALL FILL MATERIAL SHALL BE OBTAINED FROM THE APPROVED EXCAVATION OR BORROW AREAS.
3. MINIMUM WEIGHT OF CONSTRUCTION EQUIPMENT USED FOR COMPACTION SHALL BE 40,000 POUNDS AND THE TRACKS OR WHEELS SHALL TRAVERSE THE ENTIRE SURFACE OF EACH FILL LAYER, OR IF THAT ISN'T POSSIBLE, USE OTHER MEANS TO TAMP OR OTHERWISE REASONABLY CONSOLIDATE AND COMPACT THE MATERIAL.
4. DITCH PLUGS SHALL BE A MINIMUM OF 100 FEET IN LENGTH EXCLUDING SLOPING ENDS OF 3H:1V GRADIENT. PLUG MATERIAL SHALL CONSIST OF THE HIGHEST-QUALITY FINE GRAINED FILL LOCALLY AVAILABLE AND SHALL BE APPROPRIATELY COMPACTED BY TRAVERSING CONSTRUCTION EQUIPMENT OVER THE ENTIRE SURFACE OF THE FILL. ARMOR EXPOSED DITCH PLUG ENDS WITH 1-2 FEET OF SUITABLE COARSE GRAINED MATERIAL, WHERE SUCH MATERIAL IS AVAILABLE.
5. DITCH PLUG DEPICTIONS ON CONSTRUCTION DRAWINGS ARE CONCEPTUAL IN NATURE AND DO NOT REFLECT ACTUAL LINEAL DIMENSIONS. DITCH PLUG FILL VOLUMES SHOWN ON CONSTRUCTION DRAWINGS HAVE BEEN CALCULATED TO MEET OR EXCEED MINIMUM PLUG DIMENSIONS. ACTUAL DIMENSIONS AND VOLUMES WILL VARY BASED UPON LOCAL CONDITIONS.

SITE SURVEY NOTES (CTS ENGINEERS)

BASIS OF BEARING

NAD 83 (1996), WASHINGTON SOUTH ZONE COORDINATES.

HORIZONTAL DATUM

HELD WSDOT HORIZONTAL STATIONS DESCRIBED BELOW:

1. MONUMENT ID 5509 (J 306), US ARMY CORPS OF ENGINEERS BRASS DISK SET INTO A 20CM DIAMETER ROUND CONCRETE MONUMENT THAT PROJECTS 16CM ABOVE THE GROUND. LOCATED ON THE EASTERLY SIDE OF SR 101 BEHIND A LONG RUN OF BEAM GUARDRAIL, 7.79 MILES NORTHEASTERLY FROM JUNCTION OF SR 100 AND SR 101.

   GRID NORTHING: 119736.624 METERS

   GRID EASTING: 234322.002 METERS

2. MONUMENT ID 6547 (TANGENT 1937), US ARMY CORPS OF ENGINEERS BRASS DISK SET IN THE TOP OF A ROUND CONCRETE MONUMENT, WHICH IS SET LEVEL WITH THE GROUND SURFACE. LOCATED ON FORMER SR 101 ALIGNMENT HEADING SOUTHERLY, 80 METERS PASS THROUGH A LOCKED GATE.

   GRID NORTHING: 118712.213 METERS

   GRID EASTING: 234096.237 METERS

VERTICAL DATUM

HELD WSDOT STATIONS DESCRIBED ABOVE:

1. MONUMENT ID 5509 (J 306)

   ELEVATION: 4.284 METERS (NAVD88)

2. MONUMENT ID 6547 (TANGENT 1937)

   ELEVATION: 4.463 METERS (NAVD88)

3. GRID COORDINATES AND ELEVATIONS WERE TRANSFORMED TO STATE PLANE COORDINATES (WA SOUTH) THROUGH CORPSCON VER. 6.0.1 (www.tec.army.mil)

SURVEY EQUIPMENT

1. CONVENTIONAL AND GPS SURVEY EQUIPMENTS WERE USED IN THE PERFORMANCE OF THIS SURVEY. ALL EQUIPMENT IS MAINTAINED IN CONFORMANCE WITH CURRENT STATE STATUTE.

SURVEY PROCEDURES

1. OREGON REAL-TIME GPS NETWORK (ORGN), PROVIDED BY OREGON DOT WAS UTILIZED TO PROVIDE RTK MEASUREMENTS IN THIS PROJECT.
2. FIELD TRAVERSE METHOD MEETS OR EXCEEDS MINIMUM REQUIREMENTS IN ACCORDANCE WITH WAC 332-130-090.

ADDITIONAL NOTES

1. ELEVATIONS SHOWN IN THIS SURVEY ARE IN US SURVEY FEET.

70% DESIGN

REVISIONS

NO.	DESCRIPTION	BY	DATE

PROJECT: BEAR RIVER ESTUARY RESTORATION

TITLE: GENERAL NOTES

Client: WILLAPA BAY REGIONAL FISHERIES ENHANCEMENT GROUP

AMEC Earth & Environmental
11810 North Creek Parkway North, Bothell, WA, U.S.A. 98011-8201
Phone: (425) 368-1000 Fax: (425) 368-1001

7-16-10

BEAR RIVER ESTUARY RESTORATION

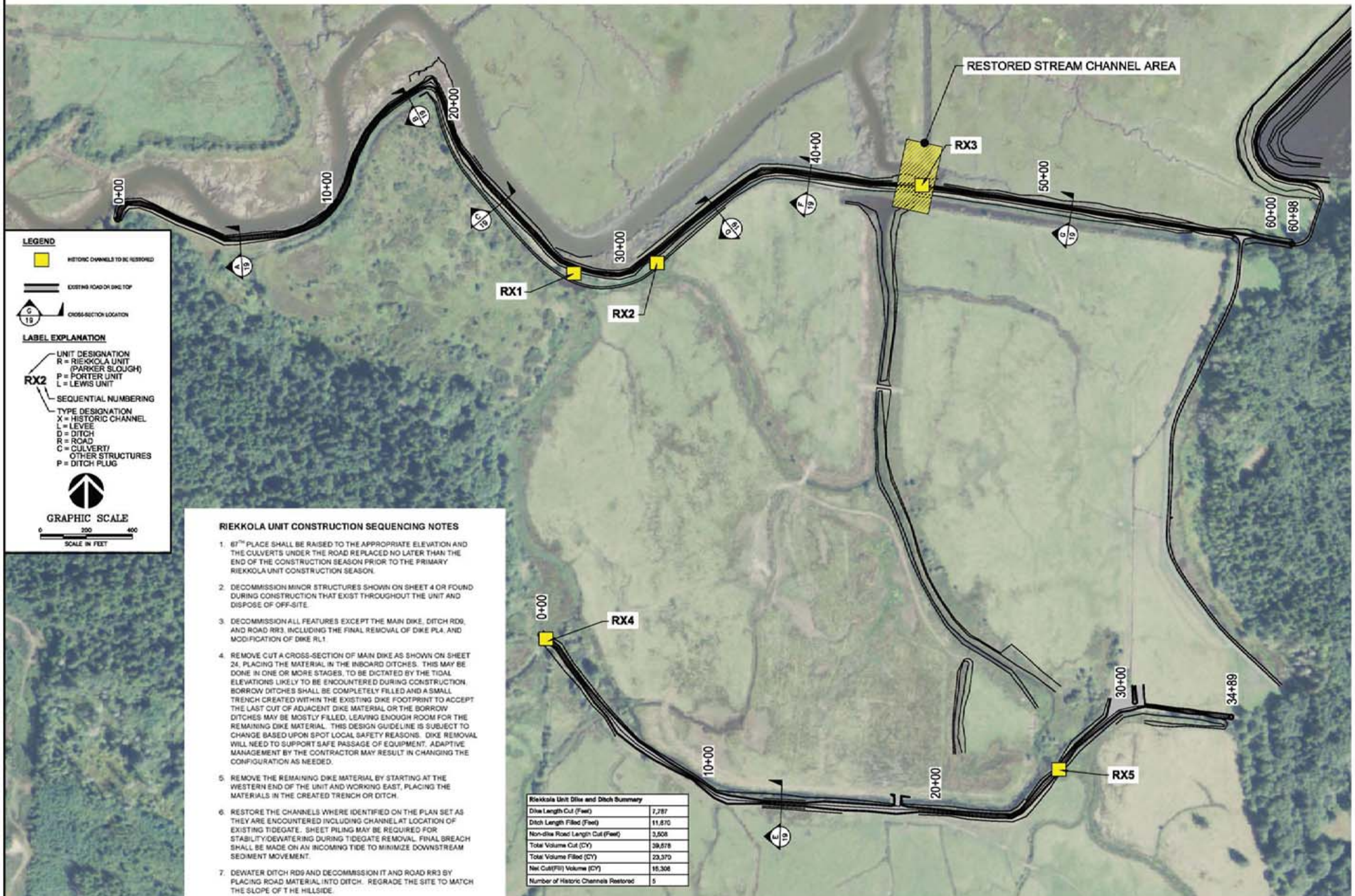
Project No. 0-915-16933-0 | REV No. 3

DR: JRS | CHK: RB/PS

DATE: JULY 2010

2

SHEET NUMBER



RIEKKOLA UNIT CONSTRUCTION SEQUENCING NOTES

1. 67TH PLACE SHALL BE RAISED TO THE APPROPRIATE ELEVATION AND THE CULVERTS UNDER THE ROAD REPLACED NO LATER THAN THE END OF THE CONSTRUCTION SEASON PRIOR TO THE PRIMARY RIEKKOLA UNIT CONSTRUCTION SEASON.
2. DECOMMISSION MINOR STRUCTURES SHOWN ON SHEET 4 OR FOUND DURING CONSTRUCTION THAT EXIST THROUGHOUT THE UNIT AND DISPOSE OF OFF-SITE.
3. DECOMMISSION ALL FEATURES EXCEPT THE MAIN DIKE, DITCH RD9, AND ROAD RR3, INCLUDING THE FINAL REMOVAL OF DIKE PL4, AND MODIFICATION OF DIKE RL1.
4. REMOVE CUT A CROSS-SECTION OF MAIN DIKE AS SHOWN ON SHEET 24, PLACING THE MATERIAL IN THE INBOARD DITCHES. THIS MAY BE DONE IN ONE OR MORE STAGES, TO BE DICTATED BY THE TIDAL ELEVATIONS LIKELY TO BE ENCOUNTERED DURING CONSTRUCTION. BORROW DITCHES SHALL BE COMPLETELY FILLED AND A SMALL TRENCH CREATED WITHIN THE EXISTING DIKE FOOTPRINT TO ACCEPT THE LAST CUT OF ADJACENT DIKE MATERIAL OR THE BORROW DITCHES MAY BE MOSTLY FILLED, LEAVING ENOUGH ROOM FOR THE REMAINING DIKE MATERIAL. THIS DESIGN GUIDELINE IS SUBJECT TO CHANGE BASED UPON SPOT LOCAL SAFETY REASONS. DIKE REMOVAL WILL NEED TO SUPPORT SAFE PASSAGE OF EQUIPMENT. ADAPTIVE MANAGEMENT BY THE CONTRACTOR MAY RESULT IN CHANGING THE CONFIGURATION AS NEEDED.
5. REMOVE THE REMAINING DIKE MATERIAL BY STARTING AT THE WESTERN END OF THE UNIT AND WORKING EAST, PLACING THE MATERIALS IN THE CREATED TRENCH OR DITCH.
6. RESTORE THE CHANNELS WHERE IDENTIFIED ON THE PLAN SET AS THEY ARE ENCOUNTERED INCLUDING CHANNEL AT LOCATION OF EXISTING TIDEGATE. SHEET PILING MAY BE REQUIRED FOR STABILITY/DEWATERING DURING TIDEGATE REMOVAL. FINAL BREACH SHALL BE MADE ON AN INCOMING TIDE TO MINIMIZE DOWNSTREAM SEDIMENT MOVEMENT.
7. DEWATER DITCH RD9 AND DECOMMISSION IT AND ROAD RR3 BY PLACING ROAD MATERIAL INTO DITCH. REGRADE THE SITE TO MATCH THE SLOPE OF THE HILLSIDE.

Riekkola Unit Dike and Ditch Summary	
Dike Length Cut (Feet)	7,787
Ditch Length Filled (Feet)	11,870
Non-dike Road Length Cut (Feet)	3,508
Total Volume Cut (CY)	39,678
Total Volume Filled (CY)	23,370
Net Cut/(Fill) Volume (CY)	16,308
Number of Historic Channels Restored	5

NOTE: USFWS REFERS TO THIS AREA AS THE RIEKKOLA UNIT (PARKER SLOUGH AREA), AND THIS CONVENTION IS FOLLOWED THROUGHOUT THIS PLAN SET. TARLATT SLOUGH IS LOCATED ALONG THE OUTBOARD DIKE, AND PARKER SLOUGH IS WITHIN THIS AREA.

70% DESIGN

REVISIONS			
NO.	DESCRIPTION	BY	DATE

PROJECT: BEAR RIVER ESTUARY RESTORATION

TITLE: RIEKKOLA UNIT (PARKER SLOUGH AREA) PLAN VIEW - FEATURES

Client: WILLAPA BAY REGIONAL FISHERIES ENHANCEMENT GROUP

AMEC Earth & Environmental
11810 North Creek Parkway North, Bothell, WA, U.S.A. 98011-8201
Phone: (425) 368-1000 Fax: (425) 368-1001

BEAR RIVER ESTUARY RESTORATION

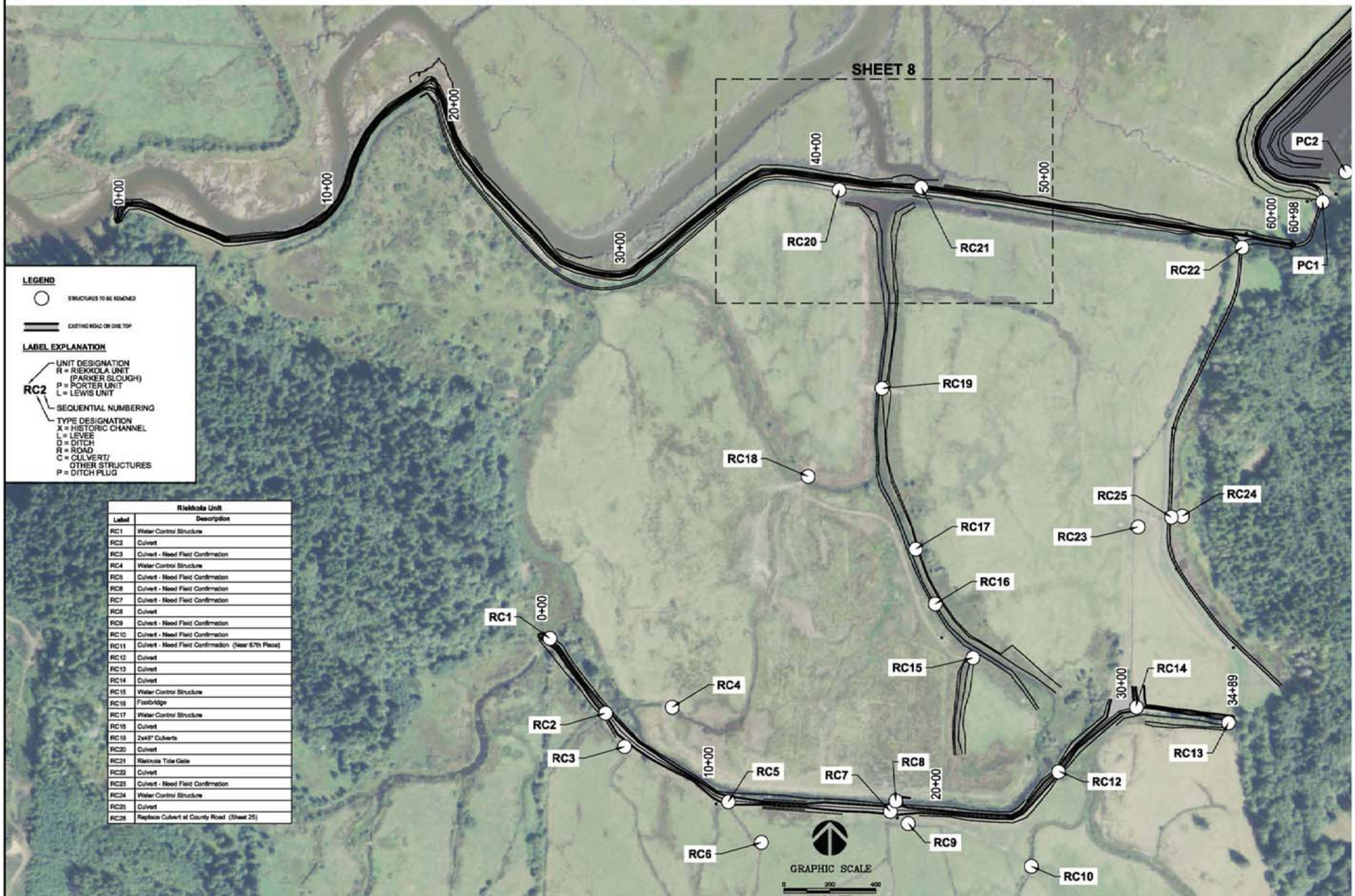
Project No. 0-915-15933-0 | REV No.

DR: JRS | CHK: RB/PS

DATE: JULY 2010

3

SHEET NUMBER



Riekkola Unit	
Label	Description
RC1	Water Control Structure
RC2	Culvert
RC3	Culvert - Need Field Confirmation
RC4	Water Control Structure
RC5	Culvert - Need Field Confirmation
RC6	Culvert - Need Field Confirmation
RC7	Culvert - Need Field Confirmation
RC8	Culvert
RC9	Culvert - Need Field Confirmation
RC10	Culvert - Need Field Confirmation
RC11	Culvert - Need Field Confirmation (Near 67th Place)
RC12	Culvert
RC13	Culvert
RC14	Culvert
RC15	Water Control Structure
RC16	Footbridge
RC17	Water Control Structure
RC18	Culvert
RC19	2x48" Culverts
RC20	Culvert
RC21	Riekkola Tide Gate
RC22	Culvert
RC23	Culvert - Need Field Confirmation
RC24	Water Control Structure
RC25	Culvert
RC26	Replace Culvert at County Road (Sheet 25)

70% DESIGN

REVISIONS

NO.	DESCRIPTION	BY	DATE

PROJECT: BEAR RIVER ESTUARY RESTORATION

TITLE: RIEKKOLA UNIT (PARKER SLOUGH AREA) PLAN VIEW - STRUCTURE REMOVAL

Client: WILLAPA BAY REGIONAL FISHERIES ENHANCEMENT GROUP

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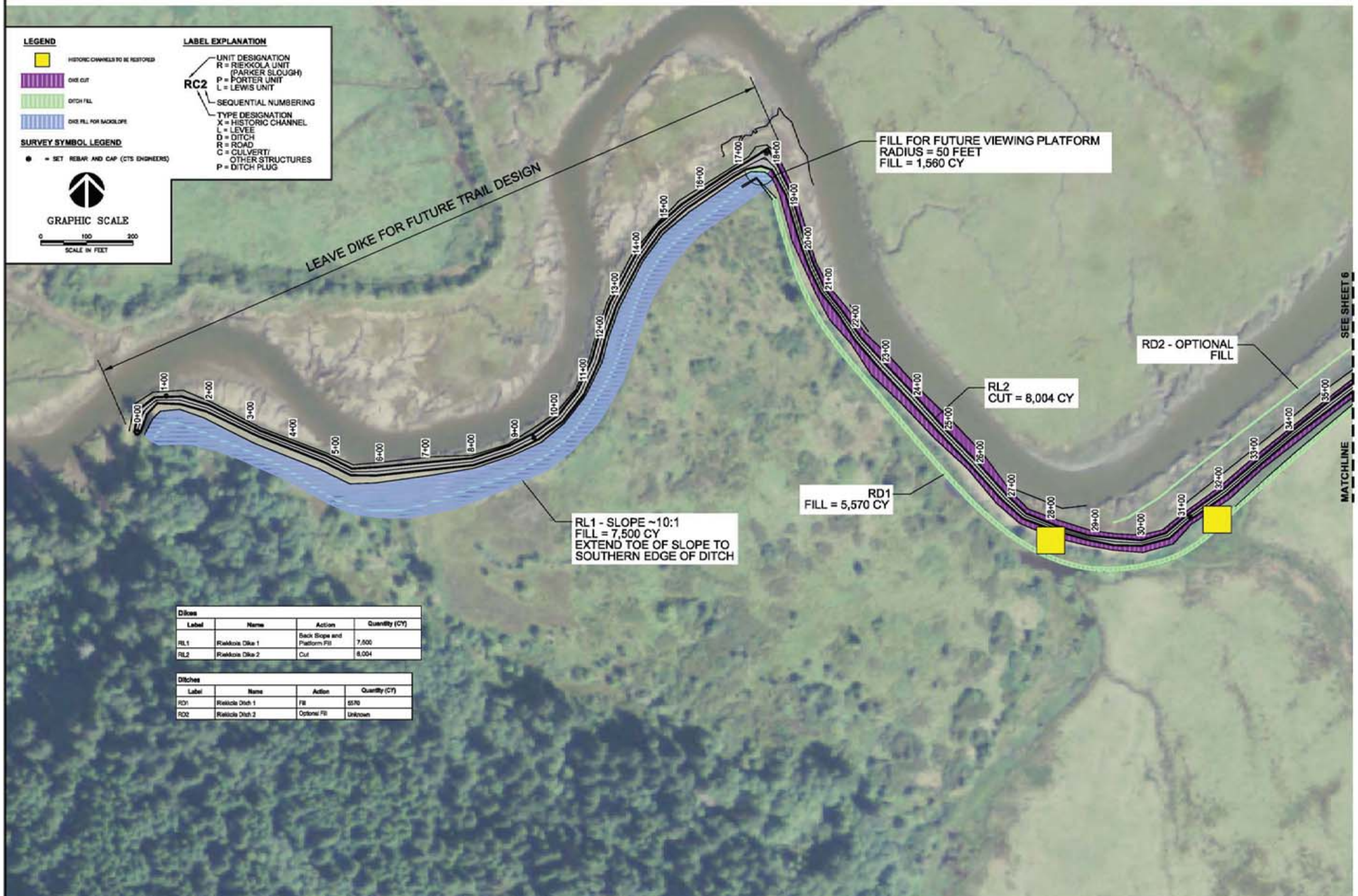
AMEC Earth & Environmental

BEAR RIVER ESTUARY RESTORATION

DATE: JULY 2010

4

SHEET NUMBER



Dikes			
Label	Name	Action	Quantity (CY)
RL1	Riekkola Dike 1	Back Slope and Platform Fill	7,500
RL2	Riekkola Dike 2	Cut	8,004

Ditches			
Label	Name	Action	Quantity (CY)
RD1	Riekkola Ditch 1	Fill	5570
RD2	Riekkola Ditch 2	Optional Fill	Unknown

70% DESIGN

REVISIONS			
NO.	DESCRIPTION	BY	DATE

PROJECT: BEAR RIVER ESTUARY RESTORATION

TITLE: RIEKKOLA UNIT (PARKER SLOUGH AREA) EARTHWORK LAYOUT 1

Client: WILLAPA BAY REGIONAL FISHERIES ENHANCEMENT GROUP

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BEAR RIVER ESTUARY RESTORATION

DATE: JULY 2010

5

SHEET NUMBER

Dikes

Label	Name	Action	Quantity (CY)
RL3	Riekkola Dike 3	Cut	11758
PL1	Porter Dike 1	Cut	3881

Ditches

Label	Name	Action	Quantity (CY)
RD3	Riekkola Ditch 3	Fill	1481
RD4	Riekkola Ditch 4	Optional Fill	Unknown
RD5	Riekkola Ditch 5	Fill	5333
RD6	Riekkola Ditch 6	Fill	From adjacent road
RD7	Riekkola Ditch 7	Fill	107
PD1	Porter Ditch 1	Fill	5095

Plugs

Label	Name	Quantity (CY)
PP1	Porter Plug 1	65

Roads

Label	Name	Action	Quantity (CY)
RR1	Riekkola Road 1	Cut	Unknown

70% DESIGN

REVISIONS

NO.	DESCRIPTION	BY	DATE

PROJECT: BEAR RIVER ESTUARY RESTORATION

TITLE: RIEKKOLA UNIT (PARKER SLOUGH AREA) EARTHWORK LAYOUT 2

Client: WILLAPA BAY REGIONAL FISHERIES ENHANCEMENT GROUP

AMEC Earth & Environmental

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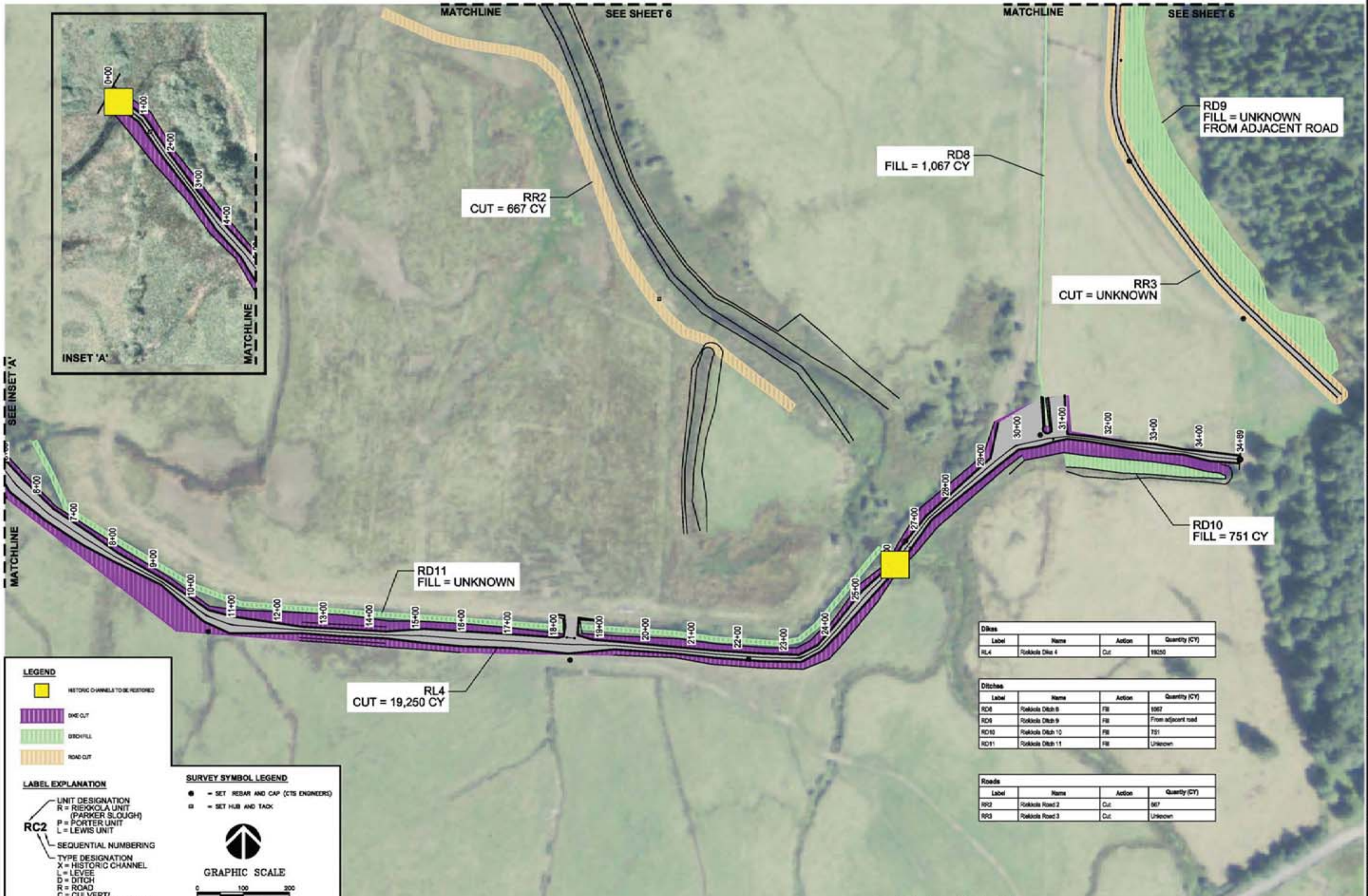
BEAR RIVER ESTUARY RESTORATION

DATE: JULY 2010

6

SHEET NUMBER



Dikes			
Label	Name	Action	Quantity (CY)
RL4	Riekkola Dike 4	Cut	19250

Ditches			
Label	Name	Action	Quantity (CY)
RD8	Riekkola Ditch 8	Fill	1067
RD9	Riekkola Ditch 9	Fill	From adjacent road
RD10	Riekkola Ditch 10	Fill	751
RD11	Riekkola Ditch 11	Fill	Unknown

Roads			
Label	Name	Action	Quantity (CY)
RR2	Riekkola Road 2	Cut	667
RR3	Riekkola Road 3	Cut	Unknown

LEGEND

- HISTORIC CHANNELS TO BE RESTORED
- DIKE CUT
- DITCH FILL
- ROAD CUT

LABEL EXPLANATION

RC2
- UNIT DESIGNATION
  - R = RIEKKOLA UNIT (PARKER SLOUGH)
  - P = PORTER UNIT
  - L = LEWIS UNIT
- SEQUENTIAL NUMBERING
- TYPE DESIGNATION
  - X = HISTORIC CHANNEL
  - L = LEVEE
  - D = DITCH
  - R = ROAD
  - C = CULVERT/ OTHER STRUCTURES
  - P = DITCH PLUG

SURVEY SYMBOL LEGEND

- ● = SET REBAR AND CAP (CTS ENGINEERS)
- ▫ = SET HUB AND TACK

GRAPHIC SCALE

0 100 200

SCALE IN FEET

70% DESIGN

REVISIONS			
NO.	DESCRIPTION	BY	DATE

PROJECT: BEAR RIVER ESTUARY RESTORATION

TITLE: RIEKKOLA UNIT (PARKER SLOUGH AREA) EARTHWORK LAYOUT 3

Client: WILLAPA BAY REGIONAL FISHERIES ENHANCEMENT GROUP

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AMEC Earth & Environmental

11810 North Creek Parkway North, Bothell, WA, U.S.A. 98011-8201

Phone: (425) 368-1000 Fax: (425) 368-1001

BEAR RIVER ESTUARY RESTORATION

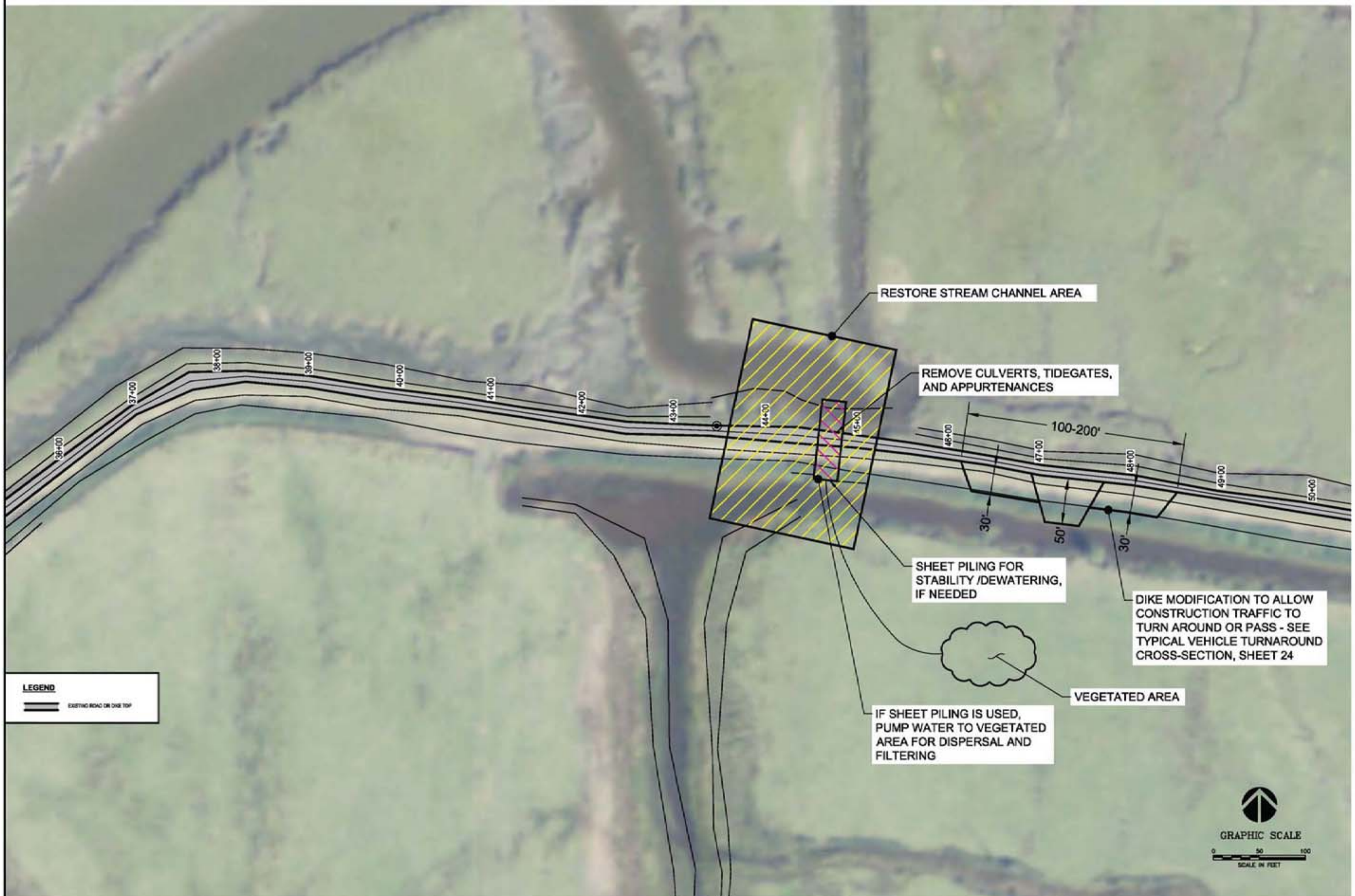
Project No. 0-915-18530-0 | REV No.

DR: JRB | CHK: RB/PB

DATE: JULY 2010

7

SHEET NUMBER



70% DESIGN

REVISIONS

NO.	DESCRIPTION	BY	DATE

PROJECT: BEAR RIVER ESTUARY RESTORATION

TITLE: RIEKKOLA (PARKER SLOUGH AREA) TIDEGATE REMOVAL DETAIL

Client: WILLAPA BAY REGIONAL FISHERIES ENHANCEMENT GROUP

AMEC Earth & Environmental

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BEAR RIVER ESTUARY RESTORATION

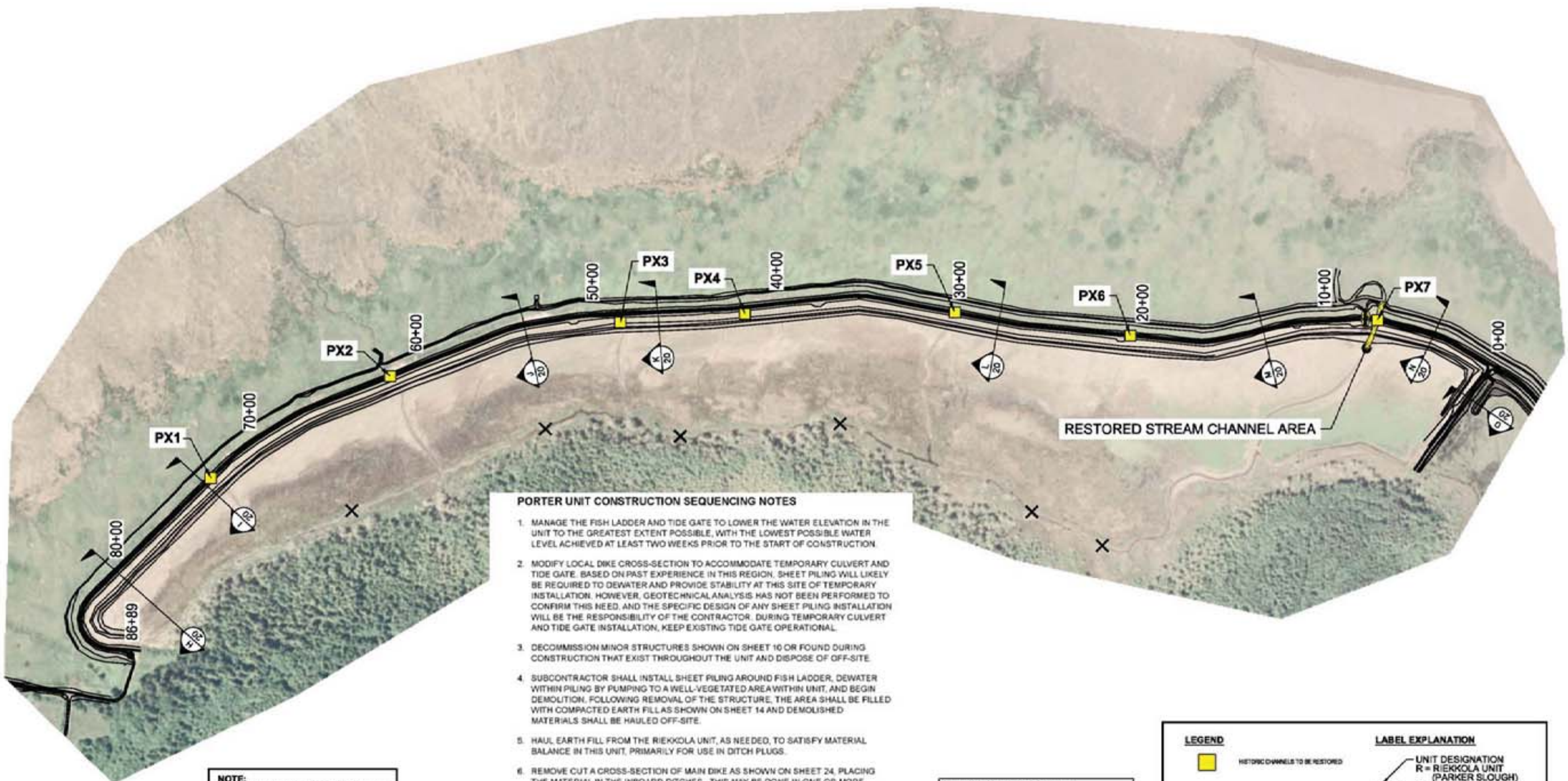
Project No. 0-915-16930-0 | REV No.

DR: JRS | CHK: RS/PS

DATE: JULY 2010

8

SHEET NUMBER



NOTE:
PLUGS SHOWN IN INTERCEPTOR DITCH ARE REPRESENTATIONS OF THE INTENT TO REDIRECT FLOWS THROUGH RESTORED STREAM CROSSINGS AFTER THEY HAVE BEEN OPENED UP. NO SURVEYS OR QUANTITY CALCULATIONS HAVE BEEN COMPLETED FOR THESE PLUGS. MATERIAL CUTS AND FILLS WILL BE LOCALIZED.

PORTER UNIT CONSTRUCTION SEQUENCING NOTES

1. MANAGE THE FISH LADDER AND TIDE GATE TO LOWER THE WATER ELEVATION IN THE UNIT TO THE GREATEST EXTENT POSSIBLE, WITH THE LOWEST POSSIBLE WATER LEVEL ACHIEVED AT LEAST TWO WEEKS PRIOR TO THE START OF CONSTRUCTION.
2. MODIFY LOCAL DIKE CROSS-SECTION TO ACCOMMODATE TEMPORARY CULVERT AND TIDE GATE. BASED ON PAST EXPERIENCE IN THIS REGION, SHEET PILING WILL LIKELY BE REQUIRED TO DEWATER AND PROVIDE STABILITY AT THIS SITE OF TEMPORARY INSTALLATION. HOWEVER, GEOTECHNICAL ANALYSIS HAS NOT BEEN PERFORMED TO CONFIRM THIS NEED, AND THE SPECIFIC DESIGN OF ANY SHEET PILING INSTALLATION WILL BE THE RESPONSIBILITY OF THE CONTRACTOR. DURING TEMPORARY CULVERT AND TIDE GATE INSTALLATION, KEEP EXISTING TIDE GATE OPERATIONAL.
3. DECOMMISSION MINOR STRUCTURES SHOWN ON SHEET 10 OR FOUND DURING CONSTRUCTION THAT EXIST THROUGHOUT THE UNIT AND DISPOSE OF OFF-SITE.
4. SUBCONTRACTOR SHALL INSTALL SHEET PILING AROUND FISH LADDER, DEWATER WITHIN PILING BY PUMPING TO A WELL-VEGETATED AREA WITHIN UNIT, AND BEGIN DEMOLITION. FOLLOWING REMOVAL OF THE STRUCTURE, THE AREA SHALL BE FILLED WITH COMPACTED EARTH FILL AS SHOWN ON SHEET 14 AND DEMOLISHED MATERIALS SHALL BE HAULED OFF-SITE.
5. HAUL EARTH FILL FROM THE RIEKKOLA UNIT, AS NEEDED, TO SATISFY MATERIAL BALANCE IN THIS UNIT, PRIMARILY FOR USE IN DITCH PLUGS.
6. REMOVE CUT A CROSS-SECTION OF MAIN DIKE AS SHOWN ON SHEET 24, PLACING THE MATERIAL IN THE INBOARD DITCHES. THIS MAY BE DONE IN ONE OR MORE STAGES, TO BE DICTATED BY THE TIDAL ELEVATIONS LIKELY TO BE ENCOUNTERED DURING CONSTRUCTION. BORROW DITCHES SHALL BE COMPLETELY FILLED AND A SMALL TRENCH CREATED WITHIN THE EXISTING DIKE FOOTPRINT TO ACCEPT THE LAST CUT OF ADJACENT DIKE MATERIAL OR THE BORROW DITCHES MAY BE MOSTLY FILLED, LEAVING ENOUGH ROOM FOR THE REMAINING DIKE MATERIAL. THIS DESIGN GUIDELINE IS SUBJECT TO CHANGE BASED UPON SPOT LOCAL SAFETY REASONS. DIKE REMOVAL WILL NEED TO SUPPORT SAFE PASSAGE OF EQUIPMENT. ADAPTIVE MANAGEMENT BY THE CONTRACTOR MAY RESULT IN CHANGING THE CONFIGURATION AS NEEDED.
7. REMOVE THE REMAINING DIKE MATERIAL BY STARTING AT THE EASTERN END OF THE UNIT AND WORKING WEST, PLACING THE MATERIALS IN THE CREATED TRENCH OR DITCH.
8. RESTORE THE CHANNELS WHERE IDENTIFIED ON THE PLAN SET AS THEY ARE ENCOUNTERED. FINAL BREACH SHALL BE MADE ON AN INCOMING TIDE TO MINIMIZE DOWNSTREAM SEDIMENT MOVEMENT.
9. REMOVE TEMPORARY CULVERT AND TIDE GATE WHEN LOCAL CHANNEL IS RESTORED.
10. CREATE MINOR PLUGS IN INTERCEPTOR DITCH AND RESTORE CHANNEL CONNECTIONS BETWEEN THE UPSLOPE PART OF THE UNIT AND THE RESTORED CHANNELS.

Porter Unit Dike and Ditch Summary	
Dike Length Cut (Feet)	9,378
Ditch Length Filled (Feet)	8,893
Total Volume Cut (CY)	44,832
Total Volume Filled (CY)	47,843
Net Cut(Fill) Volume (CY)	(3,011)
Number of Historic Channels Restored	7

LEGEND

HISTORIC CHANNELS TO BE RESTORED
EXISTING ROAD OR DIKE TOP
CROSS-SECTION LOCATION
INTERCEPTOR DITCH PLUGS

LABEL EXPLANATION

PC2
UNIT DESIGNATION
R = RIEKKOLA UNIT (PARKER SLOUGH)
P = PORTER UNIT
L = LEWIS UNIT
SEQUENTIAL NUMBERING
TYPE DESIGNATION
X = HISTORIC CHANNEL
L = LEVEE
D = DITCH
R = ROAD
C = CULVERT/ OTHER STRUCTURES
P = DITCH PLUG

GRAPHIC SCALE
0 300 600
SCALE IN FEET

70% DESIGN

REVISIONS			
NO.	DESCRIPTION	BY	DATE

PROJECT: BEAR RIVER ESTUARY RESTORATION

TITLE: PORTER UNIT PLAN VIEW - FEATURES

Client: WILLAPA BAY REGIONAL FISHERIES ENHANCEMENT GROUP

AMEC Earth & Environmental
11810 North Creek Parkway North, Bothell, WA, U.S.A. 98011-8201
Phone: (425) 368-1000 Fax: (425) 368-1001

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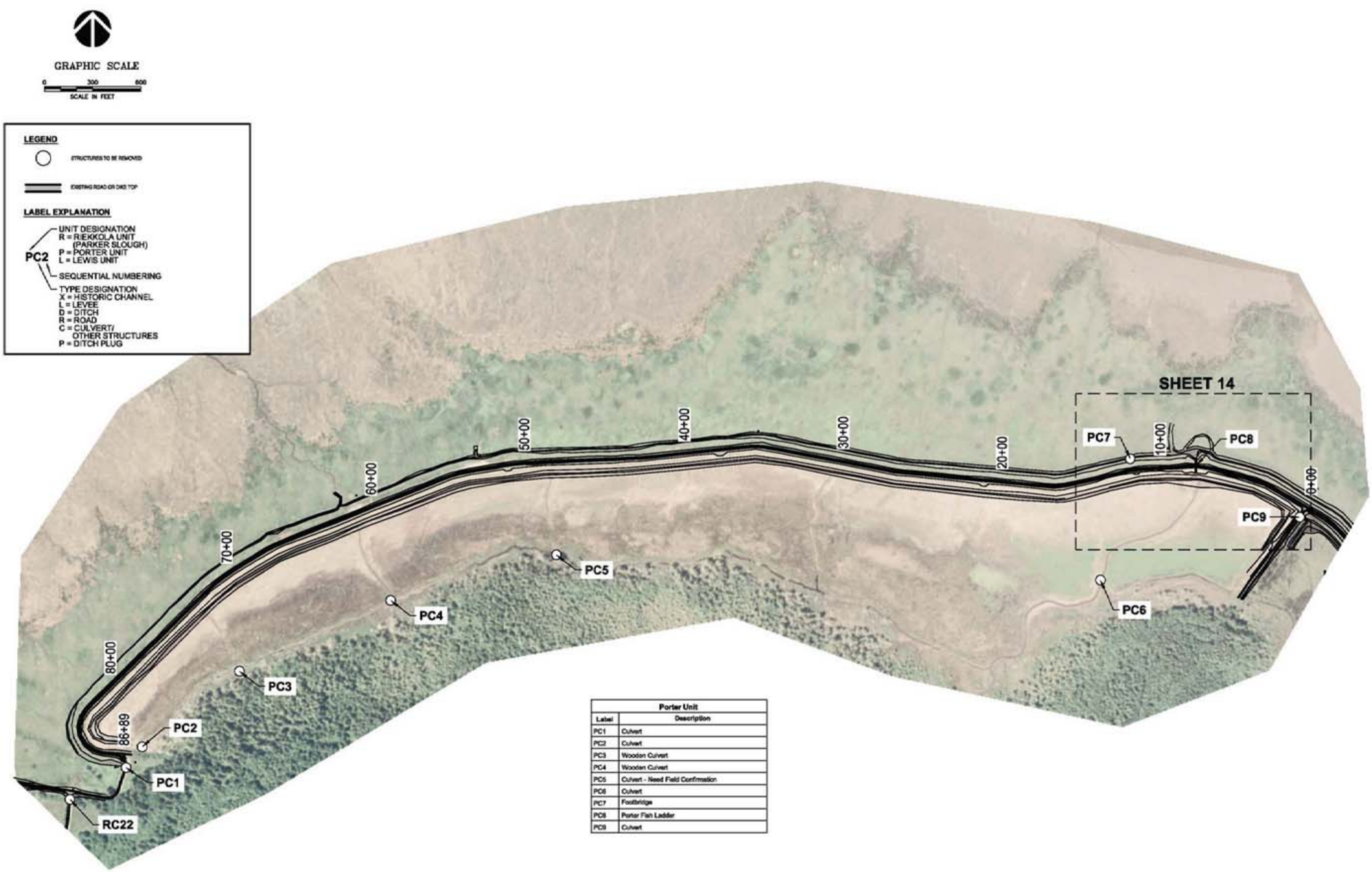
BEAR RIVER ESTUARY RESTORATION
Project No. 0-915-15933-0 | REV No.
DR: JRS | CHK: RB/PS
DATE: JULY 2010

9
SHEET NUMBER



Porter Unit	
Label	Description
PC1	Culvert
PC2	Culvert
PC3	Wooden Culvert
PC4	Wooden Culvert
PC5	Culvert - Need Field Confirmation
PC6	Culvert
PC7	Footbridge
PC8	Porter Fish Ladder
PC9	Culvert

70% DESIGN

REVISIONS			
NO.	DESCRIPTION	BY	DATE

PROJECT: BEAR RIVER ESTUARY RESTORATION

TITLE: PORTER UNIT
PLAN VIEW - STRUCTURE REMOVAL

Client: WILLAPA BAY REGIONAL FISHERIES ENHANCEMENT GROUP

AMEC Earth & Environmental
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BEAR RIVER ESTUARY RESTORATION

DATE: JULY 2010

10
SHEET NUMBER

LEGEND

HISTORIC CHANNELS TO BE RESTORED

DIKE CUT

DITCH FILL

LABEL EXPLANATION

PC2
- UNIT DESIGNATION
  - R = RIEKKOLA UNIT (PARKER SLOUGH)
  - P = PORTER UNIT
  - L = LEWIS UNIT
- SEQUENTIAL NUMBERING
- TYPE DESIGNATION
  - X = HISTORIC CHANNEL
  - L = LEVEE
  - D = DITCH
  - R = ROAD
  - C = CULVERT/ OTHER STRUCTURES
  - P = DITCH PLUG

SURVEY SYMBOL LEGEND

● = SET REBAR AND CAP (CTS ENGINEERS)

GRAPHIC SCALE

0 100 200

SCALE IN FEET

Dikes

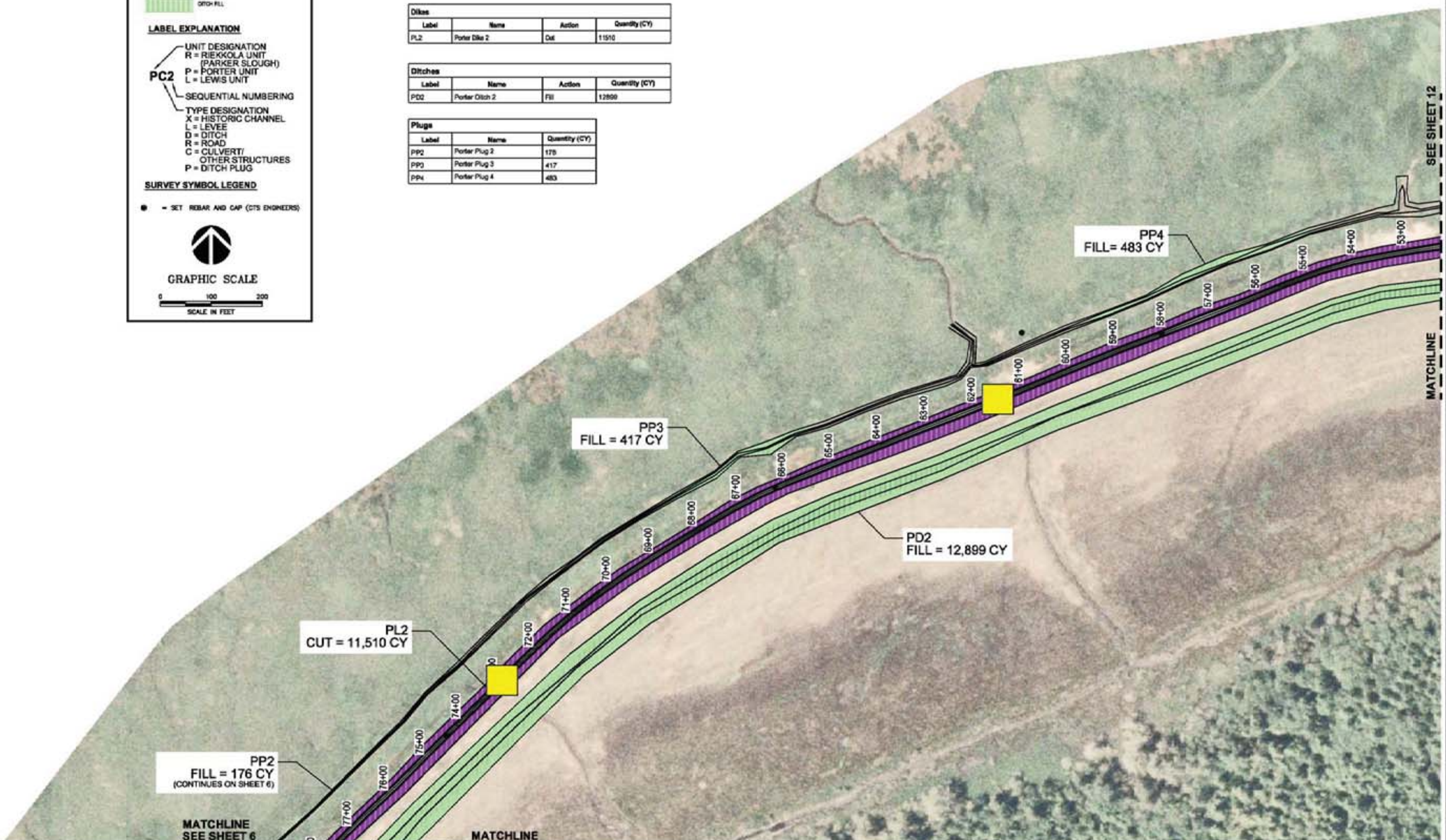
Label	Name	Action	Quantity (CY)
PL2	Porter Dike 2	Cut	11510

Ditches

Label	Name	Action	Quantity (CY)
PD2	Porter Ditch 2	Fill	12899

Plugs

Label	Name	Quantity (CY)
PP2	Porter Plug 2	176
PP3	Porter Plug 3	417
PP4	Porter Plug 4	483



70% DESIGN

REVISIONS			
NO.	DESCRIPTION	BY	DATE

PROJECT: BEAR RIVER ESTUARY RESTORATION

TITLE: PORTER UNIT EARTHWORK LAYOUT 1

Client: WILLAPA BAY REGIONAL FISHERIES ENHANCEMENT GROUP

AMEC Earth & Environmental

11810 North Creek Parkway North, Bothell, WA, U.S.A. 98011-8201
Phone: (425) 368-1000 Fax: (425) 368-1001

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BEAR RIVER ESTUARY RESTORATION

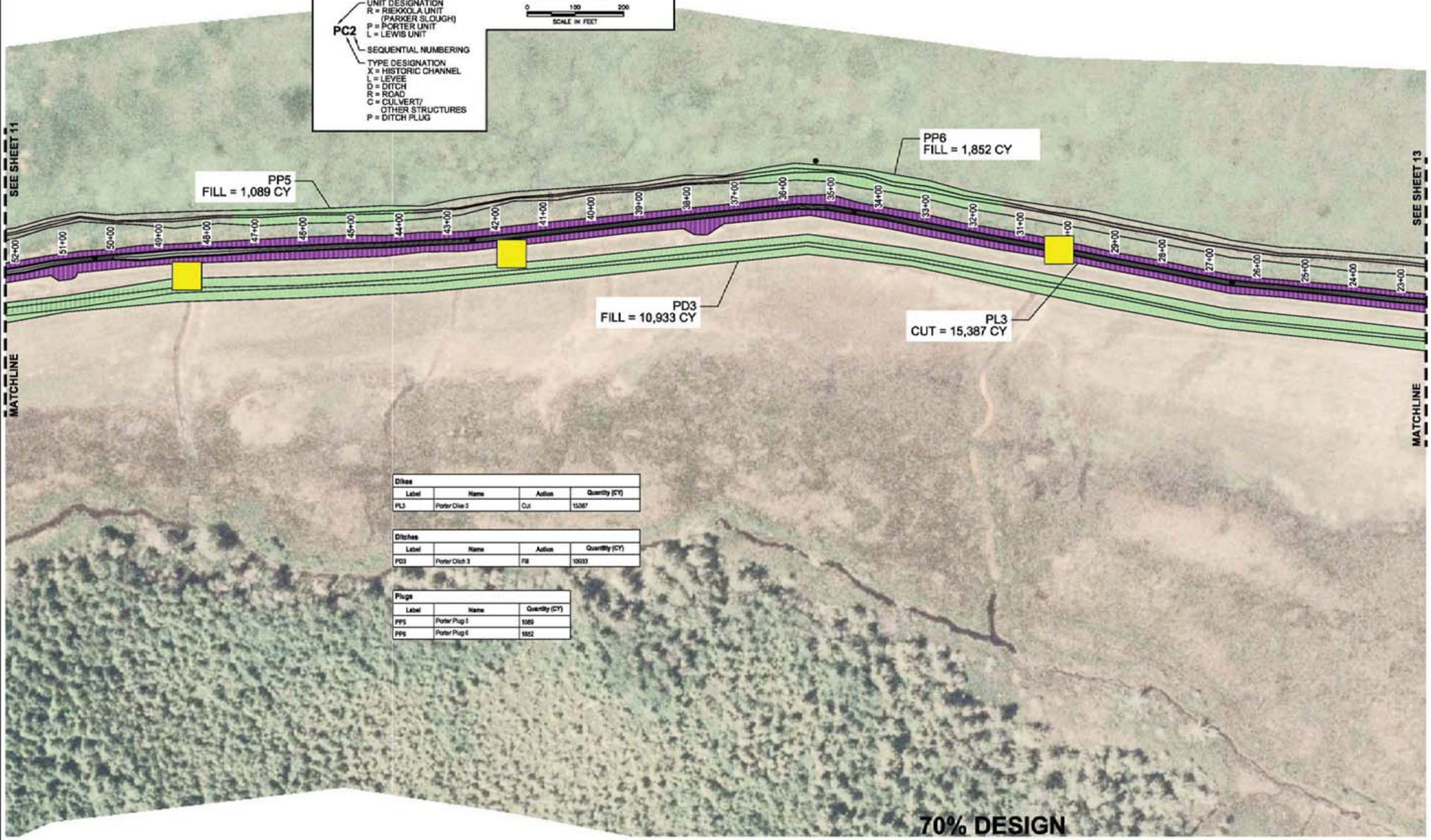
Project No. 0-915-16930-0 | REV No.

DR: JRB | CHK: RB/PS

DATE: JULY 2010

11

SHEET NUMBER



LEGEND

- HISTORIC CHANNELS TO BE RESTORED
- DIKE CUT
- DITCH FILL

LABEL EXPLANATION

PC2
- UNIT DESIGNATION
  - R = RIEKKOLA UNIT (PARKER SLOUGH)
  - P = PORTER UNIT
  - L = LEWIS UNIT
- SEQUENTIAL NUMBERING
- TYPE DESIGNATION
  - X = HISTORIC CHANNEL
  - L = LEVEE
  - D = DITCH
  - R = ROAD
  - C = CULVERT/ OTHER STRUCTURES
  - P = DITCH PLUG

SURVEY SYMBOL LEGEND

● = SET REBAR AND CAP (CTS ENGINEERS)

GRAPHIC SCALE

0 100 200

SCALE IN FEET

Dikes

Label	Name	Action	Quantity (CY)
PL3	Porter Dike 3	Cut	15387

Ditches

Label	Name	Action	Quantity (CY)
PD3	Porter Ditch 3	Fill	10933

Plugs

Label	Name	Quantity (CY)
PP5	Porter Plug 5	1089
PP6	Porter Plug 6	1852

REVISIONS			
NO.	DESCRIPTION	BY	DATE

PROJECT: BEAR RIVER ESTUARY RESTORATION

TITLE: PORTER UNIT EARTHWORK LAYOUT 2

Client: WILLAPA BAY REGIONAL FISHERIES ENHANCEMENT GROUP

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BEAR RIVER ESTUARY RESTORATION

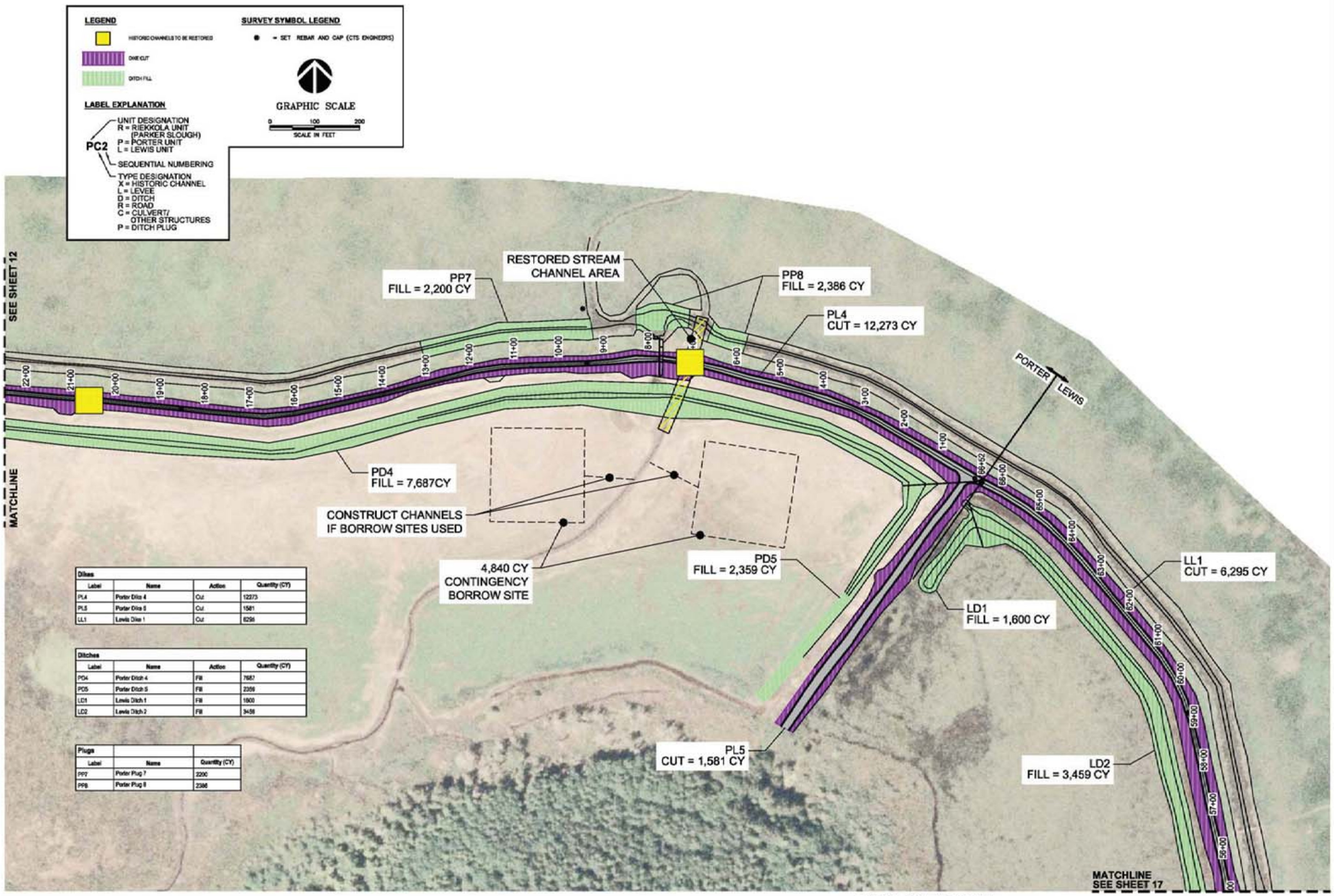
Project No. 0-915-15930-0 | REV No.

DR: JRS | CHK: RB/PB

DATE: JULY 2010

12

SHEET NUMBER



Dikes			
Label	Name	Action	Quantity (CY)
PL4	Porter Dike 4	Cut	12273
PL5	Porter Dike 5	Cut	1581
LL1	Lewis Dike 1	Cut	6295

Ditches			
Label	Name	Action	Quantity (CY)
PD4	Porter Ditch 4	Fill	7687
PD5	Porter Ditch 5	Fill	2359
LD1	Lewis Ditch 1	Fill	1600
LD2	Lewis Ditch 2	Fill	3459

Plugs		
Label	Name	Quantity (CY)
PP7	Porter Plug 7	2200
PP8	Porter Plug 8	2386

70% DESIGN

REVISIONS			
NO.	DESCRIPTION	BY	DATE

PROJECT: BEAR RIVER ESTUARY RESTORATION

TITLE: PORTER UNIT
EARTHWORK LAYOUT 3

Client: WILLAPA BAY REGIONAL FISHERIES ENHANCEMENT GROUP

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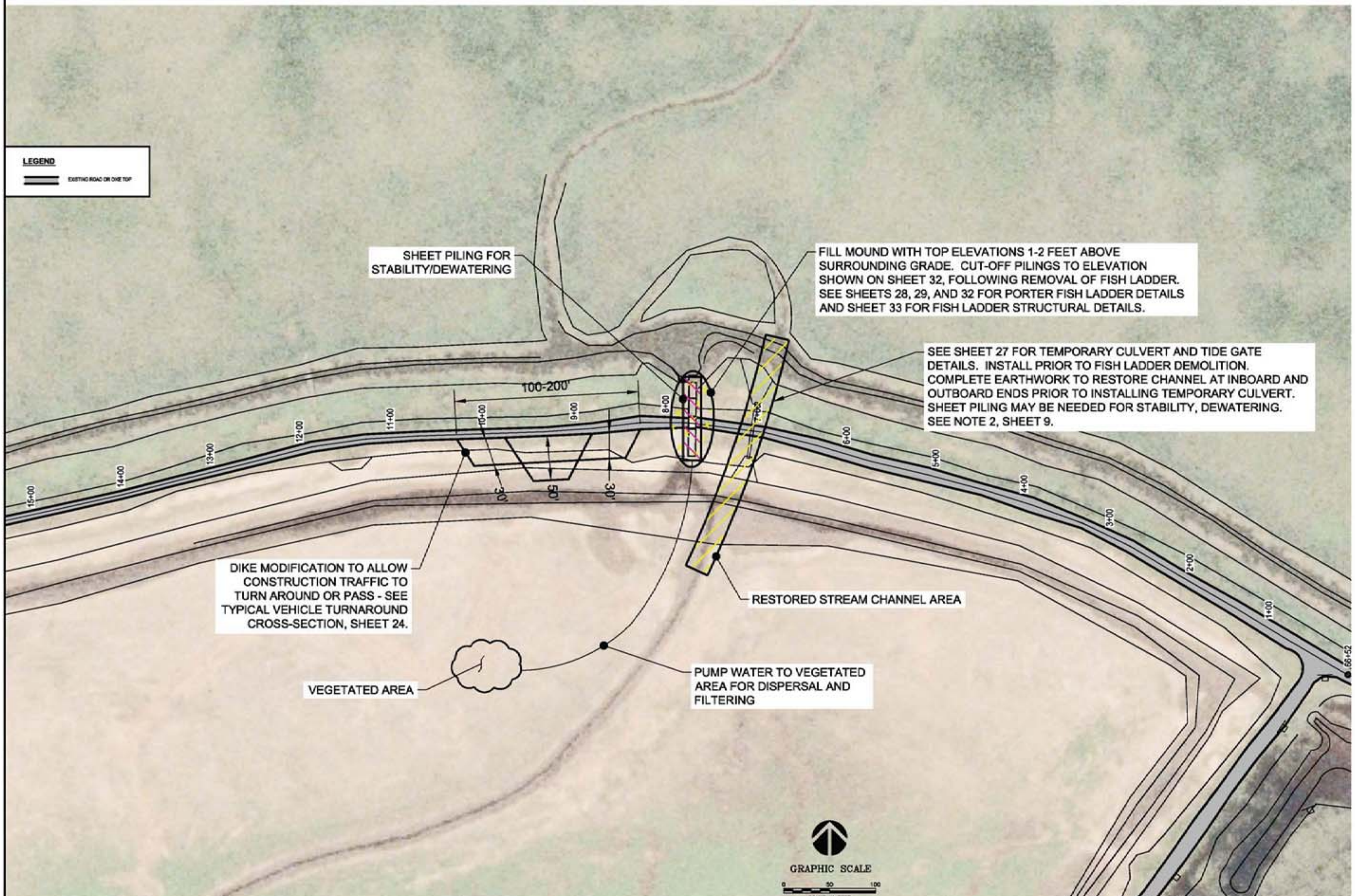
BEAR RIVER ESTUARY RESTORATION

DATE: JULY 2010

13

SHEET NUMBER



70% DESIGN

NO.	DESCRIPTION	BY	DATE

REVISIONS

PROJECT: BEAR RIVER ESTUARY RESTORATION

TITLE: PORTER FISH LADDER REMOVAL DETAIL

Client: WILLAPA BAY REGIONAL FISHERIES ENHANCEMENT GROUP

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BEAR RIVER ESTUARY RESTORATION

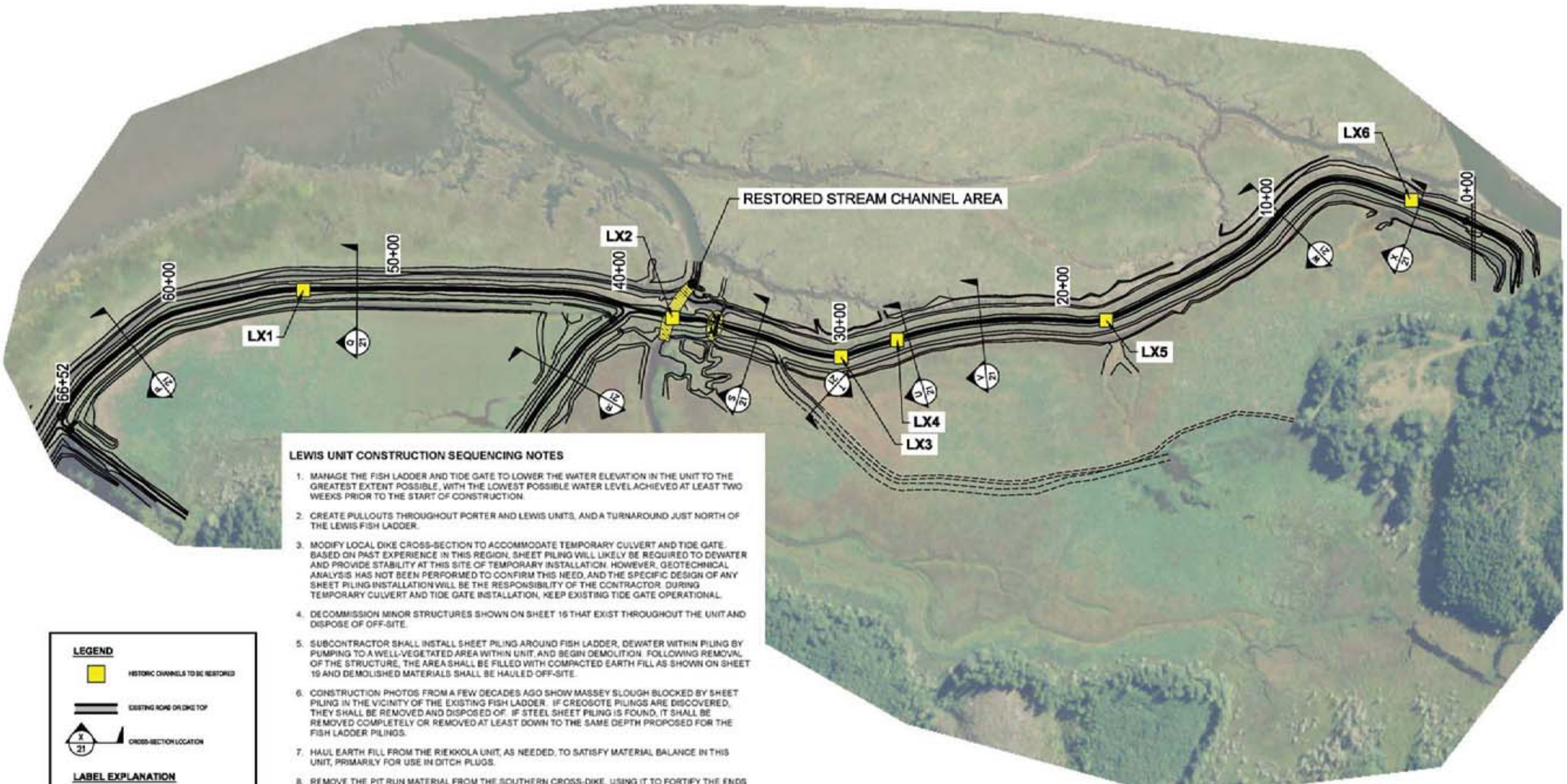
Project No. 0-915-16030-0 | REV No.

DR: JRS | CHK: RB/PS

DATE: JULY 2010

14

SHEET NUMBER



LEWIS UNIT CONSTRUCTION SEQUENCING NOTES

1. MANAGE THE FISH LADDER AND TIDE GATE TO LOWER THE WATER ELEVATION IN THE UNIT TO THE GREATEST EXTENT POSSIBLE, WITH THE LOWEST POSSIBLE WATER LEVEL ACHIEVED AT LEAST TWO WEEKS PRIOR TO THE START OF CONSTRUCTION.
2. CREATE PULLOUTS THROUGHOUT PORTER AND LEWIS UNITS, AND A TURNAROUND JUST NORTH OF THE LEWIS FISH LADDER.
3. MODIFY LOCAL DIKE CROSS-SECTION TO ACCOMMODATE TEMPORARY CULVERT AND TIDE GATE. BASED ON PAST EXPERIENCE IN THIS REGION, SHEET PILING WILL LIKELY BE REQUIRED TO DEWATER AND PROVIDE STABILITY AT THIS SITE OF TEMPORARY INSTALLATION. HOWEVER, GEOTECHNICAL ANALYSIS HAS NOT BEEN PERFORMED TO CONFIRM THIS NEED, AND THE SPECIFIC DESIGN OF ANY SHEET PILING INSTALLATION WILL BE THE RESPONSIBILITY OF THE CONTRACTOR. DURING TEMPORARY CULVERT AND TIDE GATE INSTALLATION, KEEP EXISTING TIDE GATE OPERATIONAL.
4. DECOMMISSION MINOR STRUCTURES SHOWN ON SHEET 16 THAT EXIST THROUGHOUT THE UNIT AND DISPOSE OF OFF-SITE.
5. SUBCONTRACTOR SHALL INSTALL SHEET PILING AROUND FISH LADDER, DEWATER WITHIN PILING BY PUMPING TO A WELL-VEGETATED AREA WITHIN UNIT, AND BEGIN DEMOLITION. FOLLOWING REMOVAL OF THE STRUCTURE, THE AREA SHALL BE FILLED WITH COMPACTED EARTH FILL AS SHOWN ON SHEET 19 AND DEMOLISHED MATERIALS SHALL BE HAULED OFF-SITE.
6. CONSTRUCTION PHOTOS FROM A FEW DECADES AGO SHOW MASSEY SLOUGH BLOCKED BY SHEET PILING IN THE VICINITY OF THE EXISTING FISH LADDER. IF CREOSOTE PILINGS ARE DISCOVERED, THEY SHALL BE REMOVED AND DISPOSED OF. IF STEEL SHEET PILING IS FOUND, IT SHALL BE REMOVED COMPLETELY OR REMOVED AT LEAST DOWN TO THE SAME DEPTH PROPOSED FOR THE FISH LADDER PILINGS.
7. HAUL EARTH FILL FROM THE RIEKKOLA UNIT, AS NEEDED, TO SATISFY MATERIAL BALANCE IN THIS UNIT, PRIMARILY FOR USE IN DITCH PLUGS.
8. REMOVE THE PIT RUN MATERIAL FROM THE SOUTHERN CROSS-DIKE, USING IT TO FORTIFY THE ENDS OF THE OUTBOARD DITCH PLUGS, WITH THE REST OF THE MATERIAL PLACED IN THE BOTTOM OF BORROW DITCHES OR USED TO FORTIFY THE DIKE TOPS FOR CONSTRUCTION ACCESS. WHERE USED IN BORROW DITCHES, IT SHALL BE BURIED BY AT LEAST TWO FEET OF FINE-GRAINED MATERIAL. ALTERNATELY, IF THIS MATERIAL COULD BE SUITABLE AS CHANNEL BOTTOM MATERIAL, STOCKPILE IT FOR LATER PLACEMENT.
9. REMOVE CUT A CROSS-SECTION OF MAIN DIKE AS SHOWN ON SHEET 24, PLACING THE MATERIAL IN THE INBOARD DITCHES. THIS MAY BE DONE IN ONE OR MORE STAGES, TO BE DICTATED BY THE TIDAL ELEVATIONS LIKELY TO BE ENCOUNTERED DURING CONSTRUCTION. BORROW DITCHES SHALL BE COMPLETELY FILLED AND A SMALL TRENCH CREATED WITHIN THE EXISTING DIKE FOOTPRINT TO ACCEPT THE LAST CUT OF ADJACENT DIKE MATERIAL OR THE BORROW DITCHES MAY BE MOSTLY FILLED, LEAVING ENOUGH ROOM FOR THE REMAINING DIKE MATERIAL. THIS DESIGN GUIDELINE IS SUBJECT TO CHANGE BASED UPON SPOT LOCAL SAFETY REASONS. DIKE REMOVAL WILL NEED TO SUPPORT SAFE PASSAGE OF EQUIPMENT. ADAPTIVE MANAGEMENT BY THE CONTRACTOR MAY RESULT IN CHANGING THE CONFIGURATION AS NEEDED.
10. REMOVE THE CROSS-DIKE JUST NORTH OF THE LEWIS FISH LADDER.
11. REMOVE THE REMAINING DIKE MATERIAL BY STARTING AT THE SOUTHERN END OF THE UNIT AND WORKING NORTH, PLACING THE MATERIALS IN THE CREATED TRENCH WITHIN THE CURRENT DIKE FOOTPRINT OR THE DITCH.
12. RESTORE THE CHANNELS WHERE IDENTIFIED ON THE PLAN SET AS THEY ARE ENCOUNTERED. FINAL BREACH SHALL BE MADE ON AN INCOMING TIDE TO MINIMIZE DOWNSTREAM SEDIMENT MOVEMENT.
13. REMOVE TEMPORARY CULVERT AND TIDE GATE WHEN LOCAL CHANNEL IS RESTORED.

Lewis Unit Dike and Ditch Summary	
Dike Length Cut (Feet)	9,896
Ditch Length Filled (Feet)	7,424
Total Volume Cut (CY)	43,226
Total Volume Filled (CY)	46,185
Net Cut/(Fill) Volume (CY)	(2,959)
Number of Historic Channels Restored	6

LEGEND

HISTORIC CHANNELS TO BE RESTORED

EXISTING ROAD OR DIKE TOP

X / 21 CROSS-SECTION LOCATION

LABEL EXPLANATION

LC2

UNIT DESIGNATION
R = RIEKKOLA UNIT (PARKER SLOUGH)
P = PORTER UNIT
L = LEWIS UNIT

SEQUENTIAL NUMBERING

TYPE DESIGNATION
X = HISTORIC CHANNEL
L = LEVEE
D = DITCH
R = ROAD
C = CULVERT/ OTHER STRUCTURES
P = DITCH PLUG

GRAPHIC SCALE

0 250 500

SCALE IN FEET

70% DESIGN

NO.	REVISIONS DESCRIPTION	BY	DATE

PROJECT: BEAR RIVER ESTUARY RESTORATION

TITLE: LEWIS UNIT PLAN VIEW - FEATURES

Client: WILLAPA BAY REGIONAL FISHERIES ENHANCEMENT GROUP

AMEC Earth & Environmental

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BEAR RIVER ESTUARY RESTORATION

Project No. 0-915-16603-0 REV No.

DR: JRS CHK: RB/PS

DATE: JULY 2010

15

SHEET NUMBER

LEGEND

○ STRUCTURES TO BE REMOVED

═ EXISTING ROAD OR DIKE TOP

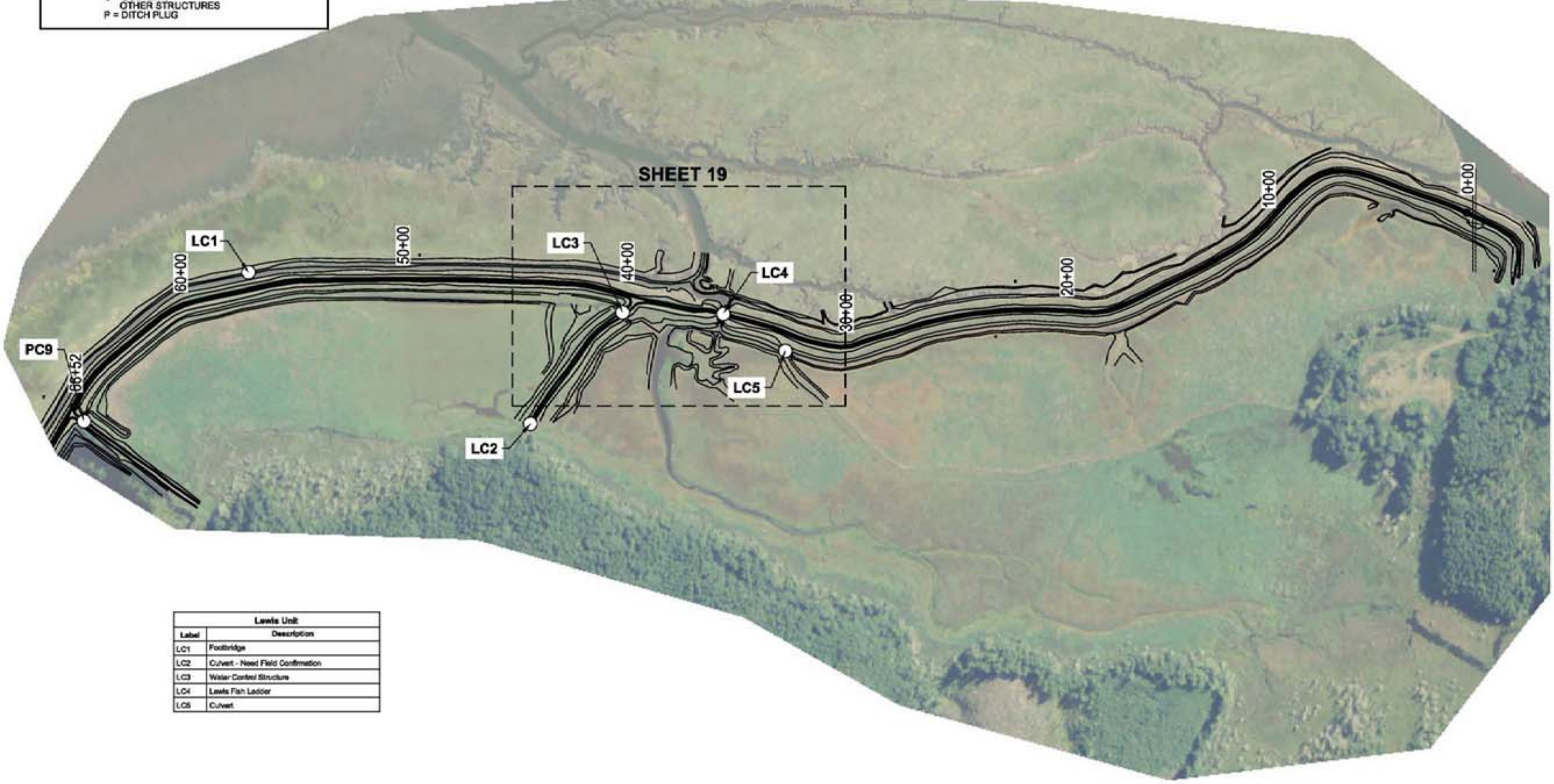
LABEL EXPLANATION

LC2
- UNIT DESIGNATION
  - R = RIEKKOLA UNIT (PARKER SLOUGH)
  - P = PORTER UNIT
  - L = LEWIS UNIT
- SEQUENTIAL NUMBERING
- TYPE DESIGNATION
  - X = HISTORIC CHANNEL
  - L = LEVEE
  - D = DITCH
  - R = ROAD
  - C = CULVERT/ OTHER STRUCTURES
  - P = DITCH PLUG

GRAPHIC SCALE

0 250 500

SCALE IN FEET



Lewis Unit	
Label	Description
LC1	Footbridge
LC2	Culvert - Need Field Confirmation
LC3	Water Control Structure
LC4	Lewis Fish Ladder
LC5	Culvert

70% DESIGN

REVISIONS

NO.	DESCRIPTION	BY	DATE

PROJECT: BEAR RIVER ESTUARY RESTORATION

TITLE: LEWIS UNIT
PLAN VIEW - STRUCTURE REMOVAL

Client: WILLAPA BAY REGIONAL FISHERIES ENHANCEMENT GROUP

AMEC Earth & Environmental

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BEAR RIVER ESTUARY RESTORATION

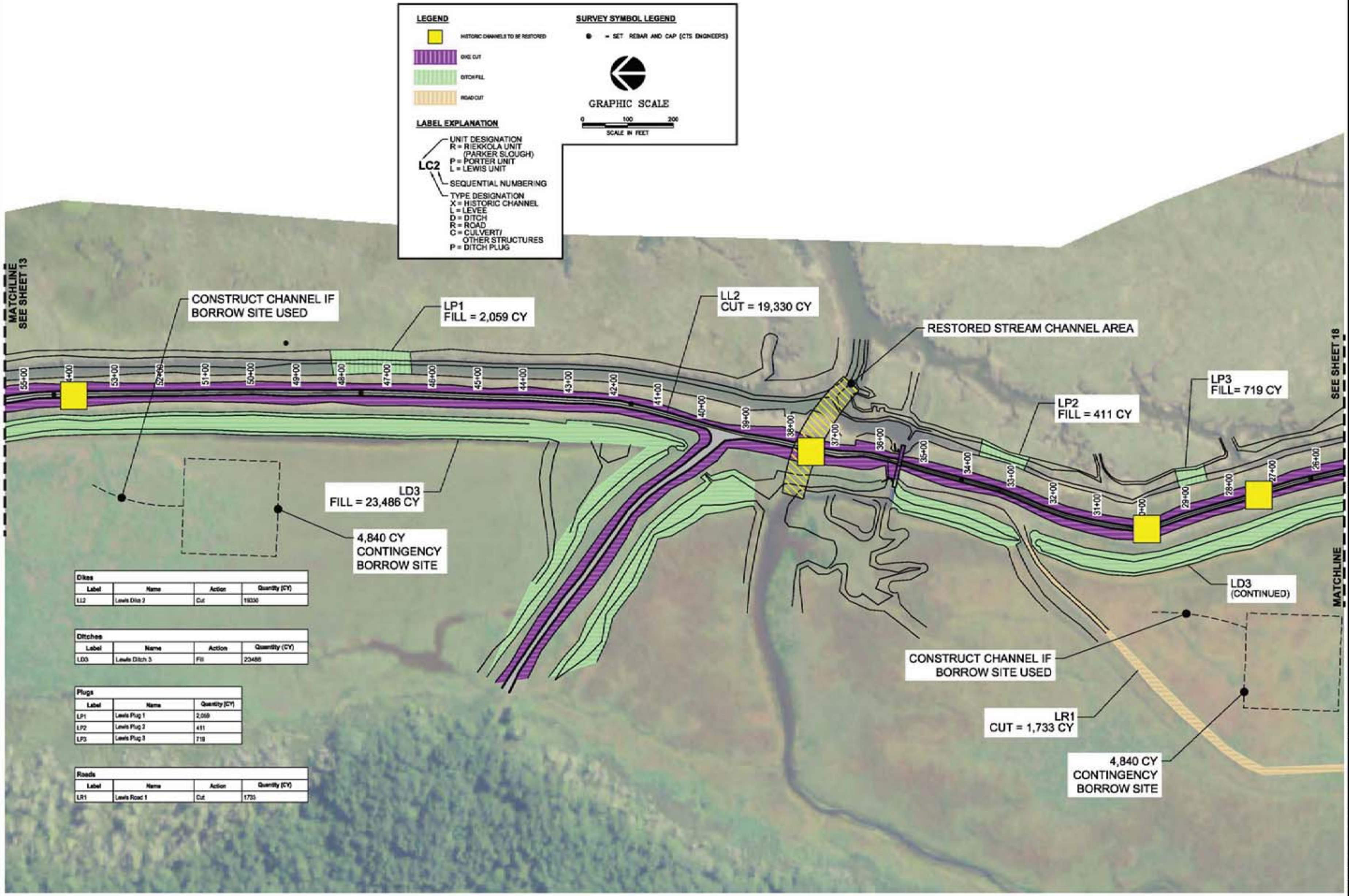
Project No. 0-915-16930-0 REV No.

DR: JRS CHK: REPS

DATE: JULY 2010

16

SHEET NUMBER



Dikes

Label	Name	Action	Quantity (CY)
LL2	Lewis Dike 2	Cut	19330

Ditches

Label	Name	Action	Quantity (CY)
LD3	Lewis Ditch 3	Fill	23486

Plugs

Label	Name	Quantity (CY)
LP1	Lewis Plug 1	2,059
LP2	Lewis Plug 2	411
LP3	Lewis Plug 3	719

Roads

Label	Name	Action	Quantity (CY)
LR1	Lewis Road 1	Cut	1733

REVISIONS			
NO.	DESCRIPTION	BY	DATE

PROJECT: BEAR RIVER ESTUARY RESTORATION

TITLE: LEWIS UNIT EARTHWORK LAYOUT 1

Client: WILLAPA BAY REGIONAL FISHERIES ENHANCEMENT GROUP

AMEC Earth & Environmental

amec

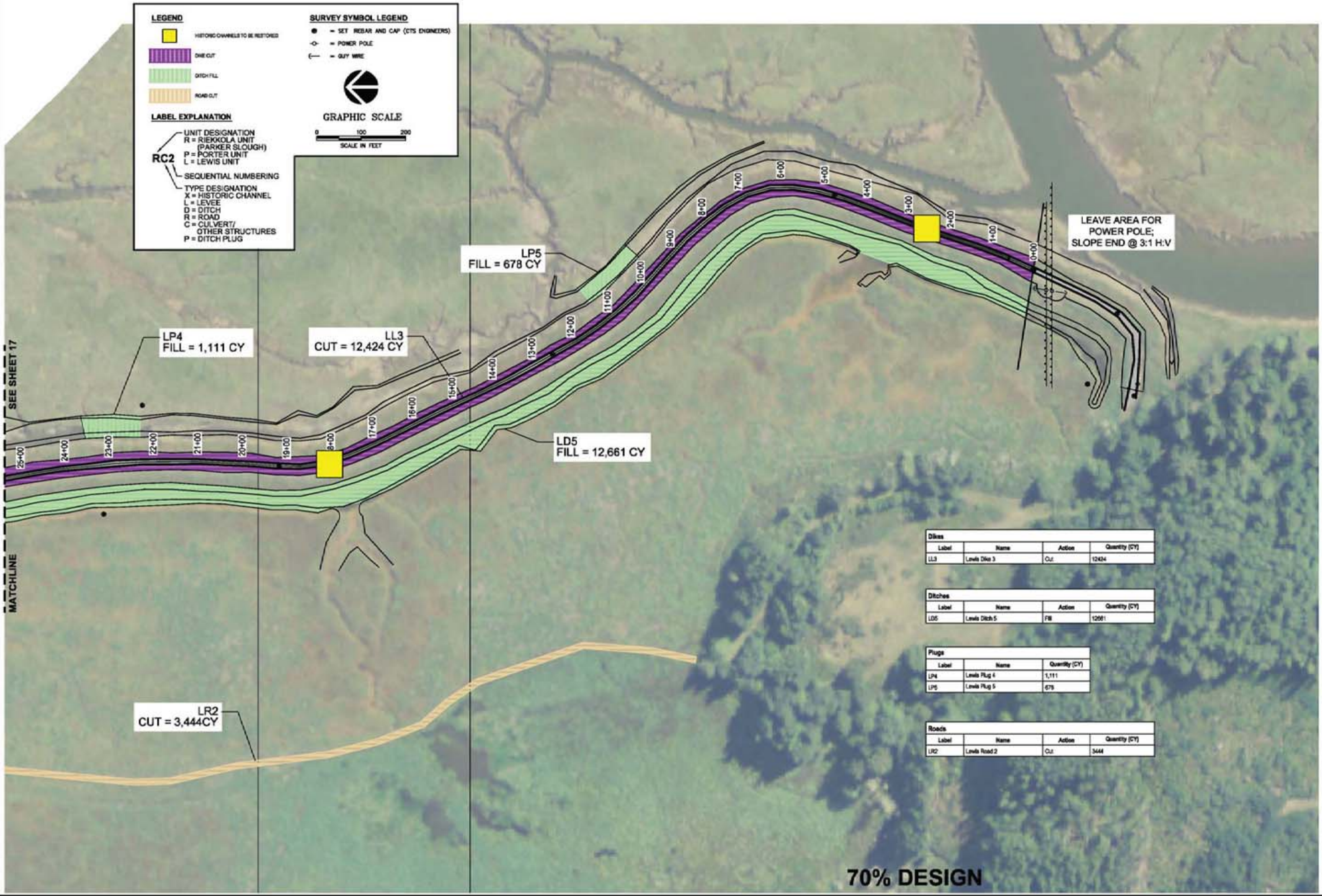
BEAR RIVER ESTUARY RESTORATION

DATE: JULY 2010

17

SHEET NUMBER

70% DESIGN



Dikes

Label	Name	Action	Quantity (CY)
LL3	Lewis Dike 3	Cut	12424

Ditches

Label	Name	Action	Quantity (CY)
LD5	Lewis Ditch 5	Fill	12661

Plugs

Label	Name	Quantity (CY)
LP4	Lewis Plug 4	1,111
LP5	Lewis Plug 5	678

Roads

Label	Name	Action	Quantity (CY)
LR2	Lewis Road 2	Cut	3444

REVISIONS			
NO.	DESCRIPTION	BY	DATE

PROJECT: BEAR RIVER ESTUARY RESTORATION

TITLE: LEWIS UNIT
EARTHWORK LAYOUT 2

Client: WILLAPA BAY REGIONAL FISHERIES ENHANCEMENT GROUP

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11810 North Creek Parkway North, Bothell, WA, U.S.A. 98011-8201
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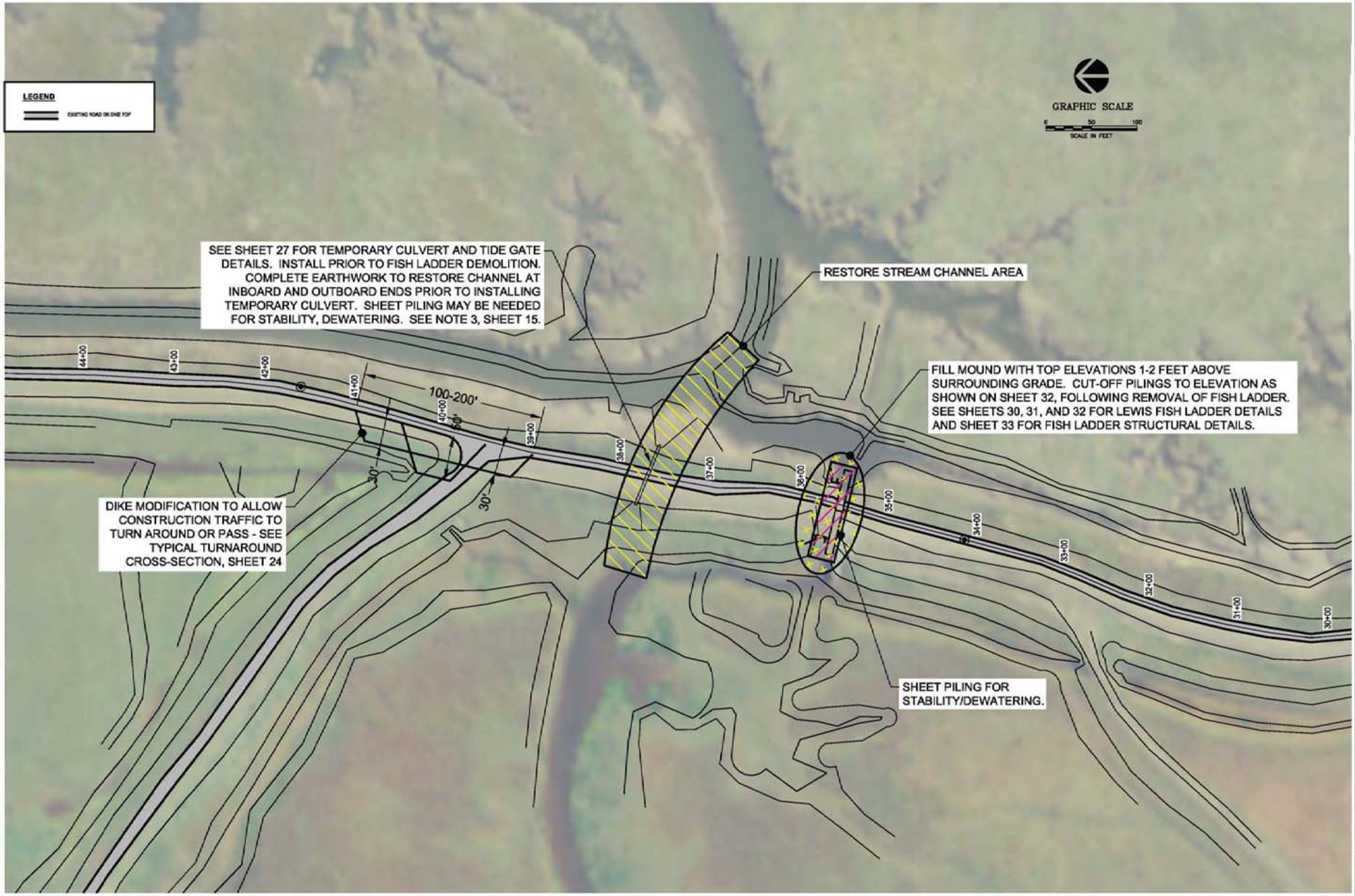
BEAR RIVER ESTUARY RESTORATION

Project No. 0-915-16930-0 | REV No.
DR: JRS | CHK: RB/PS
DATE: JULY 2010

18
SHEET NUMBER



70% DESIGN

REVISIONS			
NO.	DESCRIPTION	BY	DATE

PROJECT: BEAR RIVER ESTUARY RESTORATION

TITLE: LEWIS FISH LADDER REMOVAL DETAIL

Client: WILLAPA BAY REGIONAL FISHERIES ENHANCEMENT GROUP

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BEAR RIVER ESTUARY RESTORATION

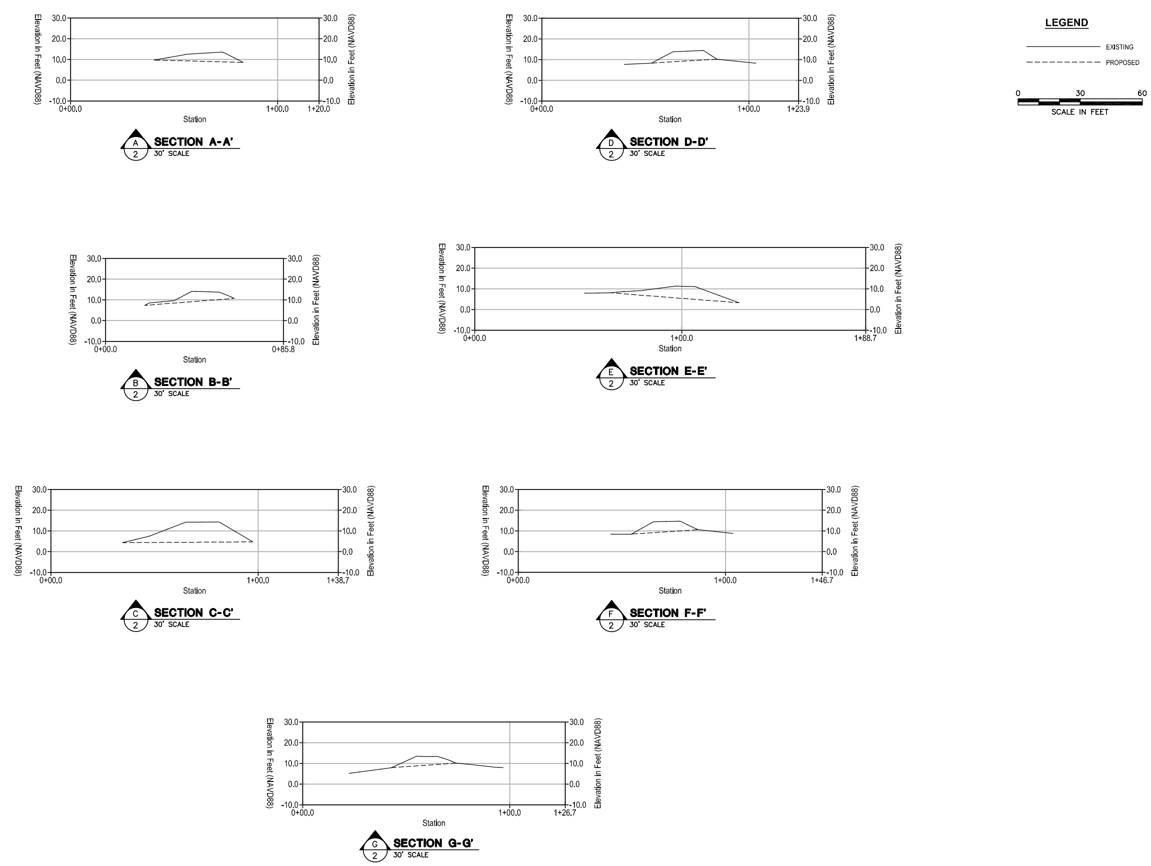
Project No. 0-915-16930-0 | REV No.

DR: JRS | CHK: RB/PS

DATE: JULY 2010

19

SHEET NUMBER



RIEKKOLA UNIT (PARKER SLOUGH AREA) EXISTING CROSS SECTIONS

70% DESIGN

NO.	DESCRIPTION	BY	DATE
	REVISIONS		

PROJECT: BEAR RIVER ESTUARY RESTORATION

TITLE: REIKKOLA UNIT (PARKER SLOUGH AREA) CROSS SECTIONS

Client: WILLAPA BAY REGIONAL FISHERIES ENHANCEMENT GROUP

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Project No. 0-915-16933-0 | REV No.
DR: JRS | CHK: RB/PS
DATE: JULY 2010

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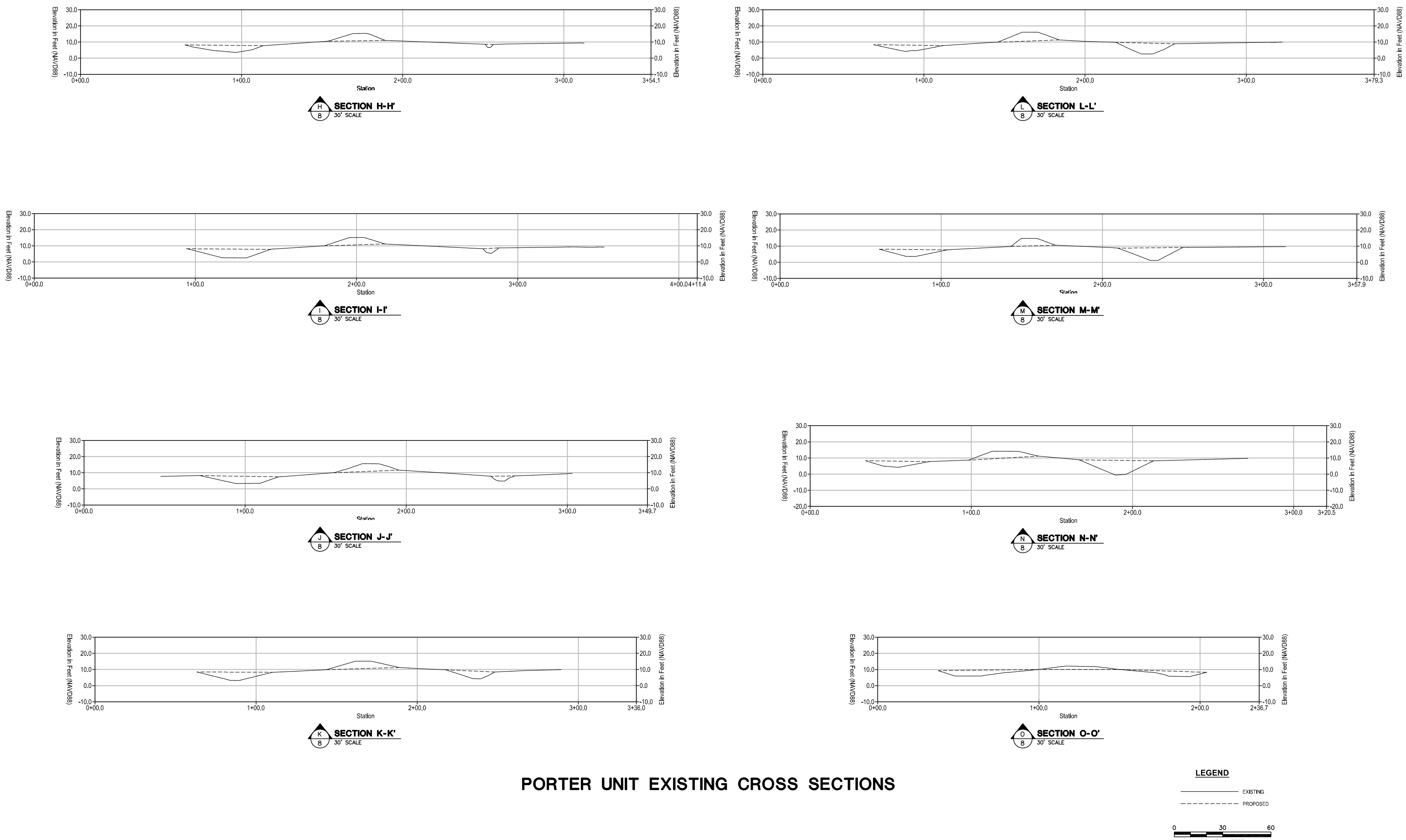

PORTER UNIT EXISTING CROSS SECTIONS

70% DESIGN

NO.	DESCRIPTION	BY	DATE

REVISIONS

PROJECT: BEAR RIVER ESTUARY RESTORATION

TITLE: PORTER UNIT CROSS SECTIONS

Client: WILLAPA BAY REGIONAL FISHERIES ENHANCEMENT GROUP

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BEAR RIVER ESTUARY RESTORATION
Project No. 0-915-16933-0 | REV No.
DR: JRS | CHK: RB/PS
DATE: JULY 2010

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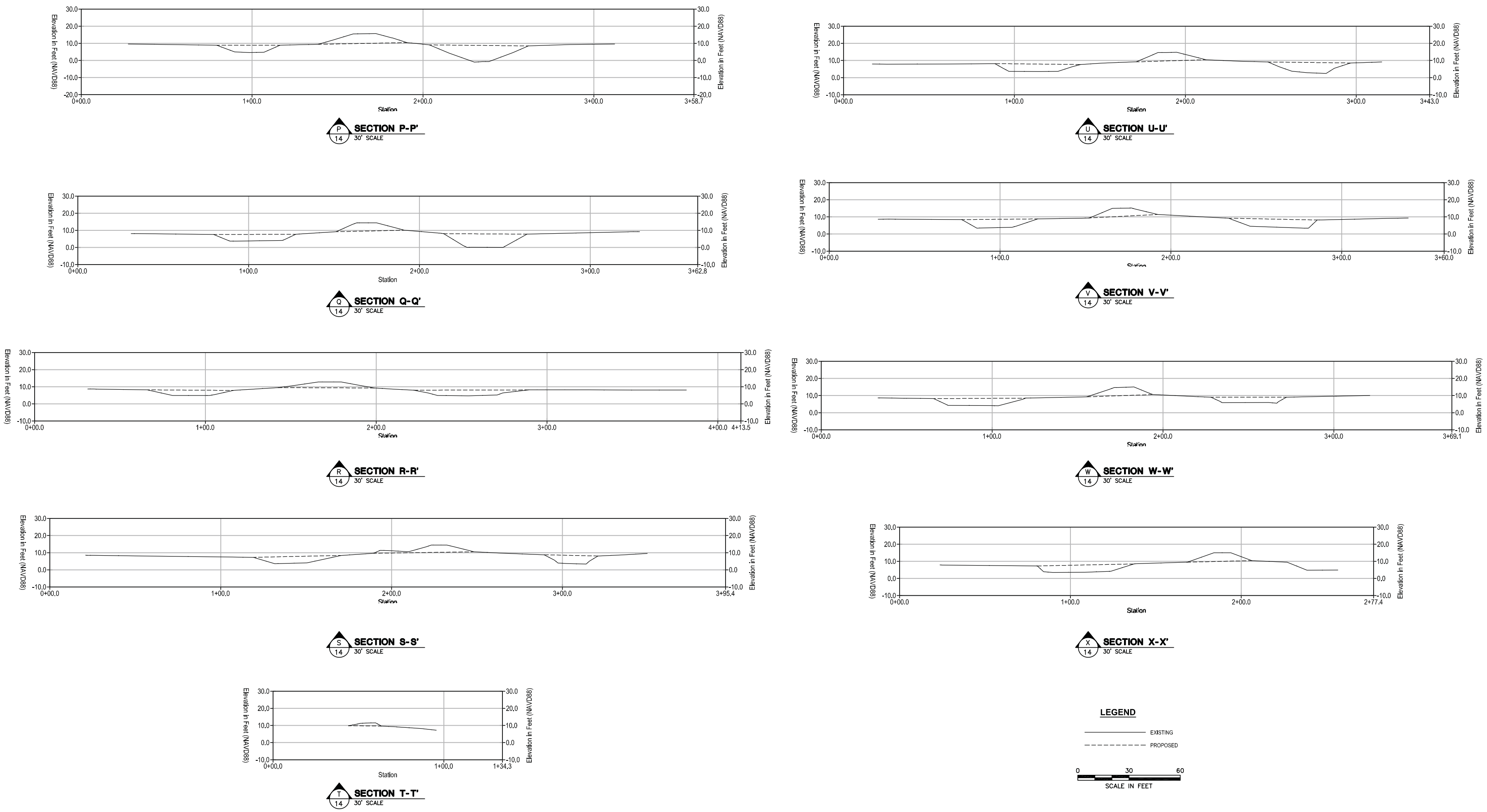

LEWIS UNIT EXISTING CROSS SECTIONS

70% DESIGN

NO.	DESCRIPTION	BY	DATE

REVISIONS

PROJECT: BEAR RIVER ESTUARY RESTORATION

TITLE: LEWIS UNIT CROSS SECTIONS

Client: WILLAPA BAY REGIONAL FISHERIES ENHANCEMENT GROUP

AMEC Earth & Environmental
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Phone: (425) 368-1000 Fax: (425) 368-1001

BEAR RIVER ESTUARY RESTORATION

Project No. 0-915-16933-0	REV No.
DR: JRS	CHK: RB/PS
DATE: JULY 2010	

22
SHEET NUMBER

THE MOST IMPORTANT PARAMETERS FOR THE CHANNELS ARE THE ELEVATION, WIDTH, AND SIDE SLOPES. THE RECOMMENDED DEPTHS AND WIDTHS FOR THE CHANNELS HAVE BEEN COMPUTED CONSERVATIVELY. THESE RECOMMENDED CONFIGURATIONS REPRESENT PREDICTED CHANNEL SIZES AND DEPTHS, USING EMPIRICAL RELATIONSHIPS FROM OTHER LOCATIONS, EXTRAPOLATED TO THE TIDE RANGE AT THIS PROJECT SITE. THERE ARE A NUMBER OF UNCERTAINTIES IN THE RELATIONSHIPS, LOCAL FACTORS, AND DATA. THEREFORE, THE HISTORIC CHANNEL DEPTHS SHOULD BE CONSTRUCTED AT AN ELEVATION NO HIGHER THAN EXISTING, AND AS CLOSE AS POSSIBLE TO THE RECOMMENDED ELEVATION. SIMILARLY, THE BOTTOM WIDTH SHOULD BE CONSTRUCTED AT LEAST AS WIDE AS THE EXISTING CHANNELS ON BOTH SIDES OF THE RESTORED CROSSING, AND AS CLOSE AS POSSIBLE TO THE RECOMMENDED WIDTH. AMEC RECOMMENDS THAT SIDE SLOPES SHOULD BE MADE AT LEAST AS FLAT AS THE EXISTING OUTBOARD CHANNEL, WITH AS CLOSE TO 3:1 AS POSSIBLE. IF THE EXISTING CHANNEL ON THE BAY SIDE OF A HISTORIC CHANNEL CROSSING IS AT A LOWER ELEVATION OR IS WIDER THAN WHAT IS LISTED IN THE TABLE, THE CHANNEL SHALL BE CONSTRUCTED TO THE LOWER ELEVATION AND/OR WIDER WIDTH OF THE EXISTING CHANNEL. SEE DESIGN NARRATIVE FOR ADDITIONAL INFORMATION.

Historic Channel To Be Restored	Bottom Elevation (NAVD ft)	Bottom Width (feet)
RX1	-4.8	31.0
RX2	-0.2	10.0
RX3	-5.8	42.0
RX4	-3.3	16.0
RX5	-3.2	16.0
PX1	1.8	3.0
PX2	1.3	6.0
PX3	2.0	3.0
PX4	1.9	3.0
PX5	1.6	6.0
PX6	1.1	4.0
PX7	0.0	12.0
LX1	0.2	3.0
LX2	-1.5	8.0
LX3	3.6	8.0
LX4	3.1	12.0
LX5	0.4	4.0
LX6	1.9	6.0

Side slopes shall be constructed at 3 horizontal : 1 vertical

NOTE: IF THE EXISTING CHANNEL ON THE BAY SIDE OF A HISTORIC CHANNEL IS AT A LOWER ELEVATION OR IS WIDER THAN WHAT IS LISTED IN THE TABLE, THE CHANNEL SHALL BE CONSTRUCTED TO THE LOWER ELEVATION AND/OR WIDER WIDTH OF THE EXISTING CHANNEL.

70% DESIGN

REVISIONS

NO.	DESCRIPTION	BY	DATE

PROJECT: BEAR RIVER ESTUARY RESTORATION

TITLE: RESTORED CHANNEL DETAILS

Client: WILLAPA BAY REGIONAL FISHERIES ENHANCEMENT GROUP

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BEAR RIVER ESTUARY RESTORATION

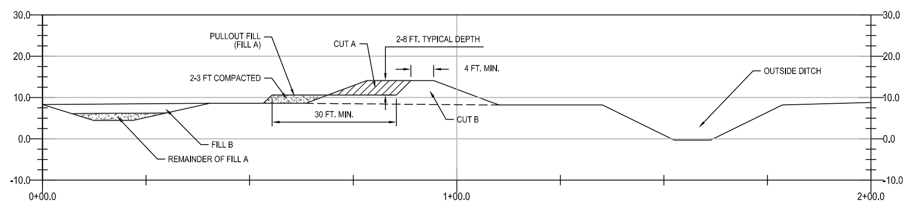
Project No. 0-915-16933-0 REV No.

DR: JRS CHK: RB/PS

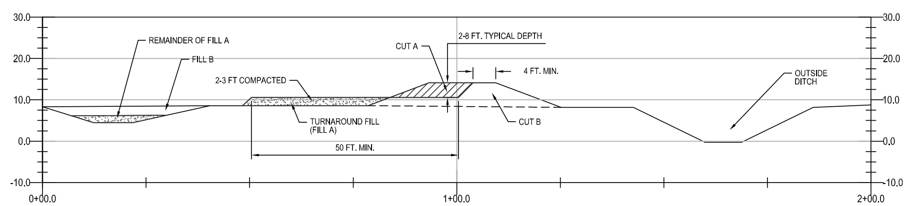
DATE: JULY 2010

23

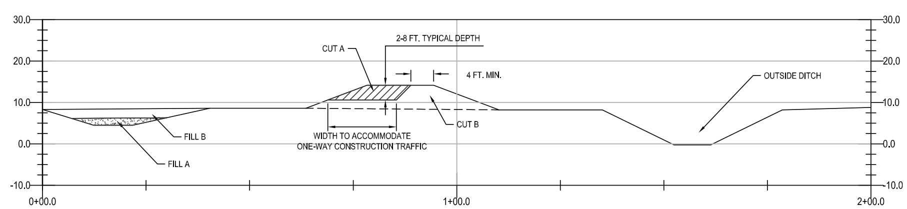
SHEET NUMBER



TYPICAL VEHICLE PULLOUT AREA CROSS-SECTION
CONCEPTUAL SCALE



TYPICAL VEHICLE TURNAROUND CROSS-SECTION
CONCEPTUAL SCALE



TYPICAL DIKE CUT CROSS-SECTION
CONCEPTUAL SCALE

70% DESIGN

REVISIONS

NO.	DESCRIPTION	BY	DATE

PROJECT: BEAR RIVER ESTUARY RESTORATION

TITLE: TYPICAL DIKE CUT CROSS SECTIONS

Client: WILLAPA BAY REGIONAL FISHERIES ENHANCEMENT GROUP

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BEAR RIVER ESTUARY RESTORATION

Project No. 0-915-16933-0 | REV No.
DR: JRS | CHK: RB/PS
DATE: JULY 2010

24
SHEET NUMBER

Earthwork quantities calculated for this project were based on survey data by CTS Engineers, where available. For those features not surveyed, their volumes are a best professional estimate based on interpretation of aerial photography and comparison with similar surveyed features on-site. All volumes are based on in-place yardage. The overall balance of materials depends significantly on the conditions experienced in the field. To anticipate potential material shortages resulting from varying conditions, contingency borrow areas have been identified in both the Porter and Lewis Units.

Cut and fill actions are organized in an approximately sequential order in this table. Cut features are listed on the left-hand column of the table, with the proposed destinations for that material shown as fill features across each row of the table. Although organized in the table by unit, certain earthwork actions in different units can be completed concurrently without breaching external dikes. Variations in soil material, quality, and moisture content, along with compaction conditions will result in volumes different from those calculated. The construction sequence reflected in this table is hypothetical in nature and suggests minor differences in earthwork actions not reflected in the raw cut/fill balance summaries on Sheets 3, 9, and 15. It is recommended that those sheets be consulted for overall project cut/fill balance information.

Earthwork Mass Balance

Earth Fill In Lewis Unit (In-place cubic yards)

Earth Cut	LP5	LP4	LP3	LP2	LP1	LD5	LC4 Fill	LD3	LD2	LD1	PD5					Earth Cut Total
RL4	678	1,111	719	411	2,059	237		115								5,330
LR2	18	30	29	17	42		1,000	2,308								3,444
LR1								1,733								1,733
LL3						12,424										12,424
LL2								19,330								19,330
LL1									3,459	1,600	1,236					6,295
Earth Fill Total	696	1,141	748	428	2,101	12,661	1,000	23,486	3,459	1,600	1,236					

Earth Fill In Porter Unit (In-place cubic yards)

Earth Cut	PD5	PC8	PD4	PP8	PP7	PD3	PP6	PP5	PD2	PP4	PP3	PP2	PD1	PP1		Earth Cut Total
RL4		542								483	417	176	1,090	65		2,773
PL5	1,123	458														1,581
PL4			7,687	2,386	2,200											12,273
PL3						10,933	1,852	1,089	1,513							15,387
PL2									11,386				124			11,510
PL1													3,881			3,881
Earth Fill Total	1,123	1,000	7,687	2,386	2,200	10,933	1,852	1,089	12,899	483	417	176	5,095	65		

Earth Fill in Riekkola Unit (Parker Slough area) (In-place cubic yards)

Earth Cut	RD11	RD10	RD8	RD7	Backslope	Platform Fill	County Road	RD5	RD3	RD4	RD2	RD1	RD6	RD9	Spread	Earth Cut Total
RL4	Unknown	751	1,067	107	1,682		7,540									11,147
RL3								5,333	1,481	Optional	Optional	4,944				11,758
RL2					5,818	1,560						626				8,004
RR1													Unknown	Unknown		
RR3													Unknown	Unknown		
RR2															667	667
Earth Fill Total	0	751	1,067	107	7,500	1,560	7,540	5,333	1,481	0	0	5,570	0	0	667	

70% DESIGN

REVISIONS
NO. DESCRIPTION BY DATE

PROJECT: BEAR RIVER ESTUARY RESTORATION ELEMENT
TITLE: EARTHWORK MASS BALANCE

Client: WILLAPA BAY REGIONAL FISHERIES ENHANCEMENT GROUP

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11810 North Creek Parkway North, Bothell, WA, U.S.A. 98011-8201
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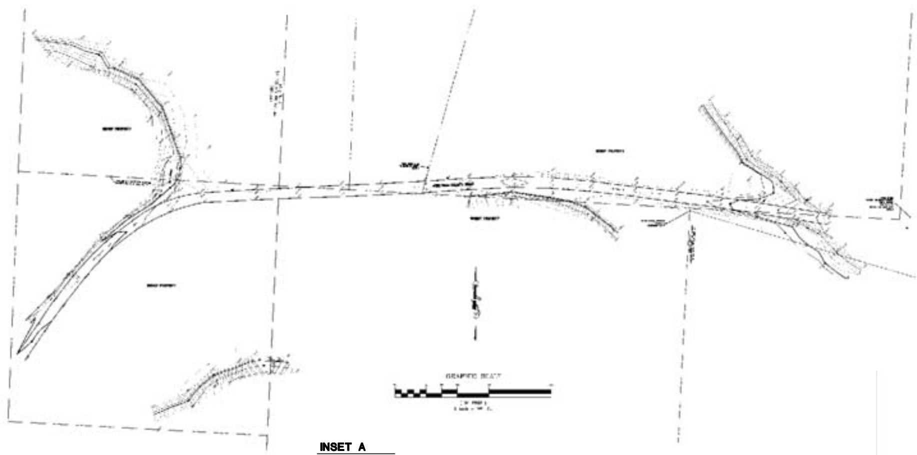
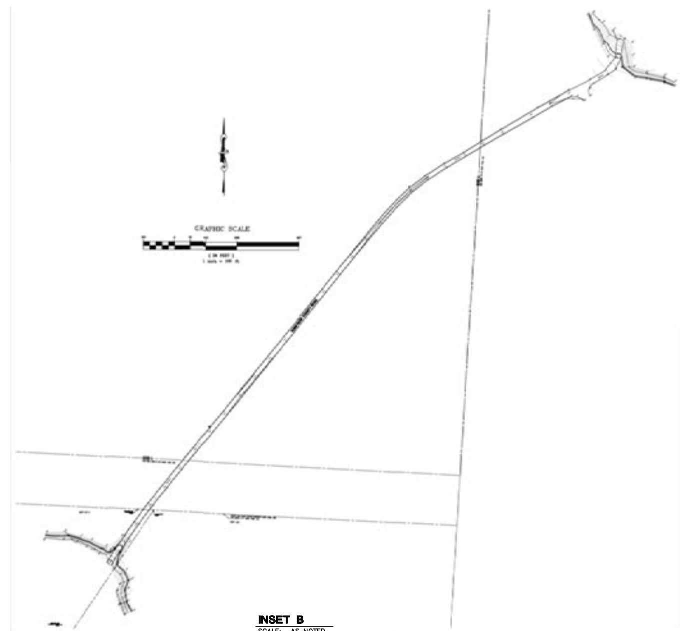
BEAR RIVER ESTUARY RESTORATION
Project No. 0-915-16933-0 REV No.
DR: JRS CHK: RB/PS
DATE: JULY 2010

25
SHEET NUMBER



INSET A
SCALE: AS NOTED



INSET B
SCALE: AS NOTED

NOTE: GRAPHICS HERE WERE PROVIDED BY CTS ENGINEERS AND ARE SHOWN "AS-IS".

70% DESIGN

REVISIONS			
NO.	DESCRIPTION	BY	DATE

PROJECT: BEAR RIVER ESTUARY RESTORATION ELEMENT

TITLE: 67TH PLACE PLACEHOLDER SHEET

Client: WILLAPA BAY REGIONAL FISHERIES ENHANCEMENT GROUP

AMEC Earth & Environmental
11810 North Creek Parkway North, Bothell, WA, U.S.A. 98011-8201
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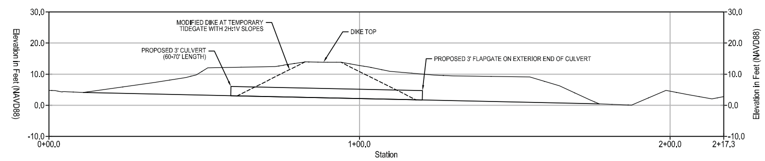
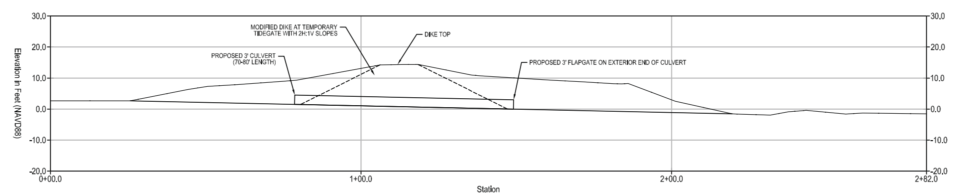
BEAR RIVER ESTUARY RESTORATION

Project No.	
0-915-16933-0	REV No.
DR: JRS	CHK: RB/PS
DATE: JULY 2010	

26
SHEET NUMBER



PORTER UNIT TEMPORARY TIDEGATE DETAIL PROFILE
20' SCALE



LEWIS UNIT TEMPORARY TIDEGATE DETAIL PROFILE
20' SCALE

LEGEND

———— EXISTING
- - - - - - PROPOSED

0 20 40
SCALE IN FEET

NOTE: TEMPORARY CULVERTS AND TIDEGATES SHALL BE INSTALLED AT AS LOW OF AN ELEVATION AS PRACTICAL AND POSSIBLE, AND IN NO CASE SHALL THEIR INVERT ELEVATIONS BE HIGHER THAN THOSE OF THE EXISTING DRAINAGE STRUCTURES. TARGET INVERT ELEVATION IN LEWIS UNIT IS -1.5 (LX2), AND 0.0 IN PORTER UNIT (PX7), TO MATCH ELEVATION PROPOSED FOR RESTORED CHANNEL ELEVATION.

70% DESIGN

REVISIONS			
NO.	DESCRIPTION	BY	DATE

PROJECT: BEAR RIVER ESTUARY RESTORATION

TITLE: TEMPORARY CULVERT AND TIDEGATE DETAILS

Client: WILLAPA BAY REGIONAL FISHERIES ENHANCEMENT GROUP

AMEC Earth & Environmental
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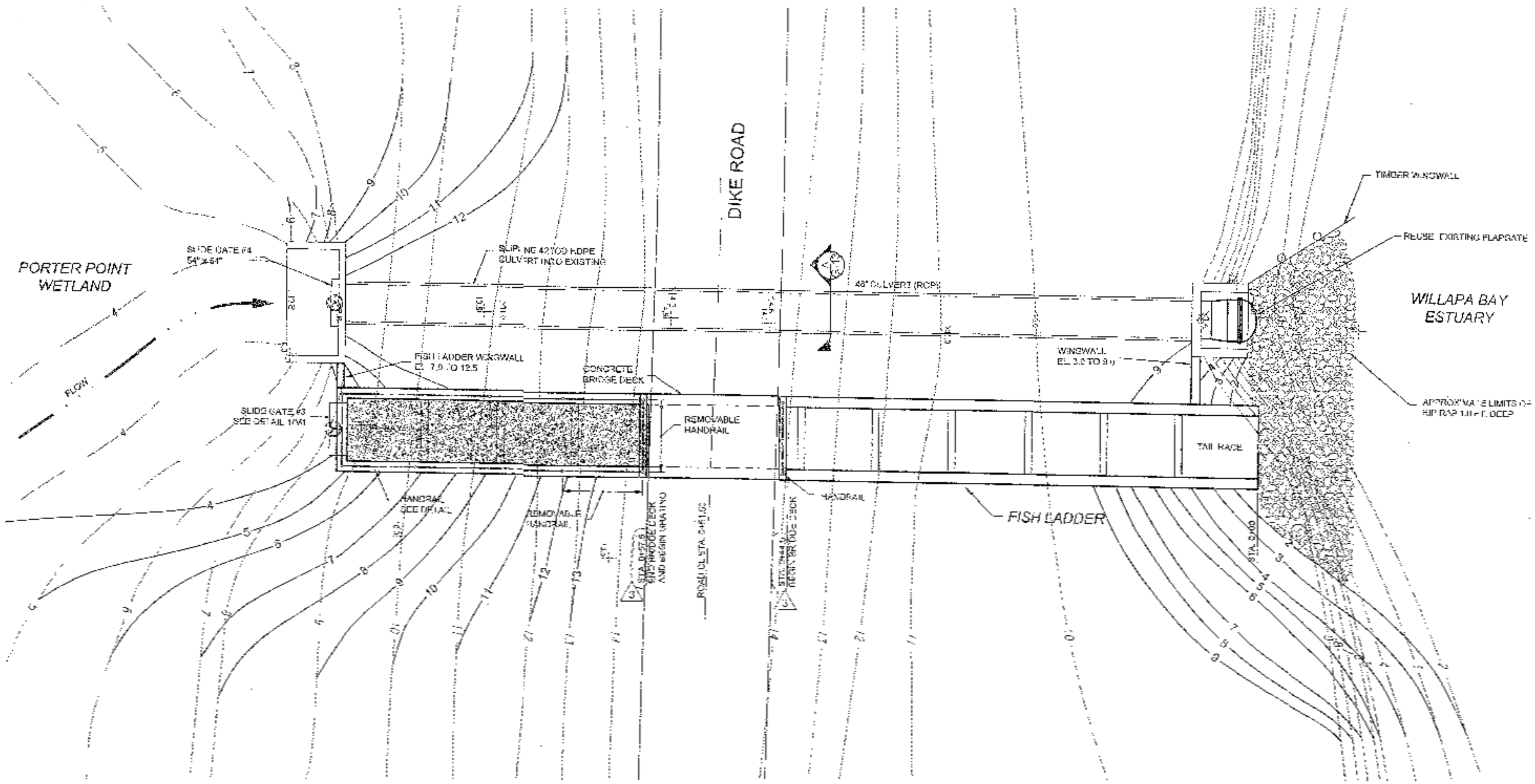
7-16-10

BEAR RIVER ESTUARY RESTORATION
Project No. 0-915-16933-0 | REV No.
DR: JRS | CHK:
DATE: JULY 2010

27
SHEET NUMBER



LEGEND

STEEL GRATING OVER FISHWAY AND OVERFLOW CHANNEL

NOTES:

1. ADAPTED FROM GOLDER ASSOCIATES, LEWIS AND PORTER FISH LADDER DESIGN, FEBRUARY 7, 2001.

N

0 5 10 FEET

GRAPHIC SCALE

0 5 10 SCALE IN FEET

70% DESIGN

NO.	DESCRIPTION	BY	DATE

REVISIONS

PROJECT: BEAR RIVER ESTUARY RESTORATION

TITLE: PORTER FISH LADDER GOLDER PLAN VIEW

Client: WILLAPA BAY REGIONAL FISHERIES ENHANCEMENT GROUP

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BEAR RIVER ESTUARY RESTORATION

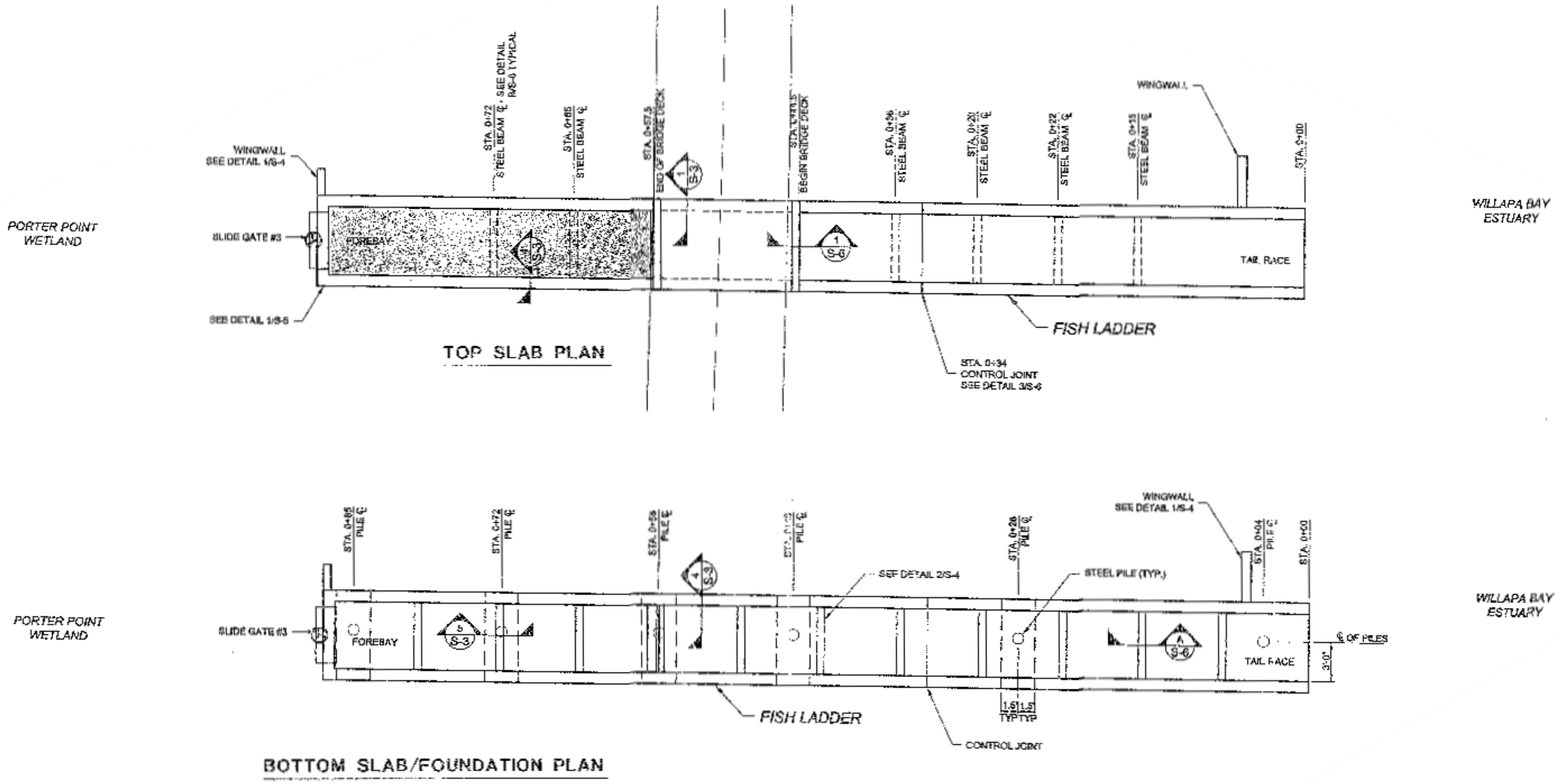
Project No. 0-915-16933-0 | REV No.

DR: JRS | CHK: RB/PS

DATE: JULY 2010

28

SHEET NUMBER



LEGEND

STEEL GRATING OVER FISHWAY AND OVERFLOW CHANNEL

0 5 10 FEET

NOTES:

1. ADAPTED FROM GOLDER ASSOCIATES, LEWIS AND PORTER FISH LADDER DESIGN, FEBRUARY 7, 2001.

GRAPHIC SCALE

0 5 10

SCALE IN FEET

70% DESIGN

REVISIONS			
NO.	DESCRIPTION	BY	DATE

PROJECT: BEAR RIVER ESTUARY RESTORATION

TITLE: PORTER FISH LADDER GOLDER SLAB DETAILS

Client: WILLAPA BAY REGIONAL FISHERIES ENHANCEMENT GROUP

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Project No. 0-915-16933-0 REV No.

DR: JRS CHK: RB/PS

DATE: JULY 2010

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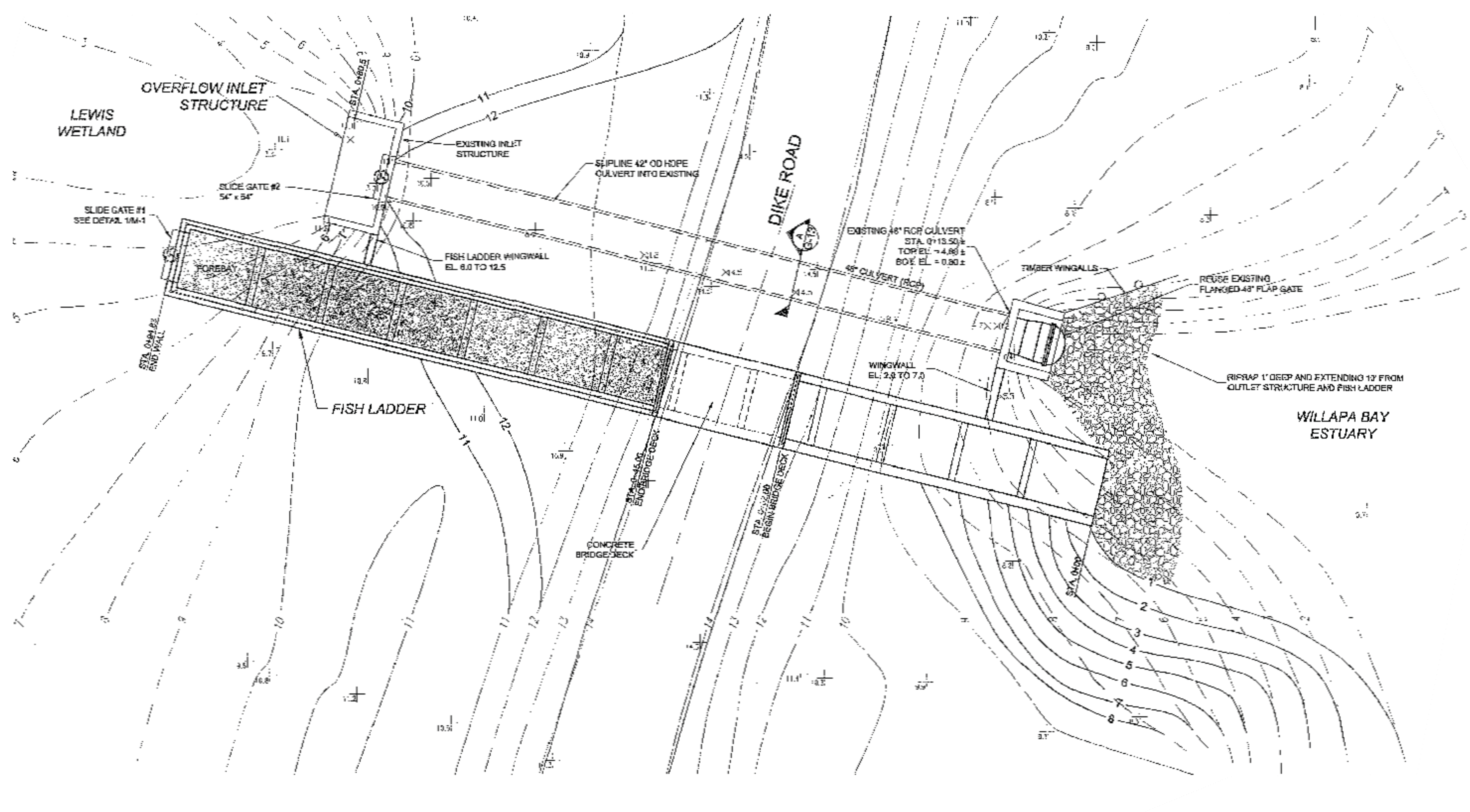

LEGEND

STEEL GRATING OVER FISHWAY AND OVERFLOW CHANNEL

NOTES:

1. ADAPTED FROM GOLDER ASSOCIATES, LEWIS AND PORTER FISH LADDER DESIGN, FEBRUARY 7, 2001.

GRAPHIC SCALE

0 5 10

SCALE IN FEET

70% DESIGN

REVISIONS			
NO.	DESCRIPTION	BY	DATE

PROJECT: BEAR RIVER ESTUARY RESTORATION

TITLE: LEWIS FISH LADDER GOLDER PLAN VIEW

Client: WILLAPA BAY REGIONAL FISHERIES ENHANCEMENT GROUP

AMEC Earth & Environmental
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BEAR RIVER ESTUARY RESTORATION

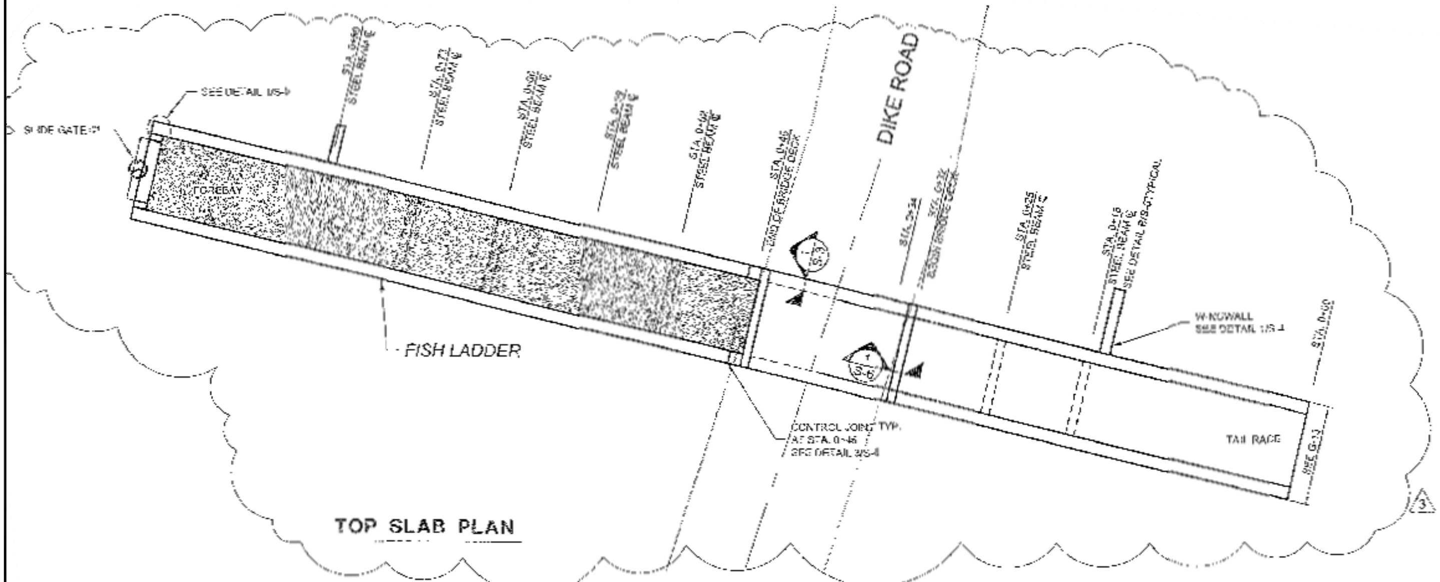
Project No. 0-915-16933-0 REV No. 0

DR: JRS CHK: RB/PS

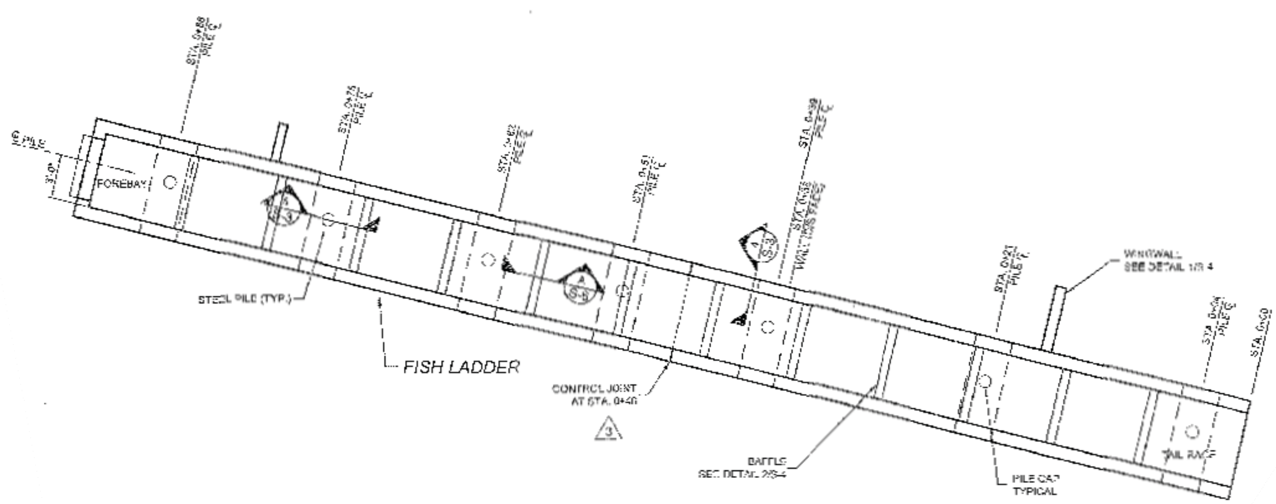
DATE: JULY 2010

30

SHEET NUMBER



TOP SLAB PLAN



BOTTOM SLAB/FOUNDATION PLAN

NOTES:
1. ADAPTED FROM GOLDER ASSOCIATES, LEWIS AND PORTER FISH LADDER DESIGN, FEBRUARY 7, 2001.

LEGEND

STEEL GRATING OVER FISHWAY AND OVERFLOW CHANNEL

GRAPHIC SCALE

0 5 10

SCALE IN FEET

70% DESIGN

NO.	DESCRIPTION	BY	DATE

REVISIONS

PROJECT: BEAR RIVER ESTUARY RESTORATION

TITLE: LEWIS FISH LADDER GOLDER SLAB DETAILS

Client: WILLAPA BAY REGIONAL FISHERIES ENHANCEMENT GROUP

AMEC Earth & Environmental
11810 North Creek Parkway North, Bothell, WA, U.S.A. 98011-8201
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BEAR RIVER ESTUARY RESTORATION

Project No. 0-915-16933-0 REV No.

DR: JRS CHK: RB/PS

DATE: JULY 2010

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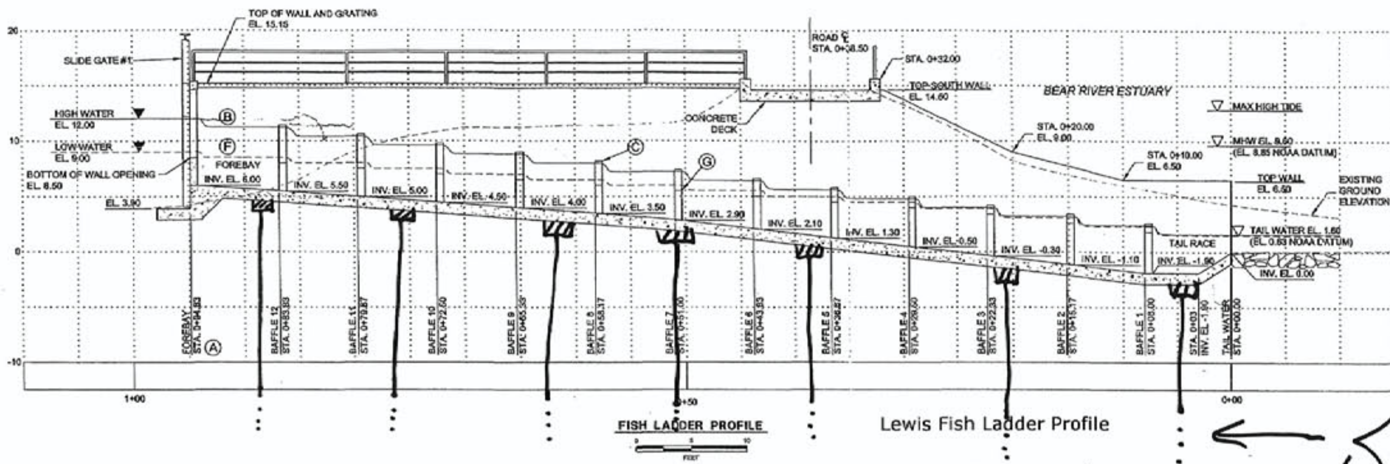
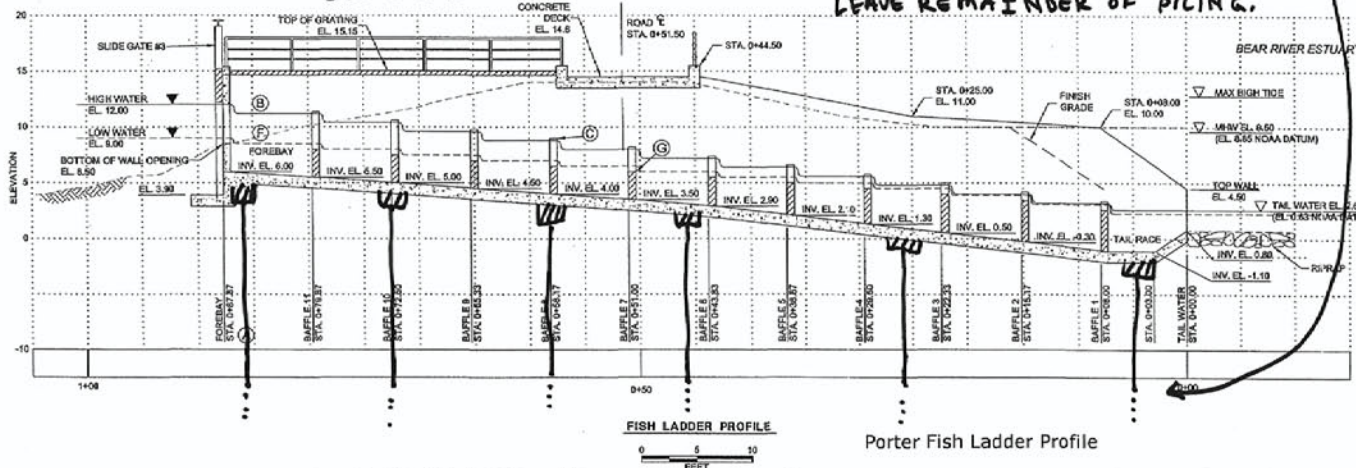
SHEET NUMBER



Lewis Fish Ladder Profile

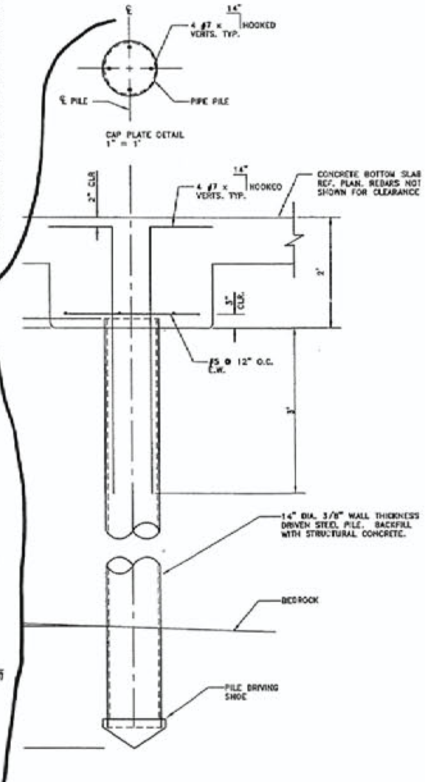
SINGLE ROW OF PILINGS, LOCATION APPROXIMATE, DERIVED FROM GOLDER DRAWINGS (LEWIS & PORTER UNITS).

IN LEWIS UNIT, REMOVE ALL FISH LADDER COMPONENTS DOWN TO ELEVATION -1.5 OR TO BOTTOM OF PILE CAP, WHICHEVER IS LOWER. LEAVE REMAINDER OF PILING.



Porter Fish Ladder Profile

IN PORTER UNIT, REMOVE ALL FISH LADDER COMPONENTS DOWN TO ELEVATION 0.0 OR BOTTOM OF PILE CAP, WHICHEVER IS LOWER. LEAVE REMAINDER OF PILING.



TYPICAL DRIVEN STEEL PILE DETAIL
Not to scale

GRAPHIC SCALE
NOT TO SCALE

NOTES:
1. ADAPTED FROM GOLDER ASSOCIATES, LEWIS AND PORTER FISH LADDER DESIGN, FEBRUARY 7, 2001.

70% DESIGN

REVISIONS			
NO.	DESCRIPTION	BY	DATE

PROJECT: BEAR RIVER ESTUARY RESTORATION
TITLE: FISH LADDER PILING LAYOUT

Client: WILLAPA BAY REGIONAL FISHERIES ENHANCEMENT GROUP

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11810 North Creek Parkway North, Bothell, WA, U.S.A. 98011-8201
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BEAR RIVER ESTUARY RESTORATION
Project No. 0-915-16933-0 | REV No.
DR: JRS | CHK: RB/PS
DATE: JULY 2010
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SHEET NUMBER

Appendix C—
Construction Narrative (AMEC)

BEAR RIVER ESTUARY RESTORATION PROJECT:
70 PERCENT DESIGN NARRATIVE

Submitted to:
Ron Craig
Willapa Bay Regional Fisheries Enhancement Group
PO Box 46
South Bend, WA 98586

Submitted by:
AMEC Earth & Environmental, Inc.
11810 North Creek Parkway North
Bothell, Washington 98011

July 16, 2010

AMEC Project No. 0-915-16933-0

RYAN STANLEY BARTELHEIMER
WASHINGTON
36563
REGISTERED PROFESSIONAL ENGINEER
7-16-10

TABLE OF CONTENTS

LIST OF TABLES

APPENDICES

1.0 INTRODUCTION

The Willapa Bay Regional Fish Enhancement Group (WBRFEG) hired AMEC Earth & Environmental, Inc. (AMEC) and its subconsultant, Philip Williams & Associates (PWA), to complete a 70 percent design for the removal of approximately 5 miles of dikes and associated roads and drainage features in south Willapa Bay in the vicinity of the Bear River estuary, Washington. WBRFEG also directed AMEC to develop and implement a monitoring plan to document the environmental changes that will occur on the project site.

The "Bear River Estuary Restoration Project Basis of Design" (Basis of Design; AMEC, May 3, 2010) gives details about the specific objectives, design considerations, and activities associated with the design and the monitoring plan. AMEC developed the Basis of Design in consultation with a design team comprising representatives of WBRFEG, the Willapa National Wildlife Refuge (WNWR), the Washington Department of Fish and Wildlife, Friends of WNWR, University of Washington, Pacific County, and a trusted construction contractor.

The 70 percent design consists of the design drawings and this report, which together depict and describe the approach used to fulfill the objectives identified in the Basis of Design. The purpose of this report is to supplement information presented in the design drawings, focusing on important elements of the design and its implementation.

The Bear River Estuary Restoration Project Monitoring Plan is on a different schedule and will be addressed in a separate report.

2.0 DEWATERING

Water levels should be kept low in the construction area behind the dikes in each management unit to facilitate construction and minimize water quality impacts.

2.1 Lewis and Porter Units

AMEC recommends installing temporary culverts and tide gates in the Lewis and Porter Units before starting work on the existing fish ladders or tide gates. This approach will keep tidal waters out of the area behind the dikes, while still allowing freshwater to drain to the bay during low tide.

Before construction starts, operate the existing fish ladders and tide gates in the Lewis and Porter Units to give the area behind the dikes as much time as possible to dry out. The temporary culverts and tide gates will facilitate drainage of these units during construction, up until the time the dikes are breached.

In each unit, after the area behind the dike has been dewatered, the contractor should modify the cross-section where the temporary culvert and tide gate are to be installed so that a shorter culvert can be used. Sheet piling and pumping may be required to stabilize and dewater the area where the temporary culvert and tide gate will be installed. Install the culvert and tide gate, place and compact backfill to rebuild the dike, and remove the sheet piling. Once the temporary tide gate is functioning, the contractor should surround the existing tide gate and fish ladder with sheet piling and dewater the area as described in section 2.3, “Pump System Discharge.”

Temporary culverts can be smaller in diameter (minimum 24 inches) if they are to be removed in the same year they are installed. If they are to remain in place for a second year, the culverts should be larger in diameter (minimum 36 inches).

2.2 Riekkola Unit

In the Riekkola Unit (also referred to as the Parker Slough area), the existing tide gates will provide for unit-wide water level control. These tide gates will be removed late in the construction sequence when the historic stream crossing is restored at this location.

2.3 Pump System Discharge

The contractor should use pumps for any localized dewatering needed in the Riekkola Unit or in the vicinity of the fish ladders and tide gates in the Porter and Lewis units. The pump system should discharge to a well-vegetated location so that the water is filtered before leaving the project area. If the receiving area is not well-vegetated or is not adequately treating the water, the contractor should implement other best management practices (BMPs) to meet water quality criteria.

2.4 Ditch Fill

Additional dewatering measures may be necessary to avoid problems associated with placing fill in ditches with water present. Slurry that forms while working in the ditches can be dealt with in one of three ways:

1. a peristaltic pump system can be used to pump the material to a nearby containment area,
2. the slurry can be bailed out with an excavator and allowed to dry on the ground surface, or
3. the slurry can be contained in an isolated portion of the ditch by placing fill on either side.

3.0 CONSTRUCTION ACCESS

All construction access will be from Sandridge Road to 67th Place[1]. The construction staging will occur at the eastern end of 67th Place in the Riekkola Unit. Construction access to all units will originate from this location, following the existing roads and dikes on the project site.

To facilitate two-way vehicle traffic on top of the dikes, AMEC recommends constructing pullouts at regular intervals in the Porter and Lewis Units and turnarounds near each fish ladder and tide gate. The plan set shows the typical details of the pullouts and turnarounds. The contractor should construct pullouts and turnarounds from material available locally in the dike, not brought in from other parts of the site. If needed, the pit-run gravelly materials in the southernmost cross-dike in the Lewis Unit, or other durable surfacing materials, should be used to top the construction travel corridors to maintain the viability of construction traffic on the dikes, pullouts, and turnarounds.

The contractor should haul fill from the inner Riekkola Unit dike or create local borrow sites to meet the import requirements in the Lewis and Porter Units, using the top of the main dikes as the corridor for moving equipment and materials. The contractor should remove the pullouts and turnarounds during the initial stage of dike modifications. The contractor shall place the material from the pullouts and turnarounds into the ditches when the initial modification to the dike cross section is made in each unit. Typical cross-sections for these areas of the dike are shown within the construction drawings.

4.0 CROSS-DIKES

Construction will begin first in the Lewis Unit, which contains three cross-dikes. The cross-dike just north of the fish ladder can be removed at any time prior to breaching the main dike. The cross-dike south of the fish ladder can also be removed at any time prior to breaching the main dike, but unlike the other dikes in this unit, it is composed of imported pit-run material. AMEC recommends using some of this material at the ends of the ditch plugs to resist erosion. The ditch plug material should be at a moisture content that allows it to be placed and compacted to be resistant to erosion. The ditch plugs are designed to be constructed in locations that break up artificial outboard drainage features but that maintain channel connections downstream to minimize the risk of fish stranding. The cross-dike between the Lewis and Porter units will not be removed until later, as part of the work in the Porter Unit.

The cross-dike between the Lewis and Porter Units will serve as a temporary sea dike after the Lewis Unit is deconstructed. The cross-dike could be augmented to have a similar top elevation and cross section as the outer dike (increasing its strength and reducing the risk of being overtopped), or the water level in the Porter Unit could be kept high in the winter, minimizing the amount of dike exposed to flowing water and the time it would take for the water levels on either side of the dike to equalize. The risk of a premature breach would be very low in either case.

[1] The eastern end of 67th Place is identified on some maps as Honeyman Road.

The design team has discussed the possibility of demolishing the Porter Unit fish ladder and tide gate and installing a temporary tide gate at the same time that similar work would be done in the Lewis Unit, which would be a year before construction in the Porter Unit. In this scenario, AMEC recommends raising the cross-dike between the Porter and Lewis Units, because there would not be water impounded within the Porter Unit to reduce the risk of a premature breach in an overtopping event.

The inner dike in the Riekkola Unit may be removed at any time before breaching the main dike. This unit has a large surplus of fill; some of this surplus should be hauled to the Lewis and Porter Units, or used as fill to raise 67th Place, to help meet the material needs in those locations. About 2,000 lineal feet of dike is proposed to remain in the northwestern part of the Riekkola Unit. The top of this dike is proposed to serve as the location of a future trail and observation platform. AMEC recommends filling the borrow ditch along this dike and creating a flatter dike backslope that stays within the ditch footprint. The flattened slope will improve the dike's stability, resistance to erosion during storms, aesthetics from the trail, and will provide a habitat face that allows wider bands or zones of different vegetation types.

5.0 DIKE MODIFICATIONS AND BREACHING

The Basis of Design identified the goal of completing as much work as possible before creating the initial dike breach in each unit. This approach relies on maintaining dry work conditions, excavating drainage channels, removing as much dike material as possible, and filling borrow ditches before breaching. Material can be removed from the top and inboard side of each dike, and then hauled away or placed into nearby borrow ditches. This material will be drier than earth fill located on the outside and lower parts of the dike. It will be easier to place and compact and should therefore be more resistant to erosion than wetter materials. AMEC recommends hauling the minimum materials needed to address fill deficits in each area, primarily for the outboard ditch plugs. As mentioned previously, fill should be moved between and within units to meet the import needs before the initial modification to the dike cross section, in order to make use of the existing road surface atop the dike.

After the dike in each unit is modified as described above, the contractor should remove the remaining material during a neap tide cycle (minimal tidal range) in order to avoid or minimize the amount of water flowing into and over the construction areas. The contractor should make the initial breach as large as possible during an incoming tide, which will keep the outbound water velocities low as the first high tide recedes, minimizing sediment movement and water quality issues outside the project area. The contractor should finish the remaining dike deconstruction and ditch filling work during the same neap tide cycle, when the high tide levels are low enough to minimize water contacting the construction area.

6.0 RIPRAP AND GRAVEL

Some sections of dike or cross-dike contain riprap armoring, pit-run, or other rocky materials. These materials should either be buried under a minimum of 2 feet of fine-grained material to leave exposed soils that are most suitable to recreate mudflat habitat or incorporated in the exposed ends of the ditch plugs to minimize the potential for erosion there.

7.0 CHANNEL DIMENSIONS AT DIKE CROSSINGS

AMEC designed channels to be located as close as possible to where they historically existed and sized them so that tidal processes would accelerate the re-establishment of natural topography and vegetation conditions. AMEC used regression equations that correlate measured tidal channel characteristics to the size of tidal marsh areas that drain through these channels, and compared the results to measurements obtained from recent and historic aerial photographs. The stormwater flow rates were calculated using USGS regression equations. The drainage basin and the tidal basin areas used in the calculations were derived by delineating these basins from available elevation data. The channel sizes on this project are dictated by tidal processes rather than precipitation processes, which will be clarified later in this section.

The plans depict the channels as trapezoidal in cross section. The most important parameters are the elevation and width of channel bottoms and the slope of the channel sides. In all cases, AMEC calculated that much larger channels are needed to convey tidal waters than runoff from precipitation. Table 1 lists the recommended depths and bottom widths for channels to be reconnected at dike crossings in the restored units. The recommended depths and widths for the channels have been computed conservatively. These recommended configurations represent predicted channel sizes and depths, using empirical relationships from other locations, extrapolated to the tide range at this project site. There are a number of uncertainties in the relationships, local factors, and data. Therefore, the historic channel depths should be constructed at an elevation no higher than existing, and as close as possible to the recommended elevation. Similarly, the bottom width should be constructed at least as wide as the existing channels on both sides of the restored crossing, and as close as possible to the recommended width. AMEC recommends that side slopes should be made at least as flat as the existing outboard channel, with as close to 3:1 as possible. Because of the shallow side slopes needed for stability, the resulting channel top widths are greater than those calculated by the regression equations. The cross-sectional areas of the reconnected channels should therefore be adequate to convey tidal flows under conditions that will exist following construction. If the existing channel on the bay side of a historic channel crossing is at a lower elevation or is wider than what is listed in the table, the channel should be constructed to the lower elevation and/or wider width of the existing channel. AMEC also recommends removing vegetation and root mass along the top and edges of the existing inboard and outboard channels, and excavating a transition area between the restored channels and the existing channels.

Table 2. Historic channel crossing details

Historic Crossing To Be Restored	Bottom Elevation (NAVD ft)	Bottom Width (feet)
RX1	-4.8	31.0
RX2	-0.2	10.0
RX3	-5.8	42.0
RX4	-3.3	16.0
RX5	-3.2	16.0
PX1	1.8	3.0
PX2	1.3	6.0
PX3	2.0	3.0
PX4	1.9	3.0
PX5	1.6	6.0
PX6	1.1	4.0
PX7	0.0	12.0
LX1	0.2	3.0
LX2	-1.5	8.0
LX3	3.6	8.0
LX4	3.1	12.0
LX5	0.4	4.0
LX6	1.9	6.0

The ground on the landward side of the dikes has subsided by approximately 1-3 feet since the dikes were built, so the quantity and rate of water flowing through the reconnected channels will be greater than in a salt marsh without subsidence. However, the beds of historical channels outside the dikes have since aggraded due to a reduction in tidal flows through them since the dikes were built. Following construction, outboard channels are expected to eventually revert to their historical sizes and depths. Channels on the inside of the dikes can be expected initially to deepen and widen but then gradually to aggrade and become more narrow as sediment is deposited over the larger subsided area. Channels will reach equilibrium when ground elevations on the inside of the dike approximately equal those on the outboard side. As this happens, AMEC predicts that the channels will evolve to sizes and depths closer to those predicted by the tidal drainage area relationships than what currently exists.

8.0 EARTHWORK QUANTITY CONSIDERATIONS

AMEC calculated earthwork quantities for this project using survey data from CTS Engineers, where available. For those features not surveyed, volumes are best professional estimates based on interpretation of aerial photography and comparison with similar surveyed features on site. All volumes were calculated as in-place yardage. The overall balance of material to be imported or exported depends significantly on the conditions experienced in the field. To address potential material shortages resulting from varying conditions, AMEC has identified contingency borrow areas in both the Porter and Lewis Units.

Cut and fill actions are organized in an approximately sequential order in the table on Sheet 25 of the design set. Cut features are listed on the left-hand column of the table, with the proposed destinations for that material shown as fill features across each row of the table. Although organized in the table by unit, certain earthwork actions, most notably the removal of the inboard Riekkola Unit dike, in different units can be completed concurrently without breaching external dikes. Variations in soil material, quality, and moisture content, along with compaction conditions, will result in volumes different from those calculated.

Appendix D—
Species Life Histories

APPENDIX D
LIFE HISTORIES

INTRODUCTION

This appendix provides brief descriptions of the life histories of species listed under the Endangered Species Act (ESA) that may occur in the action area of the proposed project. The species discussed herein include:

- North American green sturgeon (*Acipenser medirostris*);
- Marbled murrelet (*Brachyramphus marmoratus marmoratus*);
- Western snowy plover (*Charadrius alexandrinus nivosus*); and
- Streaked horned lark (*Eremophila alpestris strigata*).

NORTH AMERICAN GREEN STURGEON

This section presents descriptions of the biology, distribution, and population trends of the North American green sturgeon.

Life History

The North American green sturgeon (green sturgeon) is a long-lived, slow-growing fish and the most marine-oriented of the sturgeon species. Mature males range from 4.5 to 6.5 feet in fork length and do not mature until they are at least 15 years old, while mature females range from 5 to 7 feet in fork length and do not mature until they are at least 17 years old. Maximum ages of adult green sturgeon are likely to range from 60 to 70 years.

Green sturgeon lack scales; however, they have five rows of characteristic bony plates on their body called scuutes. The backbone of the green sturgeon curves upward into the caudal fin, forming their shark-like tail. On the underside of their flattened snouts are sensory barbels and a siphon-shaped, protrusible, toothless mouth. Recent genetic information suggests that green sturgeon in North America is taxonomically distinct from morphologically similar forms in Asia (NMFS 2009b).

Green sturgeon are believed to spend the majority of their lives in nearshore oceanic waters, bays, and estuaries. Early life-history stages reside in fresh water, with adults returning to freshwater to spawn when they are more than 15 years of age and over 4 feet in size. Spawning is believed to occur every 2 to 5 years. Adults typically migrate into fresh water beginning in late February; spawning occurs from March to July, with peak activity from April to June. Females produce 60,000 to 140,000 eggs. Juvenile green sturgeon spend 1 to 4 years in fresh and estuarine waters before dispersal to saltwater. They disperse widely in the ocean after their out-migration from freshwater (NMFS 2009b).

The only feeding data available for adult green sturgeon shows that they eat benthic invertebrates, including shrimp, mollusks, amphipods, and even small fish (NMFS 2009b).

Distribution and Habitat

The green sturgeon is the most broadly distributed, wide-ranging, and marine-oriented species of the sturgeon family, ranging from Mexico to at least Alaska in marine waters, and is observed in bays and estuaries up and down the west coast of North America (NMFS 2009b).

The historical and current spawning distribution of this species is unclear, as green sturgeon make non-spawning movements into coastal lagoons and bays in the late summer to fall, and because their original spawning distribution may have been reduced due to harvest and other anthropogenic effects. Today, green sturgeon are believed to spawn in the Rogue River, Klamath River Basin, and the Sacramento River. Spawning appears to occur rarely in the Umpqua River. Green sturgeon in the South Fork of the Trinity River were thought extirpated, but juveniles have been captured at Willow Creek on the Trinity River, and it is suspected that the fish could be coming from either the South Fork or the Trinity River. Green sturgeon appear to occasionally occupy the Eel River (NMFS 2009b).

Green sturgeon utilize both freshwater and saltwater habitat, spawning in deep pools or "holes" in large, turbulent, freshwater river mainstems. Eggs are likely broadcast over large cobble substrates, and may be deposited in clean sand to bedrock substrates as well. Regardless, it is likely that cold, clean water is important for proper embryonic development (NMFS 2009b).

Adults live in oceanic waters, bays, and estuaries when not spawning. Green sturgeon are known to forage in estuaries and bays ranging from San Francisco Bay to British Columbia (NMFS 2009b).

Population Trend

Good data on current population sizes does not exist and data on population trends are lacking (NMFS 2009b).

BULL TROUT

This section presents descriptions of the biology, distribution, and population trends of bull trout.

Life History

Bull trout typically use pristine headwater areas to spawn (WDFW 1998). Spawning begins in late August, peaks in September and October, and ends in November. Fish in a given stream spawn over a period of two weeks or fewer. Almost immediately after spawning, adults begin to work their way back to the mainstem rivers, lakes, or reservoirs to overwinter. Some of these fish stay in these areas while others move into salt water in the spring. Bull trout will spawn a second or even third time. Kelts (adults that have spawned) feed aggressively to recover from the stress of spawning (WDFW 1998).

Newly hatched bull trout emerge from the gravel in the spring (WDFW 1998). Adfluvial, fluvial, and anadromous bull trout typically spend two years in fresh water before they migrate to lakes, reservoirs, the mainstems of rivers, or salt water. Nonmigratory populations spend their entire lives in the same stretch of headwater stream. Fish that exhibit this behavior may not mature until they are 7 to 8 years old, and rarely reach sizes greater than 14 inches in length (WDFW 1998).

Bull trout are opportunistic feeders, eating aquatic insects, shrimp, snails, leeches, fish eggs, and fish. Contrary to earlier beliefs, these fish are generally no longer considered serious predators of salmon and steelhead (WDFW 1998).

Distribution and Habitat

The historical range of bull trout includes major river basins in the Pacific Northwest at about 41 to 60 degrees North latitude, from the southern limits in the McCloud River in northern California and the Jarbidge River in Nevada to the headwaters of the Yukon River in the Northwest Territories, Canada. To the west, bull trout range includes Puget Sound, various coastal rivers of British Columbia, Canada, and southeast Alaska. Bull trout occur in portions of the Columbia River and tributaries within the basin, including its headwaters in Montana and Canada. Bull trout also occur in the Klamath River basin of south-central Oregon. East of the Continental Divide, bull trout are found in the headwaters of the Saskatchewan River in Alberta and Montana and in the MacKenzie River system in Alberta and British Columbia, Canada (USFWS 2002).

Population Trend

Although bull trout are presently widespread within their historical range in the coterminous United States, they have declined in overall distribution and abundance during the last century. Retaining migratory forms of bull trout in a population is important because these forms allow fish access to more resources (i.e., food and habitat), opportunities for genetic exchange, and the ability to recolonize habitats after local extirpations (e.g., by a watershed-wide disturbance affecting all bull trout in a resident population) (USFWS 2002). In Washington, WDFW has identified 80 bull trout populations, of which 14 were considered in healthy condition, two were in poor condition, six were in critical condition, and 58 were in unknown condition (WDFW 1998).

MARBLED MURRELET

This section presents descriptions of the biology, distribution, and population trends of the marbled murrelet.

Life History

The marbled murrelet is a small seabird that nests in the coastal, old-growth forests of the Pacific Northwest. In contrast to other seabirds, murrelets do not form dense colonies and may fly about 43 miles or more inland to nest, generally in older coniferous forests. They are more commonly found inland during the summer breeding season, but make daily trips to the ocean to gather food and have been detected in forests throughout the year. When not nesting, the birds live at sea, spending their days feeding and then moving several kilometers offshore at night (SEI 2006).

The breeding season of the marbled murrelet generally begins in April, with most egg-laying occurring in late May and early June. Peak hatching occurs in July after a 27- to 30-day incubation. Chicks remain in the nest and are fed by both parents. By the end of August, chicks have fledged and dispersed from nesting areas (Marks and Bishop 1997). The marbled murrelet differs from other seabirds in that its primary nesting habitat is old-growth coniferous forest within 50 to 75 miles of the coast. The nest typically consists of a depression on a moss-covered branch where a single egg is laid. Marbled murrelets appear to exhibit high fidelity to their nesting areas and have been observed in forest stands for up to 20 years (Marks and Bishop 1997).

Marbled murrelets are presumably a long-lived species but are characterized by low fecundity (one egg per nest) and low nesting and fledging success. Fledging success has been estimated at 45 percent. Nest predation on both eggs and chicks appears to be higher for marbled murrelets than for other alcids and may be cause for concern. Principal predators are birds, primarily corvids (jays, ravens, and crows) (Marks and Bishop 1997).

At sea, foraging murrelets are usually found as widely spaced pairs. In some instances murrelets form or join flocks that are often associated with river plumes and currents. These flocks may contain sizable portions of local populations (Ralph and Miller 1994).

Distribution and Habitat

The marbled murrelet inhabits the Pacific Coast of North America from the Bering Sea to central California (SEI 2006).

Marbled murrelets are more commonly found inland during the summer breeding season, but make daily trips to the ocean to gather food, primarily fish and invertebrates, and have been detected in forests throughout the year. When not nesting, the birds live at sea, spending their days feeding and then moving several kilometers offshore at night (SEI 2006). Marbled murrelets feed in nearshore marine waters, mainly within 1 to 2 km from shore, consuming small fish such as Pacific herring, Pacific sand lance, sardines, and juvenile salmonids, as well as invertebrates such as euphasids and shrimp (USFWS 1997).

Throughout the forested portion of the species' range, marbled murrelets used forest stands with old-growth forest characteristics, generally within 80 km of the coast for nesting. The farthest known nesting site from the marine environment in Washington is 63 km. In Washington, marbled murrelet detections increased when old-growth/mature forests comprised more than 30 percent of the landscape, but decreased when the percentage of clear-cut/meadow in the landscape increased above 25 percent (USFWS 1997).

Population Trend

With declines documented separately for Conservation Zones 1 through 5 (coastal area from California to Washington) and Conservation Zone 6 (Strait of Juan de Fuca/Puget Sound), the U.S. Fish and Wildlife Service (USFWS) concluded that the listed population has declined significantly since 2002, the year of the estimate in the USFWS' previous 5-year review. For Conservation Zones 1 through 5 combined, population estimates from monitoring for 2000 to 2008 indicate an annual rate of decline in the range of 2.4 to 4.3 percent. For Conservation Zone 6, new data indicate an annual decline of about 15 percent between 2003 and 2008. Based on the tri-state estimate of about 24,400 birds used in the analysis for the 2004 5-year review, the 2008 population estimate of about 18,000 birds represents a decline of about 26 percent across the listed range from that estimate (USFWS 2009a).

WESTERN SNOWY PLOVER

This section presents descriptions of the biology, habitat, distribution, population trend, threats, and conservation efforts for the western snowy plover.

Life History

The western snowy plover is a small shorebird distinguished from other plovers (family Charadriidae) by its small size, pale brown upper parts, dark patches on either side of the upper breast, and dark gray to blackish legs. Snowy plovers weigh between 1.2 and 2 ounces. They are about 5.9 to 6.6 inches long (USFWS 2010a).

The nesting season extends from early March through late September. The breeding season generally begins earlier in more southerly latitudes, and may be 2 to 4 weeks earlier in southern California than in Oregon and Washington. Fledging of late-season broods may extend into the third week of September throughout the breeding range. Nests typically occur in flat, open areas with sandy or saline substrates. Vegetation and driftwood are usually sparse or absent. The typical clutch size is three eggs but can range from two, and in rare cases, up to six eggs (USFWS 2010a).

Snowy plover chicks leave the nest within hours after hatching to search for food. They are not able to fly for approximately 4 weeks after hatching, during which time they are especially vulnerable to predation. Adult plovers do not feed their chicks, but lead them to suitable feeding areas. Adults use distraction displays to lure predators and people away from chicks. Adult plovers signal the chicks to crouch, with calls, as another way to protect them. They may also lead chicks, especially larger ones, away from predators. Most chick mortality occurs within 6 days after hatching (USFWS 2010a).

Snowy plovers are primarily visual foragers. They forage on invertebrates in the wet sand and among surf-cast kelp within the intertidal zone; in dry, sandy areas above the high tide; on salt pans; and along the edges of salt marshes, salt ponds, and lagoons. They nest in open, flat, sparsely vegetated beaches and sand spits above the high tide. Plovers often return to the same breeding sites year after year (USFWS 2010a).

Distribution and Habitat

The Pacific Coast population of the western snowy plover is defined as those individuals that nest beside or near tidal waters, and includes all nesting colonies on the mainland coast, peninsulas, offshore islands, adjacent bays, and estuaries from southern Washington to southern Baja California, Mexico. Historic records indicate that western snowy plovers nested in at least 29 locations on the Oregon coast. Currently, only eight locations in Oregon support nesting western snowy plovers, a 72-percent reduction in active breeding locations.

The Pacific Coast population of western snowy plovers breeds on coastal beaches from southern Washington to southern Baja California, Mexico. Plovers lay their eggs in shallow depressions in sandy or salty areas that generally do not have much vegetation. Because the sites they choose are in loose sand or soil, nesting habitat is constantly changing under the influence of wind, waves, storms, and encroaching plants (USFWS 2010a).

Population Trend

The current Pacific Coast breeding population of snowy plover extends from Damon Point, Washington, to Bahia Magdalena, Baja California, Mexico (ICF 2009). There are approximately 2,230 breeding birds along the Pacific coast of California, 162 resident adults in Oregon, and 70 adult birds in Washington (ICF 2009). In 2008, the Oregon Natural Heritage Information Center observed 187 to 199 adult snowy plovers; a minimum of 129 individuals were known to have nested. The adult plover population was the highest estimate recorded since monitoring began in 1990 (USFWS 2009b). A survey of breeding snowy plovers along the Pacific coast of Baja California, Mexico, in 1991 and 1992 found 1,344 adults. A current population estimate for Baja Mexico is 2,470 (ICF 2009).

The Pacific Coast population of snowy plover in Oregon was once found along the entire coast but is currently located among eight breeding areas from Florence south (ICF, 2009). Oregon breeding sites in 2006 included Sutton Beach, the Siltcoos River Estuary, beachgrass removal sites at Dunes Overlook, the Tahkenitch Creek Estuary, the Tenmile Creek Estuary, Coos Bay North Spit, Bandon State Nature Area, and the New River spit area. Other Oregon sites where snowy plovers have nested in the recent past (since 1980) include the beach between Clatsop Spit and Gearhart, mouth of the Necanicum River, Bayocean Spit, Sand Lake Spits, South Beach (Newport), mouth of the Siuslaw River, Threemile Creek/Umpqua River, Menasha Spoils (Coos Bay North Spit), and the Floras Lake area (ICF 2009).

As early as the 1970s, observers suspected a decline in plover numbers. The primary cause of decline is loss and degradation of habitat. The introduced European beachgrass (*Ammophila arenaria*) contributes to habitat loss by reducing the amount of open, sandy habitat and contributing to steepened beaches and increased habitat for predators. Urban development has reduced the available habitat for western snowy plovers while increasing the intensity of human use, resulting in increased disturbance to nesting plovers.

STREAKED HORNED LARK

This section presents descriptions of the biology, distribution, and population trends of the streaked horn lark.

Life History

The streaked horned lark is small, ground-dwelling songbird with conspicuous feather tufts, or "horns," on its head. Its back is heavily streaked with black, contrasting sharply with its deeply ruddy nape and yellow underparts.

Nesting begins in late March and continues into June. The nest consists of a shallow depression built in the open or near a grass clump and lined with fine dead grasses. The female lays a clutch of three to five heavily streaked white eggs. Incubation is only 11 days and the young are able to fly within 9 to 12 days after hatching. Horned larks are mainly insect eaters but may eat seeds in winter (USFWS 2010b).

Distribution and Habitat

The streaked horned lark once occurred from British Columbia, Canada, south to northern California. In Oregon, the streaked horned lark was a common summer resident in the Rogue River, Umpqua, and Willamette Valleys, as well as many other smaller valleys on the west side of the Cascade Mountain range. Streaked horned larks winter in eastern Washington, Oregon, and Northern California (USFWS 2010b).

The streaked horned lark nests and breeds in short herbaceous vegetation (<30 centimeters [cm] tall [about 12 inches]) where woody plants are absent and a relatively high percentage of bare ground and patches of sparsely vegetated areas are interspersed with more densely vegetated patches (Altman 1999). Canadian and U.S. surveys indicate that the streaked horned lark currently breeds on prairie remnants and airports in the southern Puget lowlands, on beaches and accreted lands near Grays Harbor and Willapa Bays, on dredge spoil islands in the Columbia River, on an industrial site along the lower Columbia River in Oregon, and on a number of agricultural, pasture, grass, and mudflat habitats in the Willamette Valley from Portland to Eugene, Oregon. Streaked horned larks winter along the Washington Coast on dunes and beaches adjacent to open water with few or no trees and shrubs (Pearson and Altman 2005).

Population Trend

Although population estimates are not exact, the Washington Department of Fish and Wildlife (WDFW) estimates that there are approximately 774 streaked horned larks with 29 percent breeding in the Puget lowlands, 11 percent breeding on the Washington Coast, 9 percent breeding on the lower Columbia River, and 51 percent breeding in the Willamette Valley (Pearson and Altman 2005).

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Appendix E—
EFH Assessment

APPENDIX E
ESSENTIAL FISH HABITAT

ACTION AGENCY

U.S. Army Corps of Engineers, Seattle District

LOCATION

The project is located within the Willapa National Wildlife Refuge (Refuge) in Pacific County, Washington at Township 10 North, Range 11 West, Sections 1, 6, 7, 11, and 12 and Township 10 North, Range 10 West, Section 6. The project area is within the Lewis, Porter Point, and Riekkola Units in the Refuge at the southern end of Willapa Bay, just west of the mouth of Bear River.

PROJECT NAME

Bear River Estuary Restoration, Pacific County, Washington

ESSENTIAL FISH HABITAT BACKGROUND

The Magnuson-Stevens Fishery Conservation and Management Act, as amended by the Sustainable Fisheries Act of 1996 (Public Law 104-267), requires federal agencies to consult with the National Oceanic and Atmospheric Administration, National Marine Fisheries Service (NMFS) on activities that may adversely affect Essential Fish Habitat (EFH). EFH is defined as "those waters and substrate necessary to fish for spawning, breeding, feeding, or growth to maturity" (NMFS, 1999).

This assessment evaluates the impacts of the proposed project to determine whether it "may adversely affect" designated EFH for federally managed fisheries species in the proposed action area. The assessment also describes conservation measures to avoid, minimize, or otherwise offset potential adverse effects of the proposed action on designated EFH.

IDENTIFICATION OF EFH

Groundfish, coastal pelagic, and salmonid fish species that could have designated EFH in the action area are listed in the table below. Several of these species are not typically found in the high-energy regime of the action area. Assessment of the impacts on species that may occur in the action area is based on life-history stages described in Casillas et al. (1998) and PFMC (1998a, 1998b, and 1999).

Species of Fish with Designated Essential Fish Habitat in the Project Area

Common Name	Scientific Name	Common Name	Scientific Name
Groundfish		**Groundfish (cont.)**	
arrowtooth flounder	*Atheresthes stomias*	Pacific sanddab	*Citharichthys sordidus*
big skate	*Raja binoculata*	petrale sole	*Eopsetta jordani*
black rockfish	*Sebastes melanops*	quillback rockfish	*Sebastes maliger*
bocaccio	*Sebastes paucispinis*	ratfish	*Hydrolagus colliei*
brown rockfish	*Sebastes auriculatus*	redbanded rockfish	*Sebastes babcocki*
butter sole	*Isopsetta isolepis*	redstripe rockfish	*Sebastes proriger*
cabezon	*Scorpaenichthys marmoratus*	rex sole	*Glyptocephalus zachirus*
California skate	*Raja inornata*	rock sole	*Lepidopsetta bilineata*
canary rockfish	*Sebastes pinniger*	rosethorn rockfish	*Sebastes helvomaculatus*
China rockfish	*Sebastes nebulosus*	rosy rockfish	*Sebastes rosaceus*
copper rockfish	*Sebastes caurinus*	rougheye rockfish	*Sebastes aleutianus*
curlfin sole	*Pleuronichthys decurrens*	sablefish	*Anoplopoma fimbria*
darkblotch rockfish	*Sebastes crameri*	sand sole	*Psettichthys melanostictus*
Dover sole	*Microstomus pacificus*	sharpchin rockfish	*Sebastes zacentrus*
English sole	*Parophrys vetulus*	shortspine thornyhead	*Sebastolobus alascanus*
flathead sole	*Hippoglossoides elassodon*	spiny dogfish	*Squalus acanthias*
greenstriped rockfish	*Sebastes elongatus*	splitnose rockfish	*Sebastes diploproa*
hake	*Merluccius productus*	starry flounder	*Platichthys stellatus*
jack mackeral	*Trachurus symmetricus*	striptail rockfish	*Sebastes saxicola*
kelp greenling	*Hexagrammos decagrammus*	tiger rockfish	*Sebastes nigrocinctus*
lingcod	*Ophiodon elongatus*	vermilion rockfish	*Sebastes miniatus*
longnose skate	*Raja rhina*	yelloweye rockfish	*Sebastes ruberrimus*
Pacific cod	*Gadus macrocephalus*	yellowtail rockfish	*Sebastes flavidus*
Pacific ocean perch	*Sebastes alutus*		
Coastal Pelagic		**Salmonid Species**	
anchovy	*Engraulis mordax*	Chinook salmon	*Oncorhynchus tshawytscha*
market squid	*Loligo opalescens*	coho salmon	*Oncorhynchus kisutch*
Pacific mackerel	*Scomber japonicus*	pink salmon	*Oncorhynchus gorbuscha*
Pacific sardine	*Sardinops sagax*		

DETAILED DESCRIPTION OF THE PROPOSED PROJECT

The proposed project would remove about 5.74 miles of existing dike, 38 culverts, 2 fish ladders, 2 tide gates, and 2 foot bridges, and reconnect 18 estuary channels; resulting in up to 760 acres of restored estuarine habitat. The resorted habitat includes reconnection of stream channels to the estuarine environment, open water, intertidal flats, and salt marsh. Unrestricted tidal exchange is the goal and historic channels currently isolated within diked areas which are now removed from tidal influence will be reconnected to the Willapa Bay estuary. The proposed project will assist in improving and maximizing the current estuarine system and contribute to the health of the bay and associated habitats. In addition, the proposed project would reduce or eliminate the extent of a highly invasive exotic plant, reed canarygrass, which currently infests the refuge's freshwater impoundments. Tussock infestation will also be reduced. Other exotic species, including nutria and bullfrogs, which currently use the freshwater ponds behind the dike will be eliminated by restoration of estuarine habitat. Juvenile salmon habitat will be restored and other expected benefits include increased waterfowl, waterbird, and shorebird use. Protection and restoration of native estuarine and nearshore habitats is a major ecoregional and recovery goal in the Pacific Northwest Coast Ecoregional Assessment (TNC and WDFW 2006) and the Northern Pacific Coast Regional Shorebird Management Plan (Drut and Buchanan 2000).

For a more detailed project description, see Section 2.2 of the Draft Biological Evaluation.

POTENTIAL ADVERSE EFFECTS OF PROPOSED PROJECT

Groundfish Species

The proposed project could affect EFH beneficially for a limited number of groundfish species by creating 750 acres of intertidal saltmarsh and mudflats. Construction could affect EFH adversely by creating temporary and localized increases in turbidity and could eliminate nonmobile benthic and epibenthic food sources within the footprint of the base of the dike area.

Coastal Pelagic Species

The proposed project is not expected to adversely affect EFH for coastal pelagic species because the project area is limited to intertidal and subtidal zones, where coastal pelagic species are unlikely.

Salmonid Species

Chinook (*Oncorhynchus tshawytscha*) and coho salmon (*O. kisutch)*, particularly juveniles of these species, may occur in the project area or immediately offshore at any time of the year. Because of project timing, few, if any, juvenile or adult Chinook are expected to be in the action area during construction. The proposed project would increase turbidity briefly in the project area, possibly causing salmonids to avoid certain areas in the vicinity. This possible impact would be temporary and not persist beyond the construction period. The proposed project would affect salmonids beneficially by creating 750 acres of intertidal saltmarsh and mudflats.

CONSERVATION MEASURES

Implementing the conservation measures specified in Section 2.2.3 of the Draft Biological Evaluation would avoid and minimize potential adverse effects of the proposed project.

CONCLUSION

As described above, the proposed activities may cause temporary, localized adverse impacts on certain EFH parameters but should not reduce the overall value of the EFH of managed species. After completion of the proposed project, the disturbed areas would be recolonized and the benthic and epibenthic communities should return to conditions similar to those before project construction. The project would create 760 acres of intertidal saltmarsh and mudflats. Although the proposed project may have localized and temporary adverse effects on designated EFH for groundfish and salmonids, the conservation measures described above would avoid, minimize, or otherwise offset such adverse effects.

REFERENCES

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Appendix F—

Cultural Resources Assessment (AMEC)

CULTURAL RESOURCES REPORT COVER SHEET

Author: Cooper, Jason B., M.A., R.P.A

Title of Report: Cultural Resources Existing Conditions Report for the Bear River Estuary Restoration Project, Pacific County, Washington

Date of Report: July 30, 2010

County: Pacific Section: 1, 11, and 12 Township: 10 North Range: 11 W and
Section: 6, 7, and 18 Township: 10 North Range: 10 W

Quads: Chinook, Long Beach, Ocean Park, and Cape Disappointment Acres: 760

PDF of report submitted (REQUIRED) ☒ Yes

Historic Property Export Files submitted? ☐ Yes ☒ No

Archaeological Site(s)/Isolate(s) Found or Amended? ☐ Yes ☒ No

TCP(s) found? ☐ Yes ☒ No

Replace a draft? ☐ Yes ☒ No

Satisfy a DAHP Archaeological Excavation Permit requirement? ☐ Yes # ☒ No

DAHP Archaeological Site #:

- Submission of paper copy is required.
- Please submit paper copies of reports ***unbound.***
- Submission of PDFs is required.
- Please be sure that any PDF submitted to DAHP has its cover sheet, figures, graphics, appendices, attachments, correspondence, etc., compiled into one single PDF file.
- Please check that the PDF displays correctly when opened.

PROJECT REVIEW SHEET – EZ1
HISTORIC & CULTURAL RESOURCES REVIEW

PROPERTY / CLIENT NAME: Bear River Estuary Restoration Project **FUNDING AGENCY:** Recreation and Conservation Office

Project Applicant:	Willapa Bay RFEG		
Contact Person:	Ron Craig		
Address:	P.O. Box 46		
City, State:	South Bend **Zip:** 98586	**County:**	Pacific
Phone/ FAX:	360 875 6402/360 875 5802		
E-Mail:	rcraig@willapabay.org		

Funding Agency:

Organization:	Recreation and Conservation Office
Address:	PO Box 40917
City, State:	Olympia, WA **Zip:** 98504-0917
Phone:	(360) 902-
	RCO #
Date prepared:	July 30, 2010

PLEASE DESCRIBE THE TYPE OF WORK TO BE COMPLETED
(Be as detailed as possible to avoid having to provide additional information)

☒ **Provide a detailed description of the proposed project:**

See attached existing conditions report.

☒ **Describe the existing project site conditions:**

See attached existing conditions report.

☒ **Describe the proposed ground disturbing activities:**

See attached existing conditions report.

☐ **Check if building(s) will be altered or demolished. If so please complete a DAHP Determination of Eligibility "EZ2" form for each building effected by the proposed project.**

PLEASE ATTACH A COPY OF THE RELEVANT PORTION OF A 7.5 SERIES USGS QUAD MAP AND OUTLINE THE PROJECT INPACT AREA.
(USGS Quad maps are available on-line at http: www.topozone.com)

Project Location

Township: 10 and 11 North **Range:** 10 and 11 West **Section:** multiple
Address: _____ **City:** _____ **County:** Pacific

Place Map Here

See Figures within the attached existing condition report

Please be aware that this form may only initiate consultation. For some projects, DAHP may require additional information to complete our review such as plans, specifications, and photographs. An historic property inventory form may need to be completed by a qualified preservation professional.

July 30, 2010
9-915-17055-0

Cherry Creek Environmental
146 North Canal Street, Suite 111
Seattle, Washington 98103-8652

Attention: Kerrie McArthur

Subject: Cultural Resources Existing Conditions Report for the Bear River Estuary Restoration Project, Pacific County, Washington

Dear Kerrie:

A record search and literature review was conducted on July 26, 2010 on the Washington State Department of Archaeology and Historic Preservation (DAHP) electronic database by a qualified AMEC cultural resources specialist for the Bear River Estuary Restoration Project (Project). A one-mile study area was investigated surrounding the project's Area of Potential Effect (APE), which is situated in Pacific County, Washington. The proposed Project is located partially within Sections 1, 11, and 12 of Township 10 North, Range 11 West and Sections 6, 7, and 18 of Township 10 North, Range 10 West, Willamette Meridian (USGS Chinook, Long Beach, Ocean Park, and Camp Disappointment, WA-OR 7.5 minute topographic quadrangles [1949; photorevised 1984]) (Figure 1).

In 2009, the Willapa Bay Regional Fish Enhancement Group obtained funding from the Washington State Salmon Recovery Funding Board 1 to develop design plans for removing approximately 5 miles of levees, thereby restoring tidal exchange and high quality estuarine habitat to 760 acres on its landward side (Figure 1-1). The levees and associated water management features were constructed over the last 50 years. Since the Project will be receiving either federal funds and/or federal permit to complete this work, it must comply with Section 106 of the National Historic Preservation Act (NHPA) of 1966 (as amended), its implementing regulations in 36 C.F.R. 800.

To assist Cherry Creek Environmental in submitting a Biological Evaluation for the Project, AMEC conducted a background literature review and record search of the DAHP electronic database and provided an existing conditions report that documents our results of the record search. The level of effort and information provided in this document is geared toward initiating the Section 106 of the NHPA process. Formal consultation, known as government-to-government consultation, is required between the lead federal agency and affected Native

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American tribes under Section 106. AMEC was scoped to assemble cultural resources information that is known about the APE and identify areas that may contain unknown and significant cultural resources. There was no fieldwork associated with this phase of cultural resources work. If fieldwork is determined necessary at a later date, this effort will be conducted under a separate task order.

RECORD SEARCH RESULTS

The record search and literature review indicated that there are two previously documented archaeological sites within and/or adjacent to the Project's Area of Potential Effects (APE). Sites 45PC125 and 45PC126 are fish traps and located approximately 500 feet east of the APE near the point where Bear River reaches Willapa Bay. They were recorded during a surveying effort to map archaeological resources of the Willapa Bay area (Losey 2006a).

Site 45PC125, termed Big Bear River Fish Trap, consists of three closely spaced lines of densely packed vertical wood stakes that parallel the river channel for much of their length. Stakes in the features were a mix of branch wood and split stakes. Many protruded far above the mudflat surface. All wood stakes were vertical, and no horizontal elements were noted (Losey 2006b).

Site 45PC126, termed Otter Fish Trap, consists of four lines of densely arranged stakes and two lines of widely spaced single larger posts/stakes. The features are being eroded at their north end by the outer edge of the river channel as it turns northward. Stakes in the features were a mix of branch wood and split stakes. Radiocarbon tests on the portions of two wood stakes resulted in dating the age of the fish trap to approximately 1000 B.P. (Losey 2006c).

The first systematic attempt to identify archaeological resources near the Project area was conducted by Dr. Richard Daugherty in the 1940s. Dr. Daugherty (1947) surveyed large coastal sections of Washington, including the Willapa Bay area.

Abramowitz (1980) reported on a cultural resource survey of portions of the Willapa National Wildlife Refuge in Pacific County for the Office of Public Archaeology. No evidence of cultural resources were recorded during their survey, but the author did indicate that archaeological deposits may be present further upstream on Bear River associated with potential Chinook winter village locations or for travel camps (Abramowitz 1980).

Cooper (2009) conducted a cultural resources survey and evaluation of the Oman Berm-Tarlatt Slough Set-Back Project for WSDOT. A pedestrian survey coupled with an extensive sub-surface exploration program (i.e., shovel test probes and mechanical trenching) failed to identify any archaeological resources. AMEC documented a primary ditch, east/west lateral ditches, a dike and several footbridges as a historic-era structure. AMEC recommended the water management feature as not being eligible for listing in the NRHP because it lacked association with an historic event and/or persons.

GEOLOGICAL CONTEXT

The APE is predominately covered by Ocosta silty clay loam, a clayey alluvial soil deposited in coastal bays (Pringle 1986). Upland areas within the project area are generally covered by Willapa silt loam soils, which typically develop in marine sediment on coastal terraces. The APE is categorized as Agriculture (AG) by the Pacific County Comprehensive Plan. Agricultural land in the County is classified as: (1) "agricultural land of long-term significance," including all land devoted to the production of aquaculture, cranberries, or other bog related crops; and (2) "agricultural land of local importance," including diked tideland involved in existing and ongoing activities.

RECOMMENDATIONS

There are two previously documented archaeological resources directly adjacent to the Project's Area of Potential Effects (APE). Sites 45PC125 and 45PC126 are pre-contact fish traps located within the mudflats adjacent to the Bear River channel. Radiocarbon (C-14) dates on the wooden stakes from 45PC126 dated the site to 1,000 Before Present (or approximately 1000 AD). It is anticipated other unknown fish traps are located within the Bear River watershed due to the limited survey area covered during the original project which documented them.

Based on the evaluation of historic aerial photographs of the APE, the dike and ditch drainage system that extends from Tarlatt Slough around Porter Point to the Bear River channel was built / improved upon between 1942 and 1959. This would make the water management feature at least 50 years old.

There are no previously documented Traditional Cultural Properties (TCPs) identified within the APE. Ethnographic research does identify one place name associated with a former Chinook village (*nu?x*^{w}*as?nł* - "blackberry town") that was once located near the confluence of Bear River and Willapa Bay, immediately outside the Project's APE. The exact village location is unknown, but it may be closely associated with the previously documented fish traps in the area.

Government-to-government consultation with all affected Native American tribes, as directed by Section 106 of the National Historic Preservation Act of 1966, as amended, is required for this project. Consultation with the affected Native American tribes may identify culturally sensitive areas within the watershed that would require further evaluation.

Please feel free to call (425.368.0953) or email (jason.cooper@amec.com) if you have any questions about this existing conditions report.

Sincerely,

AMEC Earth & Environmental, Inc.

Jason B. Cooper, M.A., RPA
Senior Archaeologist

Attachments-Figures 1, 1-1, and 1-2

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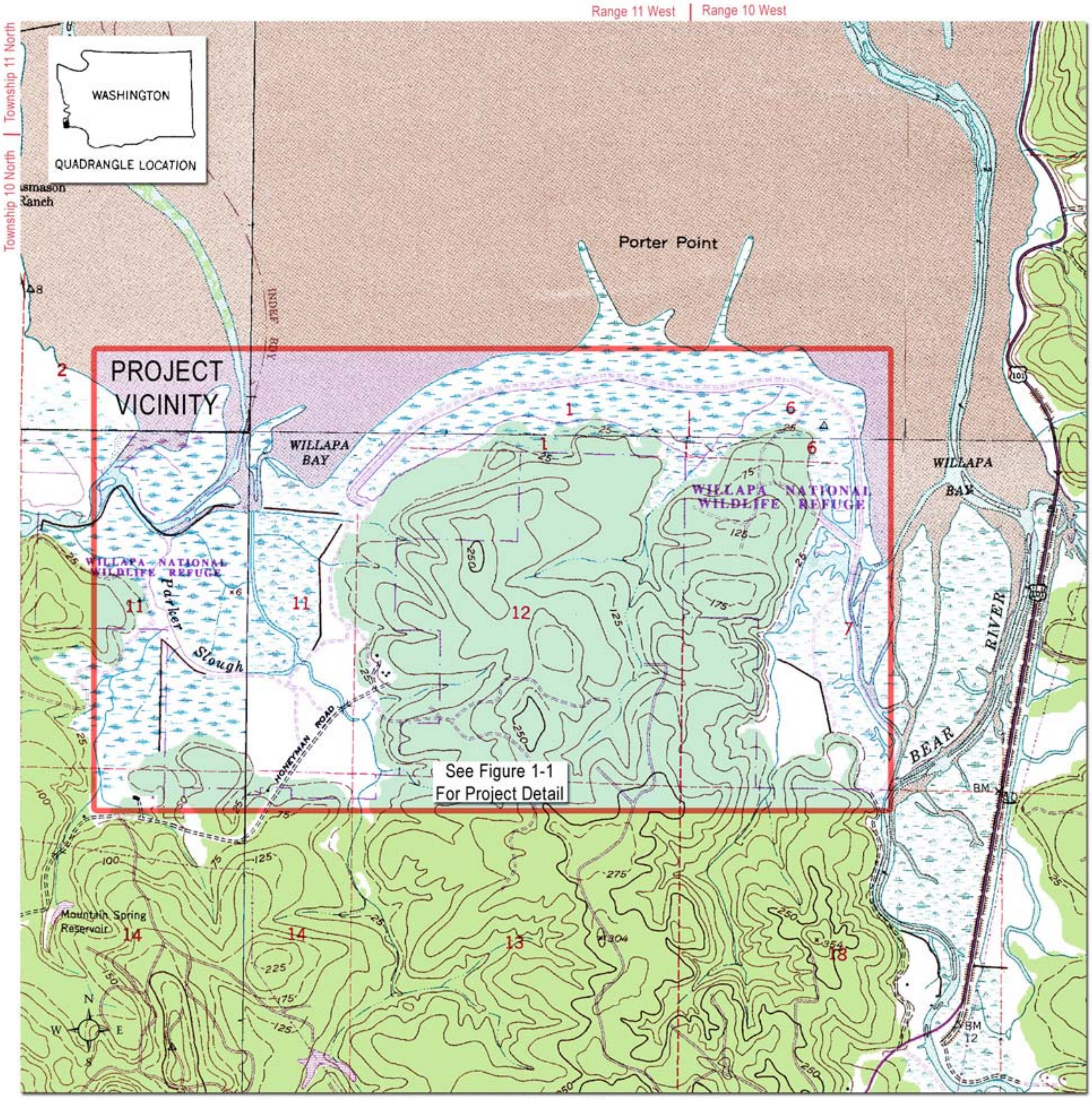

Source: USGS Long Island, Washington (1949; photorevised 1984); Chinook, Washington-Oregon (1949; photorevised 19840; Ocean Park, Washington (1949; photorevised 1984); and Cape Disappointment, Washington-Oregon (1949; photorevised 1984) 7.5 minute topographic quads.

Scale
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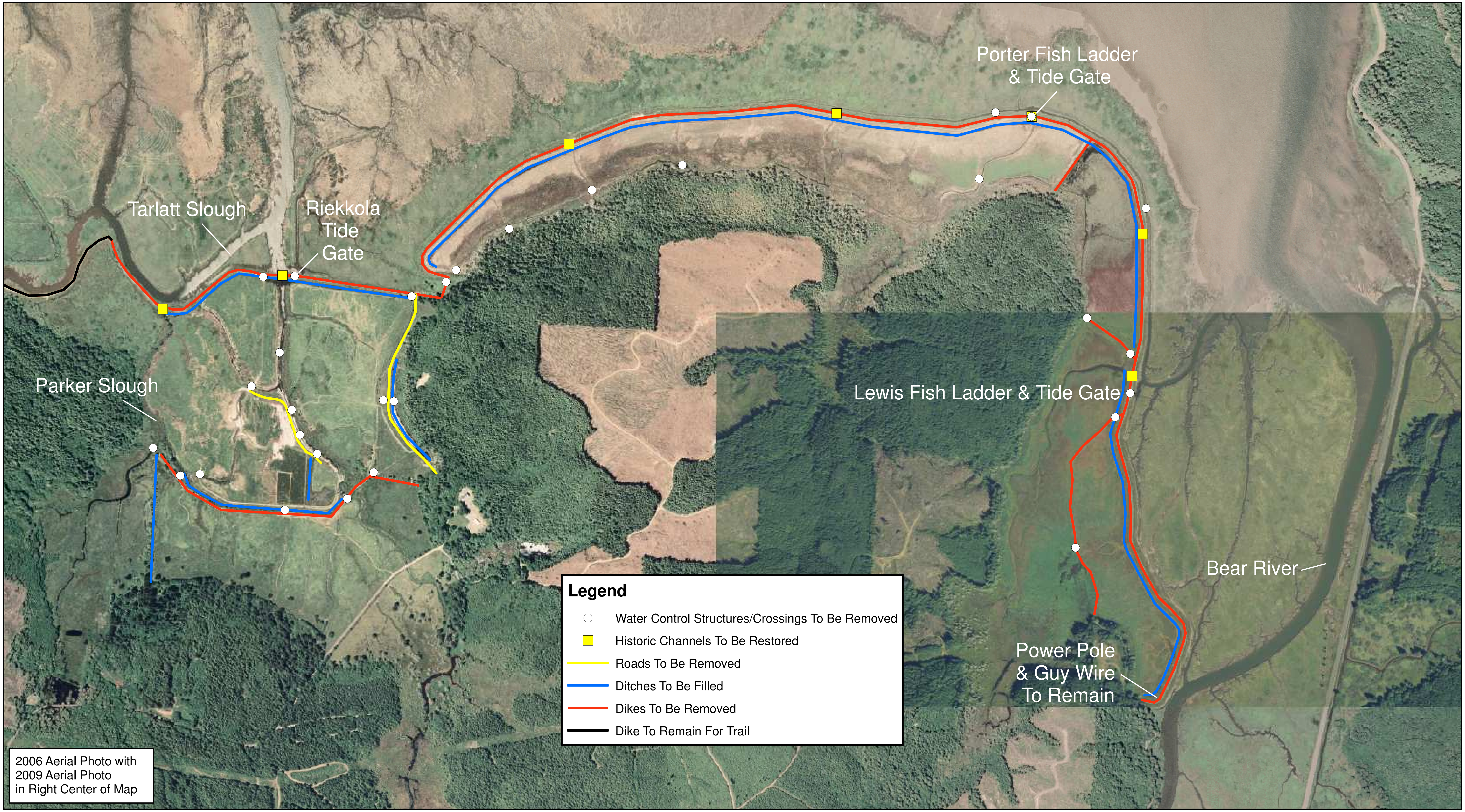
FIGURE 1

Project Vicinity Map

BEAR RIVER ESTUARY RESTORATION PROJECT

0-915170XX-0



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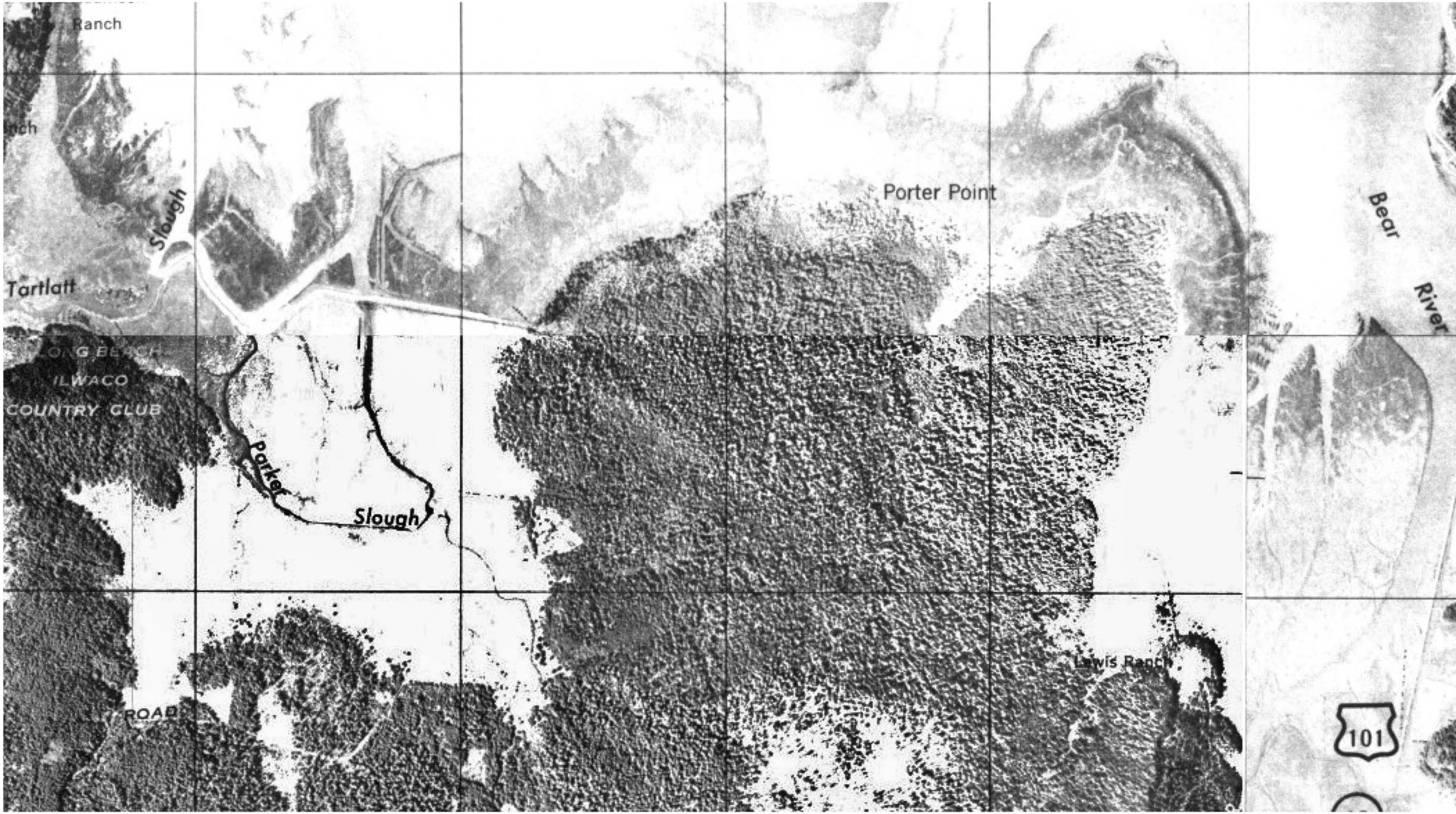
Project Map
Bear River Estuary Restoration
Willapa Bay Regional Fisheries Enhancement Group
Willapa National Wildlife Refuge

Figure 1-1



N

1000 0 1000 Feet

Approximate Scale & Orientation

amec

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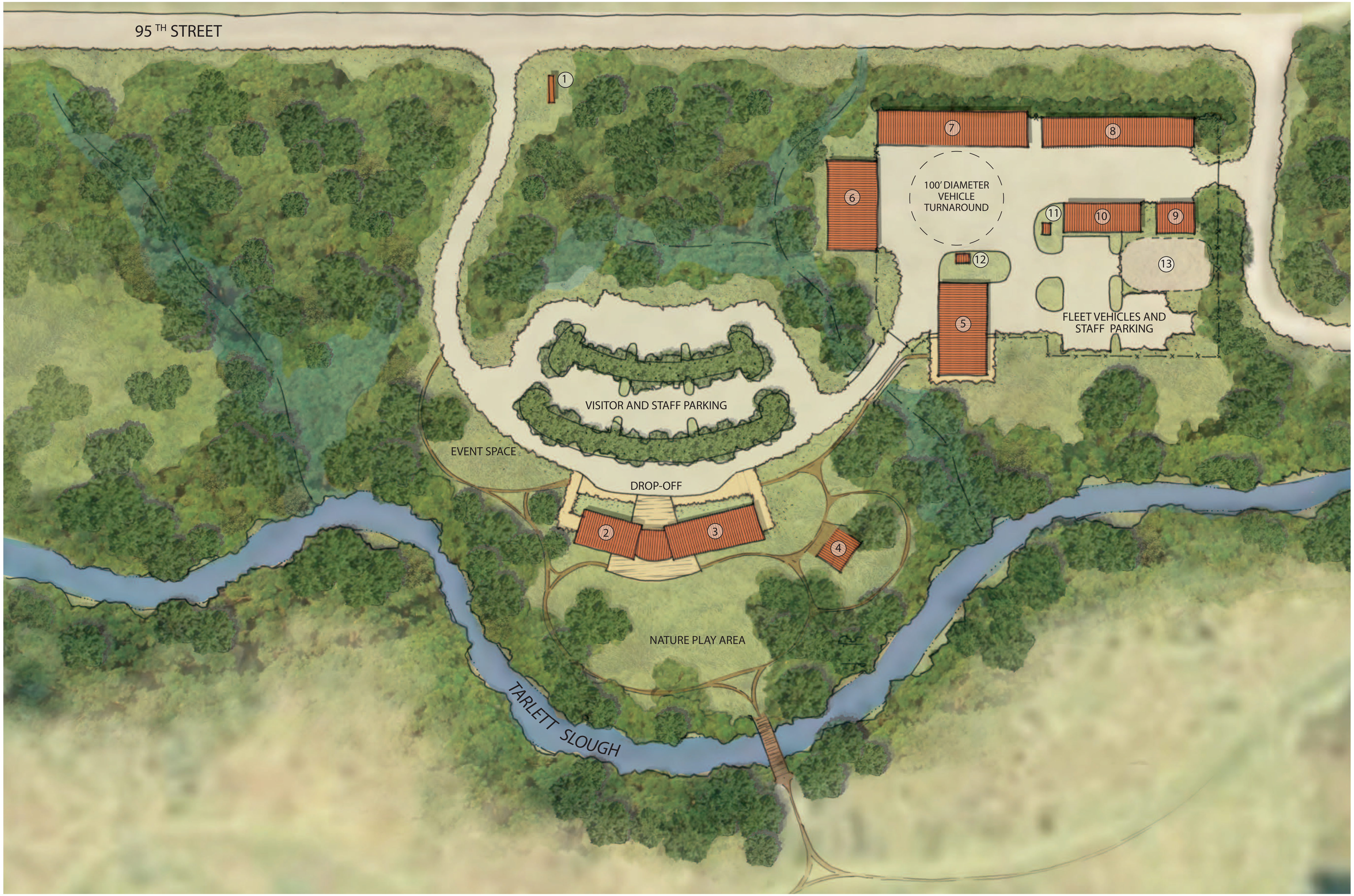
Bothell, WA 98011

1943 Aerial Photo
Bear River Estuary Restoration
Willapa Bay Regional Fisheries Enhancement Group
Willapa National Wildlife Refuge

Figure 1-2

Appendix P. Willapa National Wildlife Refuge Headquarters Draft Site Plan



1. ENTRY SIGN
2. VISITOR CENTER
3. ADMINISTRATIVE OFFICE
4. COVERED SHELTER (TO ACCOMODATE 60 PEOPLE)
5. SHOP BUILDING
6. LARGE EQUIPMENT STORAGE
7. BOAT STORAGE
8. STANDARD EQUIPMENT STORAGE
9. SMALL EQUIPMENT STORAGE
10. CARPORT
11. HAZMAT
12. FILLING STATION
13. BONEYARD

0' 50' 100' 200'

DRAFT SITE PLAN

WALKER·MACY

WILLAPA NATIONAL WILDLIFE REFUGE HEADQUARTERS

U.S. Fish & Wildlife Service

August 2010

U.S. Department of the Interior
U.S. Fish and Wildlife Service
Willapa National Wildlife Refuge
3888 State Route 101
Ilwaco, WA 98624-9707

Phone: 360/484 3482
Fax: 360/484 3109

http://www.fws.gov

National Wildlife Refuge System Information
1 800/344 WILD

December 2010

The mission of the U.S. Fish & Wildlife Service is working with others to conserve, protect, and enhance fish, wildlife, and plants and their habitats for the continuing benefit of the American people.

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