Wildlife Habitat Management Institute

Rainbow Trout
(*Oncorhynchus mykiss*)

May 2000 *Fish and Wildlife Habitat Management Leaflet* *Number 13*

General Information

Rainbow trout are coldwater fish that have long been symbolic of clear, healthy mountain streams and lakes in North America. Because of their ability to thrive in hatcheries, rainbow trout have been introduced into much of the United States and now inhabit many streams and lakes throughout the country. The popularity of rainbow trout among anglers has placed it among the top five sport fishes in North America, and it is considered by many to be the most important game fish west of the Rocky Mountains. However, reduction of good quality trout habitat due to streambank and upland soil erosion, loss of riparian vegetation, water diversion, logging and mining activities, and point and non–point source pollution from municipal development and agriculture have significantly reduced the distribution and abundance of rainbow trout. In addition, construction of dams, road crossings, and other structures impede the ability of rainbow trout to migrate upstream and downstream, which is critical to successful completion of their life cycles. Consequently, nine different populations of steelhead (sea-run rainbow trout) have been added to the federal endangered species list. Implementing sound land management practices and stream and riparian improvements on private lands can help improve coldwater habitats used by rainbow trout and a host of other aquatic species. The life history requirements of the species vary tremendously depending on where the trout lives and whether it spends its life entirely in freshwater, or migrates to the sea for several years of growth before returning to its freshwater birthplace to spawn. This leaflet will concentrate on the life history requirements of resident rainbow and redband trout, and the freshwater habitat needs of steelhead, collectively referred to here as rainbow trout.

This leaflet is designed to introduce the habitat requirements of rainbow trout and to assist private landowners and managers in the development of trout habitat management plans. The success of any aquatic species management plan depends on targeting the needs of the desired species, analyzing the designated habitat area as a whole to ensure that all required habitat elements are present, and determining what management actions will best improve a stream or lake for the species and its biotic community.

Rainbow trout current distribution.

Range

The historic range of rainbow trout extends from Alaska to Mexico and includes British Columbia, Washington, Oregon, California, Idaho, and Nevada. Rainbow trout found

primarily east of the Cascade Mountains in the U.S. and in the Upper Fraser River of British Columbia are often called redbands. Native rainbow trout are generally found in watersheds west of the Cascades. Native steelhead (west coast) are anadromous, meaning they migrate as juveniles to the Pacific Ocean and return to freshwater to lay their eggs. Most rainbow trout found outside their historic range are "domesticated" steelhead. The rainbow trout's present-day distribution is shown in the map on the previous page.

Whirling disease – Whirling disease has developed in the last two decades and is a threat to trout fisheries across the United States. Primarily affecting hatchery-raised rainbow trout and other salmonids, whirling disease is caused by a microscopic parasite that causes fingerling trout to grow with badly curved spines and other skeletal deformities that can result in high fingerling mortality. Found in 22 states to date, whirling disease made its most significant appearance in wild waters in 1994 in Colorado (upper Colorado River) and Montana (Madison River). Significant efforts are being made to understand whirling disease through research and management of hatchery-raised rainbow trout and wild trout populations with the goal of protecting rainbow trout and other native trout fisheries nationwide.

Habitat Requirements

General

Cold headwaters, creeks, small to large rivers, cool lakes, estuaries, and oceans comprise the habitats collectively used by the different populations of rainbow trout. Depending on the genetic makeup of a trout population and the habitat conditions, rainbow trout will use some or all of these aquatic habitats during their lives. Prime trout waters are clear, clean and cold. Good trout stream habitat is complex, consisting of an array of riffles and pools, submerged wood, boulders, undercut banks, and aquatic vegetation. The ability to swim to and from different habitats from ocean to headwaters, or from tributary confluence to headwaters, increases the value of individual habitat components. Assuring fish passage through artificial barriers in a system of connected habitats greatly enhances the capability of an aquatic system to sustain rainbow trout populations.

Food

Rainbow trout are opportunistic feeders that rely on a wide variety of food items ranging from small insects to crayfish. Trout inhabiting streams with a significant amount of riparian vegetation often feed heavily on terrestrial insects, such as grasshoppers and ants, that fall into the stream. Rocky stream riffles produce bottom-dwelling aquatic invertebrates, such as insects and crustaceans, that are also fed upon. In lakes and streams, invertebrates such as plankton, crustaceans, snails, and leeches, as well as small fish and fish eggs also serve as food for trout.

Important rainbow trout food items: a general list of common food items (DOES NOT represent all foods consumed).

Aquatic food items:
Invertebrates such as: larval and aquatic stages of dragonflies, mayflies, and caddis flies; worms; crayfish; plankton; snails; leeches. Also, small fish and fish eggs.

Terrestrial food items:
Grasshoppers, ants, beetles and other insects.

Spawning Habitat

Rainbow trout spawn in main river channels and their tributaries, and inlet or outlet streams of lakes. During their spawning migrations, steelhead are famous for their ability and tenacity to return to the streams where they hatched. Generally spawning in the spring and early summer, rainbow trout most commonly use stream riffles located downstream from pools as spawning areas. Tributaries and inlet and outlet streams containing gravels between one-half and three-inches in size are the most suitable resident trout spawning habitats. Using her tail, the female digs a depression in the gravel, called a *redd.* She then deposits a portion of her eggs into the redd, as an attending male fertilizes them. The fertilized eggs are covered by gravel as the female excavates yet another redd just upstream. Riffle and pool tail-out habitats with well-aerated gravels free of sediment are ideal spawning habitat. Trout deposit eggs within a range of water depths and velocities that minimize the risk of desiccation as water

levels recede with the seasons. Sufficient water depth and sediment-free spawning gravels are critical to ensure that water can percolate through the spaces in the gravel, bringing oxygen to the eggs and removing metabolic wastes associated with incubation and hatching. After hatching, young trout remain in the gravel until most of the yolk reserves they are born with are used up. They emerge from the gravel as swimming fry ready to search for food.

Cover

Bank structure, in-stream wood and boulders, and riparian vegetation provide protective refuge and hiding cover for rainbow trout. Undercut banks, overhanging vegetation, turbulent or deep water, submerged or semi-submerged wood, aquatic plant beds, root masses, and large rocks also contribute to habitat diversity for rainbow trout and other aquatic life important to trout for food. Riparian vegetation (vegetation growing along a river or stream) such as trees, shrubs, grasses, and forbs provides shade which moderates water temperatures and is a source of woody cover when limbs and trees fall into the stream. Roots of riparian vegetation help stabilize stream banks, reducing siltation and maintaining water quality. Riparian plants also provide habitat for terrestrial insects that may serve as trout food.

Interspersion of Habitat Components

Ideal interspersion of habitats within a trout stream consists of a complex of cool, clean water; undercut banks with overhanging riparian vegetation; slow-flowing shallow to deep pools; riffles in rapid-flowing water; one to three-inch diameter gravels or pebbles; aquatic weed beds; and submerged or semi-submerged logs or branches, rock piles and root masses that provide shelter. Because rainbow trout are more solitary than social in nature, an abundance of complex habitats partitions and reduces the size of territories, allowing more trout to coexist. In areas of extreme winter conditions, deep pools serve as refuges in iced-over streams and are critical for over-winter survival. Trout inhabiting lakes seek deep, cool water with access to shallows and inlet or outlet streams.

Mark Schuller. NRCS

Steelhead habitat of interspersed pools and riffles, in-stream wood, and clean gravels.

Minimum Habitat Area

Because of the opportunistic and migratory nature of rainbow trout, minimum habitat size is difficult to determine. Rainbow trout will forage far from their established territories when food is limited. If habitat conditions (such as water temperature) should change, they will swim to another part of the stream. While it is difficult to plan for minimum habitat size, connectivity between as many potential habitats as possible should be maximized. As opportunistic feeders, rainbow trout hold in stream riffles to feed. Thus, streams where food is plentiful may support numerous trout with relatively small territories. Likewise, streams with less food will support fewer trout and will require larger feeding territories.

Rainbow Trout Habitat Management – Preserving and protecting stream and lake habitat is the most effective way to maintain healthy trout numbers in water bodies where they are present. This section describes management options for protecting existing trout streams and lakes as well as a few common stream enhancements that can potentially increase a degraded stream's value as trout habitat. Sur-

rounding land uses, a stream's physical composition and water flow, management goals, and riparian and in-stream vegetation will dictate which management practices are most appropriate. Because more than one protection or improvement practice may be beneficial, consultation with and assistance from federal, state or local fish and wildlife and land management agencies can be very helpful in identifying appropriate management actions and permit requirements.

Rainbow trout stocking – Stocking hatchery-raised rainbow trout is not without controversy. The introduction of rainbow trout into eastern streams and lakes has resulted in competition for food and habitat with native brook trout (brook charr) and Atlantic salmon. Propagation of hatchery rainbow trout in the western United States has resulted in a loss of genetic variation in native rainbow trout as a result of the mixing of hatchery and native individuals during spawning. These issues have raised awareness for the need to carefully plan and monitor the release of hatchery-raised rainbow trout into watersheds supporting wild trout in order to protect native populations of rainbow trout, cutthroat trout and other native fishes.

Watershed Management – The best approach to trout habitat protection or recovery is to sustain a fully functional, well-vegetated stream corridor within a soundly managed watershed. This includes maintaining natural stream processes, minimizing erosion in uplands, protecting floodplains, wetlands and riparian areas, and managing streamside forests and riparian areas with aquatic species in mind. In areas of degraded habitat, there are both passive and active measures landowners can take to improve trout habitat. Construction of in-stream improvements is a science and an art requiring technical expertise and experience. Poorly designed and constructed "improvements" can actually lead to further degradation of habitat or loss of channel and watershed stability. Improvements in riparian management, sound grazing practices, and addition of wood to stream channels can maintain or improve aquatic habitats. Landowners should make every effort to maintain in-stream flows for trout during all seasons of the year, particularly during the growing season, make certain that irrigation diversions are screened to avoid trapping trout in irrigation ditches, and eliminate or modify water diversion structures that impede fish passage upstream and downstream.

Fencing – Fencing livestock from stream banks and trout lakes can prevent collapse of undercut banks and reduce soil erosion and siltation in the water resulting from livestock trampling stream or lake edges. Fencing livestock from trout waters can also reduce the amount of livestock waste entering a water body, reducing the risk of water quality degradation from high nutrient levels. Because fencing can be expensive, preventing overuse of an area by seasonally rotating livestock and grazing patterns and providing attractants distant from water sources such as salt blocks and watering tanks may be an alternative management option. Properly stocking a grazed range is the best way to maintain the integrity of both the range and trout stream habitat whether an area is fenced or not.

Riparian Management– Riparian vegetation protects streams from siltation, filters nutrients and contaminants in surface runoff, helps maintain stable streambanks and cool water temperatures, and provides input of wood, leaves and twigs to the aquatic ecosystem. Riparian areas provide habitat for insects and other wildlife. Sound upland management coupled with maintaining an undisturbed riparian buffer along trout streams

BLM photos

Degraded conditions of an Oregon trout stream following season-long grazing (top) were improved by addition of fencing and spring-only grazing (bottom).

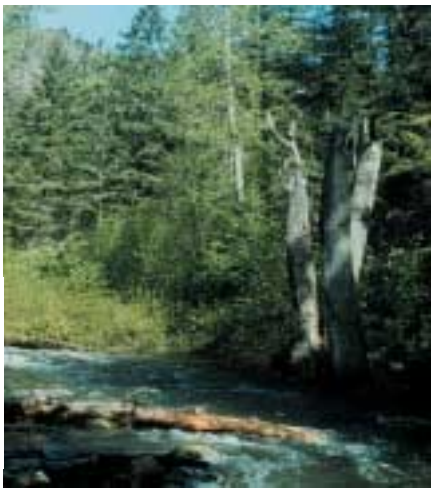
is one of the most effective practices to protect trout streams. Agriculture and logging can have potential detrimental effects on riparian areas and trout streams. Cultivated fields and timber harvest units near trout habitat should not come within an average of 100 feet of a stream, depending on the topography, plant community type, and geology of the area. A combination of native riparian vegetation (trees and shrubs and forbs) and sound upland practices provides an effective riparian buffer to filter sediment, fertilizer, and herbicide runoff and maintains critical riparian functions important to trout and aquatic life. Trees along streambanks should not be harvested and logging equipment should be kept out of riparian habitats, especially during wet periods. Soil and nutrients are trapped by vegetation as surface runoff from recently harvested uplands flows through riparian areas toward the stream.

Stream Improvements

Tim Dring. NRCS

Riparian vegetation provides shade and organic matter to the stream and helps maintain stable steambanks.

In severely degraded stream habitats, adding physical structure can influence the development of scour holes, pools, narrowed stream channels, and increased water velocity of the stream. Additions of wood or boulders and planting of riparian vegetation can expedite an increase in overhanging bank cover and submerged habitat components that provide spawning, feeding, and hiding cover for rainbow trout. In-stream improvements should always be designed to emulate the historical or desired ecological conditions of the stream in the context of its watershed. Watershed conditions, streambank stability, channel and streambank gradient levels, and project costs all influence which techniques best suit a particular stream. Instruction and technical assistance from federal, state or local fish and wildlife and land management agencies should be sought before any stream improvements are undertaken. An evaluation of the watershed conditions both upstream and downstream of the proposed improvement project will increase the likelihood that in-stream projects will be successful in improving trout habitat. The text below briefly explains a few common trout stream improvement techniques. Complete diagrams and instruction for these and other trout stream improvements can be found in *Trout Stream Therapy* by Robert Hunt or the interagency *Stream Corridor Restoration Manual* (1998). See the reference section for complete citations.



Tim Dring. NRCS

In-stream wood provides important trout habitat.

***Riparian vegetation* –** Planting and maintaining native riparian vegetation along trout streams provides shade, organic material and overhanging cover to the channel. In addition, riparian vegetation attracts terrestrial insects used as food by trout. Native trees and woody shrubs provide a source of large wood to the stream. Native grasses, sedges, forbs, and shrubs can be planted or encouraged along trout streams in which woody riparian vegetation is limited or absent due to the ecological conditions of the site. Planting willows along stream banks is encouraged, especially to aid in soil stabilization and rapid revegetation of areas denuded during floods or bank stabilization activities. Local conservation agents can assist in

the planting of appropriate species and planting techniques.

Scott Wixsom. USFS

"Downstream V" current deflectors can be used to increase stream channel complexity in degraded streams.

In-stream wood -- Adding large wood to streams where little or no wood exists because of logging or poor retention capacity can increase pool area and provide cover for trout, especially in low-gradient channels with mobile substrates (see Hilderbrand et al. 1997). In forested streams, logs provide resting and hiding cover for rainbow trout and can be imported from outside of the riparian zone and placed in the stream channel. In more stable streams, untrimmed whole trees with branches and root wads placed in the channel may not need to be secured to the bank. These structures mimic the natural recruitment of fallen trees into the stream channel and will move and adjust to the stream channel and floodplain during rain events. If a more secure structure is desired, cover logs can be cabled to stationary objects such as boulders with enough slack to allow the logs to shift slightly as the channel fluctuates. In areas where artificially placed logs may present a hazard to infrastructure, such as bridges, logs may be held into place on the stream bottom with rebar reinforcements four feet or longer in length. Low-gradient streams with slow flowing water and limited amounts of cover are good candidates for addition of large wood, including root wads.

Current deflectors – In seriously degraded streams, deflectors alter the course of shallow streams and concentrate flow to create deeper channels, scour pools and increase the diversity of current velocities. Log deflectors are generally V-shaped and are constructed on the stream edge with the closed end waterside. Both free ends are anchored in the stream bank at least three feet, and three- to four-foot lengths of rebar is used to fasten the in-stream logs to the stream bottom and to one another. Boulder and cobble fill is used to fill the deflector and stabilize it and the stream bank. Deflectors made solely of stone can be used as well. Bank cover logs installed opposite deflectors are necessary to protect the bank into which the redirected water is forced. Deflectors should only be used in channels of low habitat diversity where pools are limited, and watershed conditions warrant their use.

Brian Abbott. Pierce Co.. WA SWCD

Well-designed culverts allow trout to move upstream and downstream.

Boulders - In-stream boulder clusters can be placed in streams to provide a break in the current and pockets of slow water in which trout can rest between feeding activities. Boulders can be placed within any gradient stream channel where resting cover is limited, and where such in-stream structural components were likely present historically.

Culverts – Stream crossings such as bridges and culverts should be designed to allow trout to move upstream and downstream. For trout to be able to swim through culverts, the structure should have a minimum water depth of 0.8 feet, a maximum hydraulic

drop at the outfall of 0.8 feet, and maximum water velocity of less than 4.0 feet per second (culverts greater than 100 feet in length should have slower water velocities). Other criteria and design specifications can be found in the Washington Department of Fisheries and Wildlife Fish Passage Design at Road Culverts Design Manual, available on their website at http://www.wa.gov/wdfw/hab/engineer/habeng.htm

Rainbow Trout Habitat Requirements Summary Table.

Habitat Component	Habitat Requirements
General	• Cold creeks, rivers, cool lakes; for steelhead, also include oceans and estuaries • Complex array of in-stream wood, boulders, undercut banks • Provisions for fish passage throughout the watershed to the extent possible
Food	Aquatic food items: • larval and adult insects (mayflies, stoneflies, caddis flies), worms, crayfish, plankton, snails, leeches • Small fishes, fish eggs Terrestrial food items: • Grasshoppers, ants, beetles
Spawning Habitat	• Riffles in tributaries of rivers and inlet or outlet streams of lakes
Cover	• Undercut banks, overhanging riparian vegetation, turbulent or deep water, aquatic weed beds, submerged or semi-submerged logs, boulders, rock piles or root masses
Interspersion	• Stream habitat: Complex of cool, clean water; undercut banks with overhanging riparian vegetation; slow-flowing shallow to deep pools; riffles in high-velocity water; gravel substrate of one to three-inch diameter gravels or pebbles; aquatic weed beds; and submerged or semi-submerged logs, rock piles, root masses that provide shelter • Lake habitat: Complex of moderately deep to deep, cool water, shallows, vegetation, and unimpeded access to inlet or outlet streams

Limiting Factors

For planning purposes, assess the site to subjectively rate the availability and quality of rainbow trout habitat within a planning area, based on the above habitat requirement descriptions. Habitat and stream community components that are absent or rated low are likely limiting rainbow trout habitat quality. Land uses and stream conditions on adjacent properties may need to be considered to accurately rate the quality and potential of one's property as trout habitat.

	Availability/Quality			
Habitat Component	**High**	**Medium**	**Low**	**Absent**
General (temperature, wood, pools, riparian area)				
Food				
Spawning habitat				
Cover				
Interspersion of habitat components				
Minimum habitat size, degree of connectivity				

Management Prescriptions

Management treatments should address the habitat components that are determined to be limiting rainbow trout habitat potential. For planning purposes, select among the possible action items listed below to raise the quality or availability of each habitat component determined to be limiting. NRCS Conservation Practices and various programs that may provide financial or technical assistance to carry out specific management practices are listed where applicable.

Habitat Component	Management Options for Increasing Habitat Quality or Availability	Conserv. Practices and Assistance Programs
Food	• Fence livestock from streamside riparian vegetation and trout lakes; pipe storage tank and trough water away from riparian areas and implement seasonal grazing prescriptions to minimize livestock damage to streambanks and native riparian vegetation. • Maintain a buffer of 80-100 feet between trout streams and agriculture fields to reduce siltation and non-point source pollution from fertilizer and pesticide runoff.	382, 391a, 395, 614 WHIP, EQIP, PFW, CRP
	• Along trout streams, plant and maintain native willows, trees, grasses, sedges, forbs, shrubs, and other riparian vegetation suitable to the site.	391 WHIP, EQIP, PFW, CRP, WRP
	• Place gravel to create aquatic food habitat in stream riffles above and below pools, dams, or wherever water velocity increases. • Install boulders and wood to provide cover and habitat for insects.	395 WHIP, EQIP, PFW, CRP, WRP
Spawning and rearing habitat	• Install gravel and rubble to create stream riffles above and below pools, dams, or wherever water velocity increases from a slow flow. • Install channel constrictors in very shallow, wide streams . • Maintain instream flow and eliminate fish passage barriers to allow fish to move upstream and downstream during all times of the year. • Maintain healthy riparian vegetation to provide source of wood for stream, shade for water, and habitat for insects.	391a, 395, 396 WHIP, EQIP, PFW, CRP, WRP
Cover	• Preserve and plant, when practical, native trees, willows, grasses, sedges, forbs, shrubs, and other riparian vegetation along trout streams.	391a WHIP, EQIP, PFW, CRP, WRP
	• Install log covers, current deflectors, boulders, and channel constrictors in severely degraded trout streams to expedite habitat recovery. • Install inverted and submerged tree root masses in trout streams.	395 WHIP, EQIP, PFW, CRP, WRP
Interspersion & minimum habitat size	• Combine above prescriptions to increase interspersion of habitat components and amount of suitable rainbow trout habitat. • Replace culverts considered a barrier to fish passage • Manage irrigation water and systems to maximize water efficiency and allow more water to remain in streams.	395, 396, 449 WHIP, EQIP

NRCS Conservation Practices that may be useful in undertaking the above management actions.

Conservation Practice	Code	Conservation Practice	Code
Fence	382	Fish Passage	396
Riparian Forest Buffer	391a	Irrigation Water Management	449
Fish Stream Improvement	395	Trough and Tank	614

Available Assistance

Landowners interested in making their individual efforts effective for their entire community can work with the Wildlife Habitat Council and NRCS to involve school, scout, and community groups and their families, as well as state and federal fish and wildlife agency personnel, in habitat projects when possible. On-site education programs demonstrating the value of rainbow trout habitat management can greatly increase the effectiveness of an individual management project. Corporate landowners should encourage interested employees to become involved. Involving federal, state and non-profit conservation agencies and organizations in the planning and operation of a rainbow trout management plan can greatly improve the project's success. Assistance programs available through various sources are listed below.

Programs that provide technical and financial assistance for improvement of fish habitat on private lands.

Program	Land Eligibility	Type of Assistance	Contact
Conservation Reserve Program (CRP)	Highly erodible land, wetland, and certain other lands with cropping history. Stream-side areas in pasture land	50% cost-share for establishing permanent cover and conservation practices, and annual rental payments for land enrolled in 10 to 15-year contracts. Additional financial incentives are available for some practices	NRCS or FSA State or County Office
Environmental Quality Incentives Program (EQIP)	Cropland, range, grazing land & other agricultural land in need of treatment	Up to 75% cost-share for conservation practices in accordance with 5 to 10-year contracts. Incentive payments for certain management practices	NRCS State or County Office
Partners for Fish and Wildlife Program (PFW)	Most degraded fish and/or wildlife habitat	Up to 100% financial and technical assistance to restore wildlife habitat under minimum 10-year cooperative agreements	Local office of the U.S. Fish and Wildlife Service
Waterways for Wildlife	Private land	Technical and program development assistance to coalesce habitat efforts of corporations and private landowners to meet common watershed level goals	Wildlife Habitat Council (301-588-8994)
Wetlands Reserve Program (WRP)	Previously degraded wetland and adjacent upland buffer with limited amount of natural wetland and existing or restorable riparian areas	75% cost-share for wetland restoration under 10-year contracts, and 30-year easements, and 100% cost-share on restoration under permanent easements. Payments for purchase of 30-year or permanent conservation easements	NRCS State or County Office
Wildlife at Work	Corporate land	Technical assistance on developing habitat projects into a program that will allow companies to involve employees and the community	Wildlife Habitat Council (301-588-8994)
Wildlife Habitat Incentives Program (WHIP)	High-priority fish and wildlife habitats	Up to 75% cost-share for conservation practices under 5 to 10-year contracts	NRCS State or County Office
State fish and wildlife agencies and private groups such as Trout Unlimited may have assistance programs, publications, or other useful tools in your state.			State or local contacts

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In cooperation with partners, the mission of the Wildlife Habitat Management Institute is to develop and disseminate scientifically based technical materials that will assist NRCS field staff and others to promote conservation stewardship of fish and wildlife and deliver sound habitat management principles and practices to America's land users.

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The Wildlife Habitat Council's mission is to increase the amount of quality wildlife habitat on corporate, private, and public land. WHC engages corporations, public agencies, and private, non-profit organizations on a voluntary basis as one team for the recovery, development, and preservation of wildlife habitat worldwide.

www.wildlifehc.org

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