Establishing a Population of Blanding's Turtles (*Emydoidea blandingi*) on the Assabet River National Wildlife Refuge

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Chapter 1 - Introduction

Executive Summary

The Blanding's turtle (*Emydoidea blandingii*) is a medium-sized, semi-aquatic freshwater turtle that inhabits wetlands throughout the upper Midwest and New England. The New England population is disjunct from the main portion of the range.

The global rank of the Blanding's turtle is currently G4 (apparently secure; NatureServe, 2006) and it is listed as LT (Least Threatened) by the IUCN Red List. It occurs in 15 U.S. states and 3 Canadian provinces, and has protected status in most of them (Compton, 2006). It is most common in Nebraska where it is listed as S4. All other Midwest states and provinces rank it as S1 (critically imperiled), S2 (imperiled) or S3 (vulnerable). In the Midwest, it is declining is some regions, notably the Great Lakes region (Southwell, 2002). In New England, the Blanding's turtle occurs in New York (S2, state Threatened), Massachusetts (S2, state Threatened), New Hampshire (S3, state Special Concern), and Maine (S2, state Endangered). In Nova Scotia, Blanding's turtle is listed by the Canadian government as a threatened species.

Loss of wetland habitats, as well as the upland habitats that connect them, and adult road mortality are the main threats to Blanding's turtles (Compton, 2006; Congdon and Keinath, 2006). Although wetland loss is sometimes reduced due to regulations and local community action, loss of upland habitats and landscape fragmentation continues as the results of development and road construction.

In a recent assessment by Compton (2006), it was reported that the number of known records for Blanding's turtles in New England total 180 element occurrences (EOs), although 169 of these are represented by only one or a few animals. Most of these EOs are observations of turtles crossing roads. Only nine sites in New England have documented 10-50 turtles (Compton, 2006) and only two sites in New England have more than 50 animals known; these are represented by the Oxbow National Wildlife Refuge (NWR) /U.S. Army Fort Devens complex and the Great Meadows NWR (at the Concord Impoundments). Further, it might be speculated that with the possible exception of the Oxbow NWR population, none of these sites represent long-term viable populations under current conditions. Therefore, simply proposing to protect existing sites may not be enough to maintain this species as a viable component of the New England landscape.

The purpose of this proposal is to investigate the possibility of taking proactive conservation efforts to establish a Blanding's turtle population on the Assabet River NWR, a protected area that is of suitable size and is believed to contain the habitat components necessary for a viable population. Potential source populations of Blanding's turtles occur on two nearby NWRs. The project requires a multi-year commitment, although not an expensive one. New research results from repatriation and reintroduction studies with other turtle species suggests that success is possible, although not guaranteed.

The goal of this project would be to establish a self-contained, viable population on the Assabet River NWR. This document is an attempt to outline and evaluate potential strategies. The project must be conducted in a scientifically sound manner, with appropriate coordination with affected

parties, while ensuring that other Blanding's turtle populations are not negatively affected as a result. Therefore, this is a proposal to initiate a proactive conservation intervention, not to solely defend an ever-dwindling resource.

Three national wildlife refuges are considered for involvement in the project: two potential donor sites (Oxbow NWR and Great Meadows NWR) and a recipient site (Assabet River NWR), which is located intermediate between them. It is the aim of this proposal to work in coordination with current and future recovery efforts for this species in New England.

Purpose and Need for Action

Blanding's turtles are regarded as a species of conservation concern in every New England state in which they occur. More recently, concern at the federal level has resulted in multiple conservation assessments rangewide (e.g., Southwell, 2002; Congdon and Keinath, 2006; Compton, 2006). Increasing concern about populations in New England resulted in the formation of a Blanding's Turtle Working Group with state, federal, and academic participation. Blanding's turtles require large landscapes, relative to many other turtle species. They require a variety of wetland habitats, make frequent seasonal overland movements between them, and therefore suffer mortality not only from direct wetland habitat loss, but from upland landscape fragmentation as well. Protection of individual wetland sites has been difficult enough, but large-scale landscape conservation is even more daunting, especially in the expensive real estate market of the heavily-developed northeastern U.S.

Currently, few large populations of Blanding's turtles are known in New England. In fact, the only population known to contain more than 50 individual animals is the Oxbow NWR in Massachusetts. The Oxbow NWR has been the site of a long-term study and head-starting program for Blanding's turtles, and the population is apparently growing (Butler 2003; Butler 2004). The next largest population is reported from the Concord Impoundments of the Great Meadows NWR. Recent research indicates that this population has declined (Windmiller, 2004) since the 1970s (Graham and Doyle, 1977).

The Assabet River NWR was established in 2000 from lands acquired from the U.S. Army. The refuge was previously known as the Fort Devens Sudbury Annex. Botanical and zoological surveys conducted since the early 1990s have documented a diverse botanical fauna, unique and diverse wetland habitats, and several rare vertebrate species (Aneptek, 1991; Hunt, 1992; Butler, 1992; Buhlmann and Gibbons, 2006). To date, Blanding's turtles have not been discovered on the Assabet River NWR, but one road-killed individual was found adjacent to the refuge in 2000 (B. Butler, pers. comm) and the consensus among knowledgeable biologists is that the Assabet River NWR represents ideal habitat for Blanding's turtles. A valid question therefore is, why are they not present? The answer may lie with the land use practices of the site over the past century and prior to its transfer to the U.S. Fish and Wildlife Service (USFWS) National Wildlife Refuge System. Once a population has been extirpated from a site in a developed landscape, it will be difficult for a species to recolonize if there are no nearby populations and road mortality is a limiting factor.

Informal discussions between biologists, refuge managers, state wildlife managers, and federal regulatory staff led to a discussion at the Blanding's Turtle Working Group meeting held in conjunction with the Partners for Amphibian and Reptile Conservation (PARC) Northeast meeting at the Session Woods WMA, Connecticut in August 2006. Interest was expressed in entertaining a proposal to establish a population of Blanding's turtles on the Assabet River NWR. Such a proposal would be reviewed in coordination with the Blanding's Turtle Working Group as well as coordinated with on-going efforts to assess the status of Blanding's turtles in the Northeast. This proposal intends to work within that framework.

This document reviews the ecology of Blanding's turtles and identifies the threats facing this species. A review of the literature on reintroductions and translocation technologies is provided and we identify problems and concerns associated with this conservation technique. The sites for implementation of the project are described. The proposal presents a multi-year adaptive management strategy of repatriation releases and habitat management with the goal of establishing a population of Blanding's turtles on the Assabet River NWR.

Justification for this Proposal

The Blanding's turtle is a species that requires large, unfragmented blocks of diverse wetland and upland habitat in order for viable populations to exist. Such locations are becoming scarcer in human-dominated landscapes, especially in the northeastern United States. Most existing Blanding's turtle sites in the Northeast are likely remnants of once more extensive habitats. Protecting these existing sites and adding to their acreage is critical for the future recovery of this species. It must also be noted that this objective becomes more difficult and expensive to achieve with each passing year. The persistence of certain species on the landscape may ultimately depend in part on the establishment or reestablishment of populations on large tracts of suitable land already set aside for wildlife conservation. In our assessment, the Assabet River NWR may represent such a site for Blanding's turtles. It is located within the heart of this species range within the New England landscape. The total acreage (2,230 acres) is large enough to support a population of these turtles: the site is currently managed for wildlife conservation and Assabet River NWR is located roughly equi-distant between the two largest known Blanding's turtle populations in all of New England. The size of the Assabet River NWR, the numerous vernal pools, the forested habitat between wetlands, and minimal automobile traffic within the Refuge all seem to suggest that a Blanding's turtle population could be favored. However, given the lack of nearby sizable populations and the fragmented landscape between Assabet River NWR and other known populations, natural re-colonization is unlikely. The USFWS is completing a draft status assessment for Blanding's turtle. Evidence indicates that the magnitude of the threats to the species may warrant the need to provide federal protection for the species in the northeast. A project that aims to establish a population on an existing national wildlife refuge would help meet recovery goals, and the USFWS mission of restoration of wildlife populations.

Decision to be Made

Based on the information provided in this Environmental Assessment (EA), our Regional Director will select a preferred alternative. The recovery of endangered or threatened species

often requires determined human action (USFWS, 1981). Repatriation has been used successfully with some birds and mammals, and to a lesser degree with reptiles. The decision is whether to authorize the release of hatchling, juvenile, and/or adult Blanding's turtles on Assabet River NWR over a multiple-year period with the intent of monitoring the growth, survivorship and movements of the introduced turtles. Establishment of a reproducing, self-sustaining, viable population is the overall goal.

Chapter 2 - Species of Interest

The Blanding's Turtle

This summary is intended to familiarize the reader with the Blanding's turtle and to briefly summarize its general distribution, relevant life history and ecology, habitat needs, movement patterns, and threats to its persistence in New England. For a complete review of literature on the species and a detailed assessment of this species status, we refer the reader to Compton (2006).

Description

Blanding's turtles are moderate-sized semi-aquatic turtles (Gibbons, 1968) with plastron lengths up to 190 mm. Males may be slightly larger than females. The carapace is dark, usually black with numerous white or yellow speckling. The plastron is hinged, generally yellow with black blotches within each scute. The head is somewhat flattened dorsally, the neck is relatively long, and the chin and throat are bright yellow.

Distribution

Blanding's turtles have a strictly northern distribution and are confined to the upper midwestern U.S., New England, and southeastern Canada. Blanding's turtles are the most latitudinally-restricted turtle species in the U.S. with a north to south range not exceeding 900 km. The New England populations are disjunct from the midwestern populations (Figure 1). Blanding's turtles have been known from New England since 1839 (Storer 1839). Blanding's turtles have a low thermal maximum of between 38.2°-40.6° C, limiting their southern distribution.

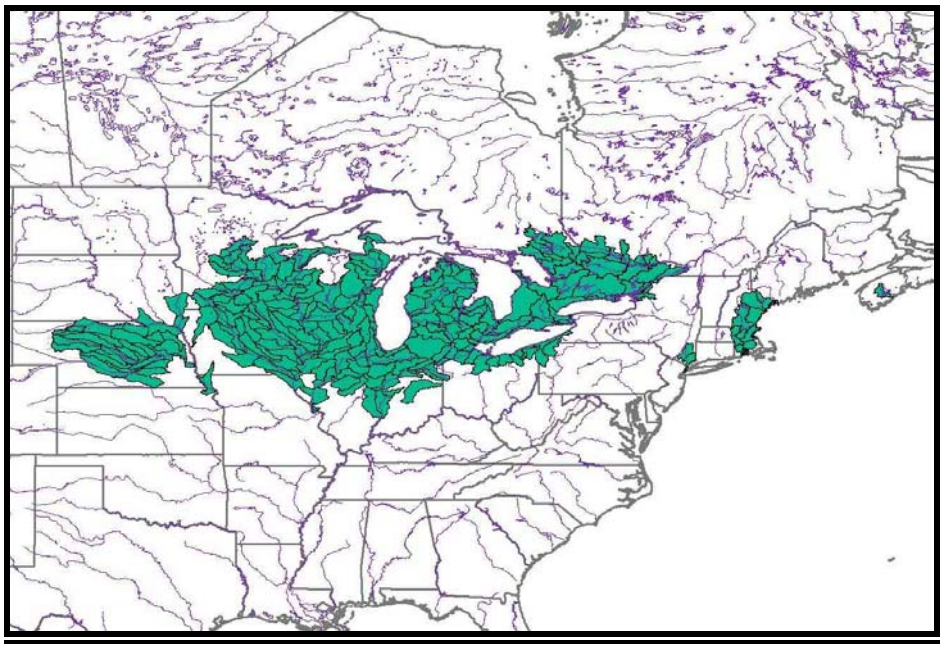

Figure 1. The global range of the Blanding's turtle (*Emydoidea blandingii*), as indicated by known hydrologic unit compartments (HUCs).

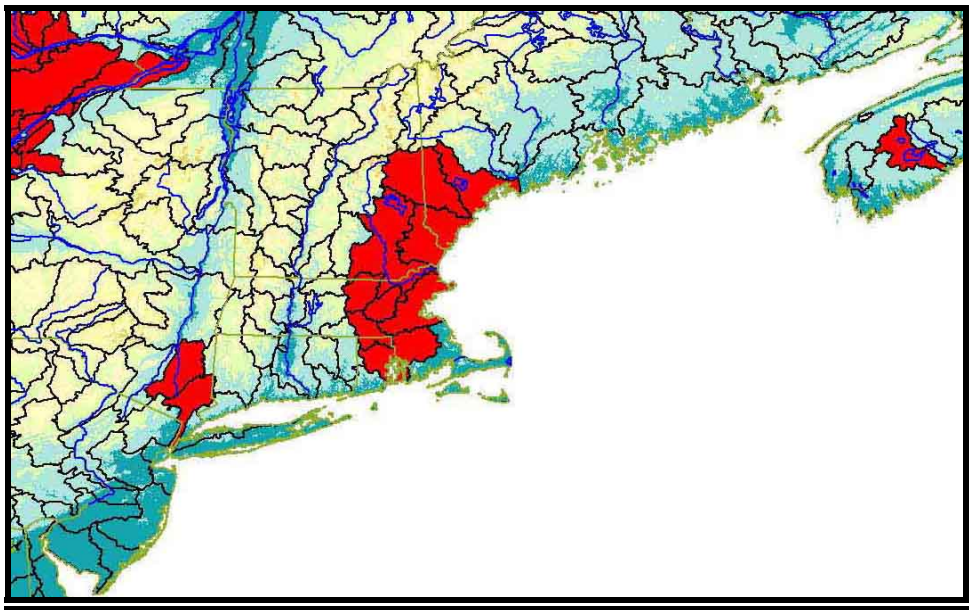

Figure 2. The hydrologic unit compartments (HUCs) indicated in red represent watersheds known to contain Blanding's turtles in New Engand.

Life History

Blanding's turtles are long-lived with a long generation time (minimum 37 years; Congdon et al., 1993) and individuals have been known to survive in the wild in excess of 70 years (Breck and Moriarty, 1989; Congdon and vanLoben Sels, 1993). Blanding's turtles require 14-20 years to

reach sexual maturity (Congdon and van Loben Sels, 1993). Minimum size at maturity for females is 163 mm carapace length (CL) (Congdon and vanLoben Sels 1993). Females, and presumably males, are reproductive throughout the rest of their lives, showing no signs of senescence. In fact, evidence is strong that the oldest females have increased clutch size, greater reproductive frequency, and higher survivorship compared to younger animals providing evidence for the relative reproductive rate hypothesis for evolution of longevity (Congdon et al. 2001) and illustrating the incredible value of old individuals in healthy populations. Congdon and Keinath (2006) suggested through modeling that one breeding female is demographically equivalent to 100 eggs (equivalent to 8-12 years of her reproduction).

In Maine, clutch size in Blanding's turtles ranged from 5-11 eggs (Joyal et al. 2000); Butler and Graham (1995) reported 8-13 eggs per nest in Massachusetts. Females nest no more than once per year and some females skip years of reproduction (Congdon et al, 1993). Mating has been observed in the fall, spring, and other times of the year.

Nest survivorship is highly variable and can range from 0% to 100% of all nests in a population in a given year. Over a 23-year period, 78% of all Blanding's turtle nests were destroyed by predators in a Michigan study, and in nine of those years 100% were destroyed (Congdon et al., 2000). Mammalian predation is the greatest cause of nest failure, and may be increasing as many meso-predators (raccoons, opossums, skunks, gray fox) have increased their abundance as a result of human development and subsidized food.

In a long-term Michigan study, first year survivorship of hatchlings has been estimated at 26% (Congdon and van Loben Sels, 1993), and juvenile survivorship (> age 1 to maturity) averages 72% annually. High annual adult survivorship (96% annually) characterizes natural populations, as adults have few natural predators. Human-induced mortality greatly reduces this value, and almost certainly causes populations to decline.

Nesting habitats consist of open canopy areas with gravely or sandy soils. Naturally occurring glacial deposits, as well as man-made borrow pits and excavation sites are frequently used. Throughout their range, Blanding's turtles are known to nest early June through early July (Congdon et al. 2000). In New England, peak nesting times have been reported between 12-17 June (Butler and Graham, 1995). Nesting is most often observed during evening hours, and often after a rain. Congdon (2000) reported that 99% of nests on the ES George Reserve in Michigan were within 400m of wetland habitats used by Blanding's turtles. Although the maximum distance from wetland to nesting has been known to exceed 500m, only 1% of 263 nests were greater than 400 m from the wetland. Nest site fidelity is relatively high (Congdon et al. 1983).

Hatchling Blanding's turtles emerge from nests during late summer and early fall. Many hatchlings travel to wetlands adjacent to nesting areas (Congdon et al., 2000), but some hatchlings remain buried under forest litter for several days (Butler and Graham, 1995). In some cases, hatchlings have been observed entering wetlands in spring (Congdon et al 2000), suggesting that they may spend the winter buried in terrestrial habitats. Butler and Graham (1995) found that hatchlings often sought refuge under *Sphagnum* in dry vernal pools.

Ecology

Adult Blanding's turtles use a variety of wetland habitats. These include vernal pools (especially in spring), bogs, marshes, buttonbush shrub marshes, and impoundments dominated by cattails, water lilies, and duckweed. Blanding's turtles are generally diurnal, but are most often observed in the early morning or evening hours. They bask frequently in April and May. Juveniles are secretive and few are found at sizes less than 90 mm plastron length (PL) (Gibbons, 1968). In Nova Scotia, juveniles selected habitats with *Sphagnum*, sweet gale (*Myrica gale*), and leatherleaf (*Chamaedaphne calyculata*) (McMaster and Herman, 2000).

Food consists primarily of crayfish and aquatic insects. They visit vernal pools in the spring months where they gorge themselves on newly hatched tadpoles. It is generally unknown what the hatchlings eat, but they are presumed to be carnivorous and likely eat small aquatic insects and crustaceans, perhaps including amphipods and isopods.

Terrestrial habitats are frequently used as travel corridors between wetlands, and upland habitats that are unfragmented by roads and developments are essential. Over a two-year study in Massachusetts, Grgurovic and Sievert (2005) recorded average home range areas of 27.5 ha for males and 20.0 ha for females. Home range lengths averaged 866 m for males and 852 m for females. The longest movement by a Blanding's turtle in their study was 3.2 km for a male that was subsequently killed crossing a highway. Haskins et al. (2005) reported that the number of wetlands used by individual Blanding's turtles in one season averaged 6.3 (range 2-12) and that the number of overland migrations averaged 7 (range: 1-16). One individual traveled more than 3000 m over the span of one month. Piepgras and Lang (2000) reported home ranges of up 63 ha. Grgurovic and Sievert (2005) suggested that home range and movements of this size would require numerous stakeholders to work together to protect most populations – a difficult task to be sure. In eastern Massachusetts, projected continuous development will result in more habitat fragmentation and road mortality. Besides use as travel corridors, uplands habitats are used for aestivation (periods of inactivity during the summer).

Chapter 3 - Affected Environments

The three National Wildlife Refuges proposed for involvement in this project, Great Meadows NWR, Assabet River NWR, and Oxbow NWR are all located approximately 20, 30, and 40 miles west of Boston, respectively.

Figure 3. The locations and sizes of the three NWRs involved in this study.

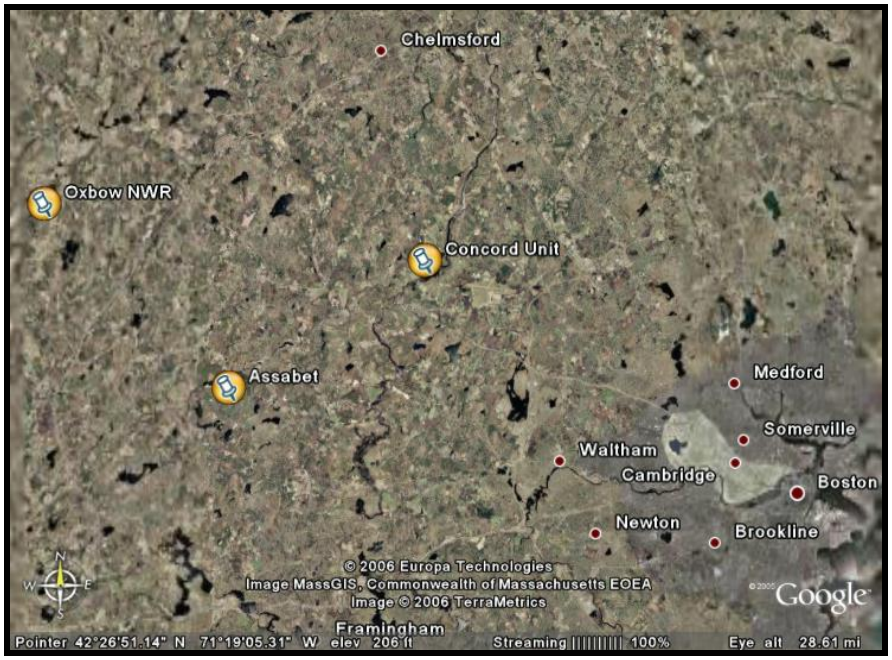

Figure 4. The locations of the three refuges within the eastern Massachusetts landscape.

Assabet River NWR (Recipient Site)

Location and Size

The Assabet River NWR was established in 2000 from lands acquired from the U.S. Army-Fort Devens complex and is located in eastern Massachusetts, approximately 30 miles west of Boston and 4 miles west of Sudbury. It was originally referred to as the Fort Devens Sudbury Annex.

The refuge comprises 2,230 acres (approximately 3.5 sq. miles) in portions of the towns of Hudson, Maynard, Stow, and Sudbury.

Mission and Refuge Purpose

The mission of the National Wildlife Refuge System (and therefore a mission for all refuges) 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. Assabet River NWR's purpose is its "...particular value in carrying out the national migratory bird management program." (16 U.S.C. 667b-d, as amended).

Description

The Refuge is bisected by Hudson Road, with 1930 acres occurring on the north side and 300 acres occurring on the south side. Each of these parcels is unfragmented by commuter roads, although some vehicles do drive on remnant roads on both parcels. Additionally, construction of a visitor center at Assabet River NWR will result in some vehicular traffic on the east side of the Refuge, north of Hudson Road. The northern portion, which is the focus of this project, is bordered on the east by Rt. 27, on the south by Hudson Road, and on the west by Sudbury Road. The Assabet River forms the northern boundary of the Refuge. The Refuge is also connected to Sudbury State Forest and Marlboro State Forest to the south. Large ponds and wetlands on the southern and eastern borders include Vose, Cutting, and Willis Ponds. These ponds are both partially in state ownership and private developments.

Habitats within Assabet River NWR are diverse. The Assabet River flows north to the Sudbury River where they merge to form the Concord River, which flows north to the Merrimack River near Lowell, Massachusetts. A 24-acre natural glacial lake (Puffer Pond) is located within the interior of the refuge. Taylor Brook originates from Puffer Pond and flows into the Assabet River. The diversity of wetland habitats within the Refuge includes numerous vernal pools and extensive shrub swamps. Six dwarf shrub bogs, two minerotrophic (oligotrophic) peatland bogs, and one cranberry bog have been described during earlier inventories (Aneptek, 1991; Butler, 1992). Other unique habitats on Assabet River NWR include an Atlantic white cedar (*Chamaecyparis thyoides*) swamp (along the edge of Willis Pond), a kettlehole pond, and exposed sands (Hunt, 1992). Botanical surveys have found similar habitats, some uncommon to the region, at both the Assabet River NWR and Fort Devens, adjacent to Oxbow NWR (Hunt, 1992). Approximately 20% of the Refuge is wetlands. The terrestrial habitat is primarily forested and is comprised of white pine (*Pinus strobus*) and mixed hardwoods.

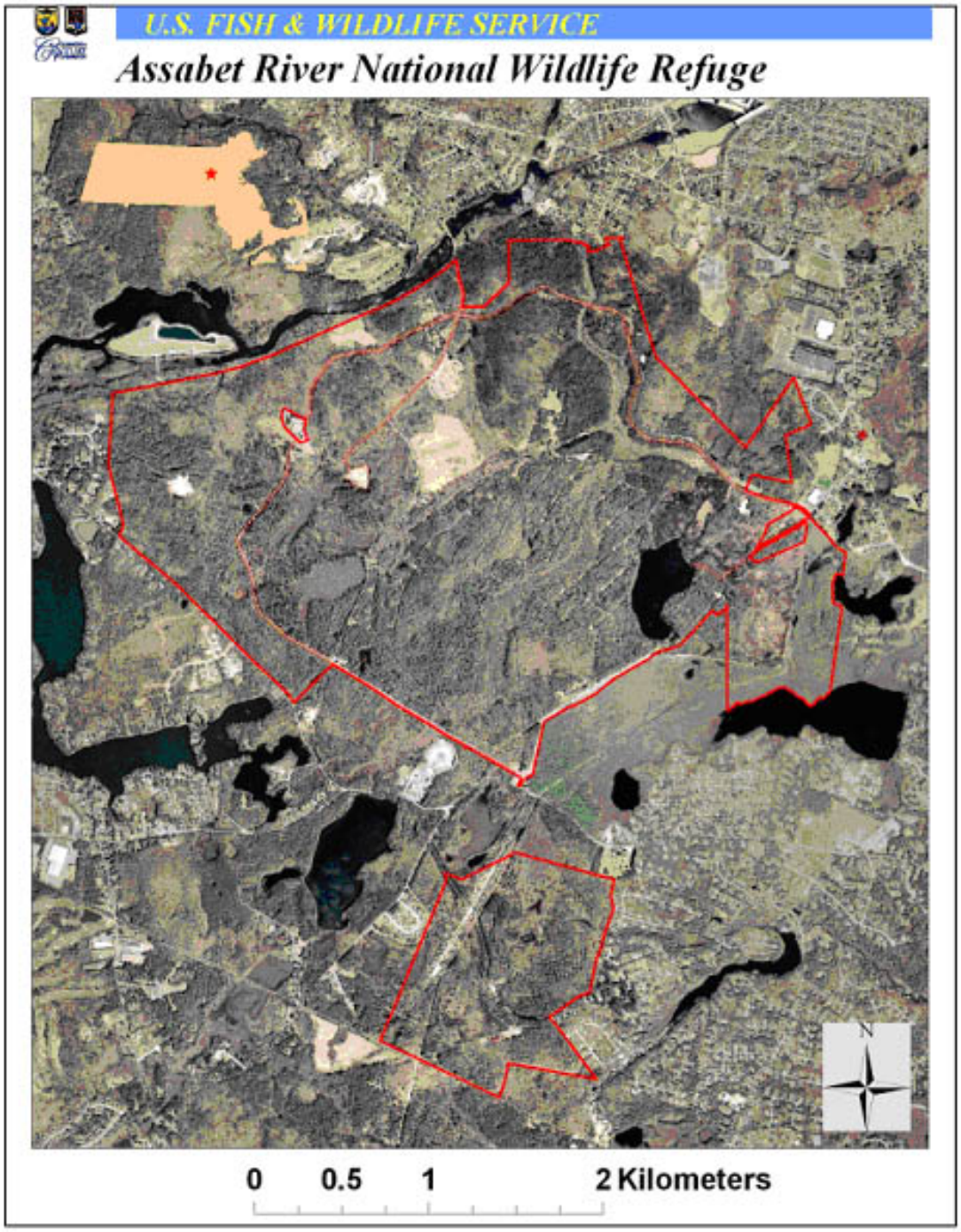

Figure 5. The landscape of Assabet River NWR encompasses about 10 square km.

Previous Surveys for Blanding's Turtles

Trapping efforts to find Blanding's turtles were made on Assabet River NWR during the early 1990s (Butler, 1992), but no animals were found. Butler (pers. comm.) found a road-killed adult female turtle on Rt. 27 on 17 June 2000 near Vose Hill, northeast of the Federal Emergency

Management Agency and Vose Pond, on the east side of the Refuge. Another live adult animal was also reported in recent years in that vicinity (Butler, pers.comm.).

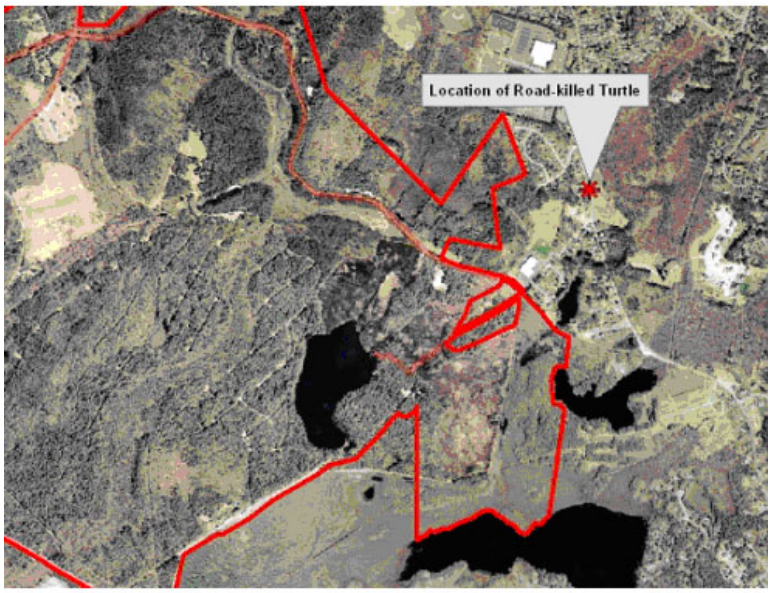

Figure 6. Location of road-killed female Blanding's turtle near Assabet River NWR, 17 June 2000. Map from Oxbow Associates, Inc.

During 2004, Savannah River Ecology Laboratory (SREL) staff visited the Assabet River NWR on two occasions, 26-27 April and 25-26 May and visually surveyed all aquatic habitats present on the refuge. During 2005, SREL staff visited the Assabet River NWR on 27-29 June. During this field period, aquatic turtle traps were set at several habitats in efforts to detect Blanding's turtles on the Refuge and to identify additional wetlands for spotted turtles (*Clemmys guttata*), a rare species that is known to occur on the Refuge (Aneptek Corporation, 1991; Butler, 1992; Meyer, 1995). Several ponds and wetlands adjacent to the refuge were also visited to assess potential habitat for Blanding's turtles (Buhlmann and Gibbons, 2006). Photographs and descriptions of potential Blanding's turtle habitats on Assabet River NWR are found in Appendix 1.

Other turtle species known from the Assabet River NWR include painted turtles (*Chrysemys picta*), box turtles (*Terrapene carolina*; listed SC), and snapping turtles (*Chelydra serpentina*). Puffer Pond is known to contain a sizable population of both painted and snapping turtles and

over 173 individual painted turtles have been marked (B. Butler, pers. comm). Snapping turtles were protected from harvest by the Army's Natural Resource Manager, when the property was managed as the Fort Devens Sudbury Annex.

Management
Wildlife management activities on the Assabet River NWR have been focused primarily on neo-tropical migratory birds and management for this group is a stated priority objective. Some open fields are mowed and maintained for grassland birds and native grasses. Invasive plant species include purple loosestrife and phragmites and management plans for control are being implemented (Refuge staff, pers. comm). Potential turtle nesting areas have been managed to remove invading shrubs. Portions of the Assabet River NWR are open for public use, although there is limited access for certain activities.

Likelihood of Blanding's turtles being present at Assabet River NWR
It is possible that a few individual Blanding's Turtles may exist on the Assabet River NWR, although it is unlikely that a viable population exists. A diverse habitat matrix exists that includes the various habitats known to be used by both juvenile and adult Blanding's Turtles.

Assabet River NWR is a previously disturbed site. During a period of extensive use from the 1940s through 1970s, numerous bunkers, buildings, and hand-dug wells were built. A railroad siding extended onto the site. Prior to the 1940s, agriculture and timber activities were conducted on site. A commercial cranberry bog operated prior to the 1940s. Since transfer to the USFWS, these human activities have ceased. The size of the Assabet River NWR, the numerous vernal pools, the forested habitat between wetlands, and minimal automobile traffic within the Refuge all seem to suggest that a Blanding's turtle population could be favored. However, given the lack of nearby sizable populations and the fragmented landscape between Assabet River NWR and other known populations, natural re-colonization is unlikely.

Oxbow NWR (Potential Donor Site)

Location and Size
The Oxbow NWR was established in 1974 with the transfer of approximately 730 acres of Fort Devens lands to the USFWS. The Refuge eventually grew to 1667 acres as a result of the base closure program. It is located along the Nashua River in the towns of Harvard, Lancaster, Ayer, and Shirley. The Nashua River flows to the Merrimack River in Nashua, New Hampshire. The Refuge is located approximately 40 miles west of Boston and is bisected east to west by Rt. 2.

Refuge Purpose
Oxbow NWR's purpose is its "...particular value in carrying out the national migratory bird management program." (16 U.S.C. 667b-d, as amended).

Description
The refuge contains a diversity of habitats including wetlands, forested uplands, oxbow ponds of the Nashua River, and open sandy areas. The dynamics of a changing river have created the oxbow ponds and extensive wetlands that give Oxbow NWR its name.

Figure 7. A large Oxbow NWR wetland dominated by leatherleaf, sweet gale, and *Sphagnum*.

Management

Historical use of the land included farming along the river bottomlands. The U.S. Army acquired lands in 1917 and used the area for military training. The Refuge currently adjoins the Fort Devens Military Reservation, a contiguous federally-owned area more than twice the size of Oxbow NWR. Wildlife management activities on Oxbow NWR have been focused primarily on neo-tropical migratory birds and management for this group is a stated priority objective. Some open fields are mowed and maintained for grassland birds and native grasses, and additional open areas are managed as needed to maintain nesting habitat for Blanding's turtles. Invasive plant species include purple loosestrife and spotted knapweed and management plans for control are being developed for these and other species (Refuge staff, pers. comm).

Excellent nesting habitat currently exists, however, old aerial photographs indicate that nesting areas were once more extensive, and have since succumbed to vegetative succession. The availability of open areas had declined since the cessation of military training activities. Nesting habitat for Blanding's turtles has been a focus of habitat management efforts in recent years. Clearing of invading shrubs and trees on the open sandy areas has resulted in a net gain of nearly 9 acres since 2003 (Butler, 2004).

Figure 8. Managed nesting habitat at Oxbow NWR.

Figure 9. Nesting habitat on Oxbow NWR.

Research with Blanding's Turtles

Blanding's turtles have been captured and marked on the Oxbow NWR and adjacent Fort Devens since 1986 (Butler, 2004). An adult population is present and juveniles are known from all age classes. Mortality of adult Blanding's turtles has been noted on Rt. 2 which bisects the refuge (Butler, 2004).

Figure 10. Wetland habitats used by Blanding's turtles at Oxbow NWR and Rt. 2 which bisects the Refuge.

New primiparous females have been found in 2003 (14% of total females on the nesting areas) and 2004 (16%) and may represent successful hatchling recruitment from nest protection efforts that began in 1987 (Butler 2004). All hatchlings have been cohort marked by year through 2006 (Butler, 2004; B. Butler, pers. comm).

Hatchlings have been produced and released into Oxbow NWR each year for the past 10 years through a nest protection program. Nests are protected with wire screens to prevent excavation by predators. The nest protection program has been very successful at reducing predation by mammals, notably raccoons, and thus has greatly boosted the number of hatchlings entering the population. However, wire screens have also occasionally attracted poachers to nests.

Not all nests have been protected. In 2004, only 16 female Blanding's turtles were observed in the process of nesting and those nests were protected with wire cages. The 16 nests had a 92% hatchling success and produced 135 hatchlings. The total number of nests protected from 2000-2004 was 139.

Although it is unknown what the carrying capacity of Oxbow NWR is for Blanding's turtles, it is apparent that large numbers of hatchlings are being added each year as the result of nest protection. We believe there are also an equal or greater number of eggs that are currently being destroyed by predators. Based on our current knowledge of the population characteristics, we believe that Oxbow NWR could provide hatchlings for an introduction effort at Assabet River NWR, with no adverse effects to the Oxbow NWR Blanding's turtle population.

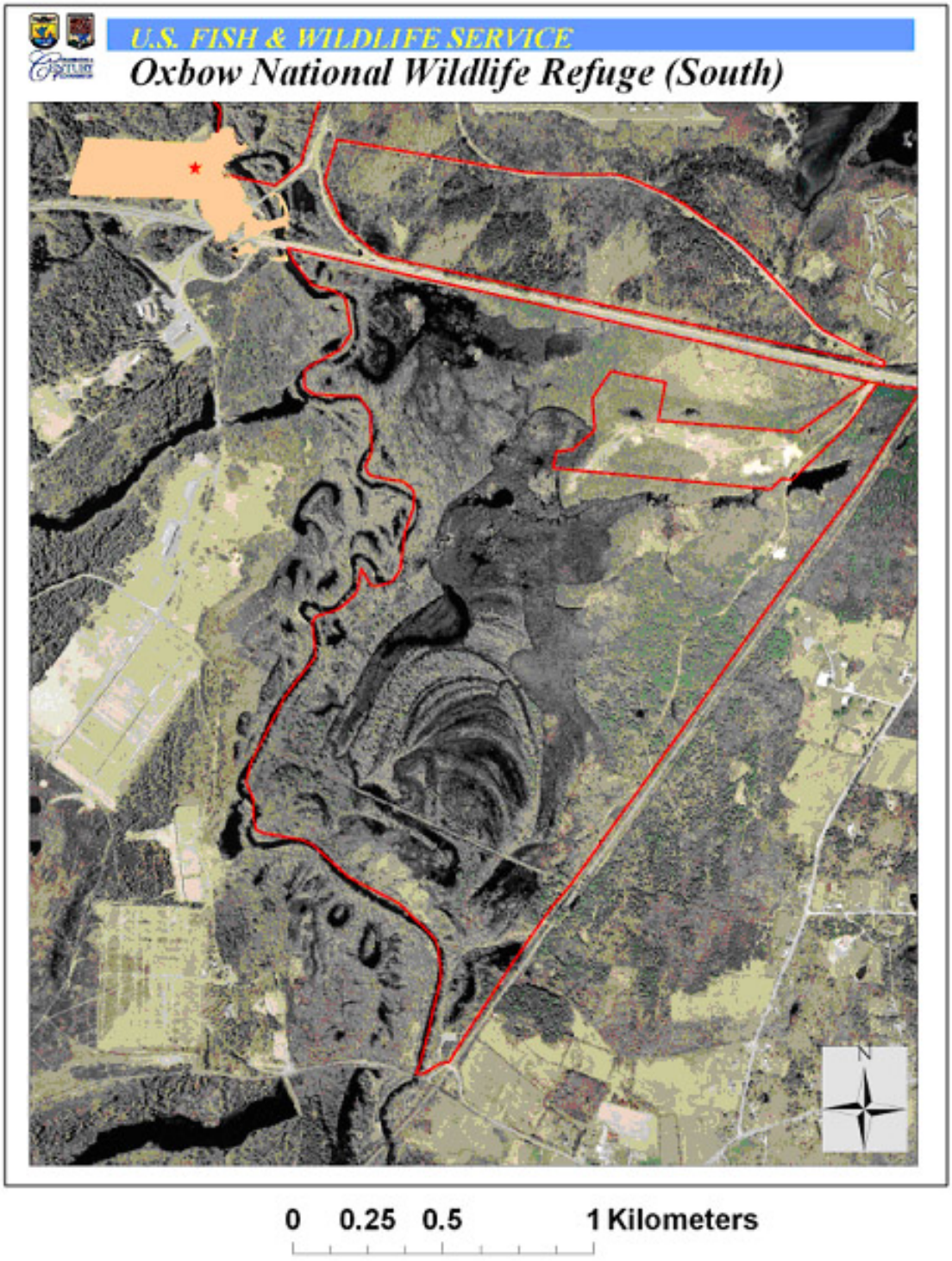

Figure 11. A current aerial photograph of the Oxbow NWR. The Nashua River runs north to south and separates Oxbow NWR (boundary shown in red) from Fort Devens Military Reservation (to the left). Rt. 2 runs east to west in the upper portion of the photograph. The extensive wetlands and oxbow ponds are obvious in the center of the photo.

Great Meadows NWR-Concord Impoundments (Potential Donor Site)

Location and Size

The Concord Impoundments of the Great Meadows NWR were first designated in 1994 and are located approximately 20 miles west of Boston in Concord. They are bordered by the Concord River to the north and housing developments to the south. The Concord River is formed by the confluence of the Sudbury and Assabet Rivers and eventually empties into the Merrimack River.

Refuge Purpose

The purposes of Great Meadows NWR are:

- "...for use as an inviolate sanctuary, or for any other management purpose, for migratory birds." (16 U.S.C. § 715d),
- "... suitable for -- incidental fish and wildlife-oriented recreational development," (16 U.S.C. § 460k-1),
- "the protection of natural resources," (16 U.S.C. § 460k-1),
- "and the conservation of threatened or endangered species..." (16 U.S.C. § 460k-1)

Description

The Concord Unit consists of two large, flooded impoundments that were originally built in 1928 by a private landowner. The impoundments encompass approximately 250 acres along the meadow floodplain of the Concord River. Dense stands of cattail (*Typha latifolia*) dominate the edges of the Concord Impoundments. Vegetation with the pools varies with the season (and water levels) but includes beggars ticks (*Bidens spp.*), Walter's millet (*Echinochloa walteri*) umbrella sedges (*Cyperus spp.*), and American lotus (*Nelumbo lutea)*. The edges of the large impoundments, ringed with cattails, are used by adult Blanding's turtles (Windmiller, 2004).

Figure 12. The Upper Impoundment in June 2005.

Figure 13. The Lower Impoundment drained for waterfowl management and invasive plant control during June 2005.

Research with Blanding's Turtles

Studies of the Blanding's turtle population at the Concord Unit have been on-going since the 1970s. Graham and Doyle (1977) marked 92 individuals and estimated the population size of adult Blanding's turtles at 135 in 1976. Windmiller (2004) reported that 31 adult and juvenile turtles were captured during a 2003-2004 study and estimated the population at 54 animals. All 10 adult females that were captured in 2003-2004 were originally marked as adults in the 1970s. Thus, there appears to be minimal recruitment of juveniles into the adult population, as well as attrition of adult animals over the past 30 years. The sex ratio of adult turtles is skewed towards males, and likely represents possible road-kill mortality of nesting females (Windmiller, 2004), a phenomenon that has been observed in other species of aquatic turtles (Steen et al., 2006). Thus, the Concord Unit population has presumably declined and appears in contrast with the population status of Blanding's turtles at Oxbow NWR. It is possible that the population decline is a result of movements of Blanding's turtles out of the refuge and subsequent road-kill. The individuals remaining in the population may represent more sedentary individuals.

Radio-telemetry of adult turtles indicate that individuals prefer the cattail-lined edges of the impoundments. Radio-tagged, headstarted juveniles were released in areas of shallow water in areas with cattail and purple loosestrife. During the first year, all head-started juveniles were found 43-123 m from their release points (Windmiller, 2004). During water draw-down of the impoundments, these juveniles were found buried in saturated mud under cattail roots (Windmiller, 2004). During drawdown, adults were found in deeper dredged channels in the pools. The effect of pool drawdowns on hatchlings is unknown, however, Refuge staff manage the two pools differently from each other to ensure that at least one pool has water during any given time of the year.

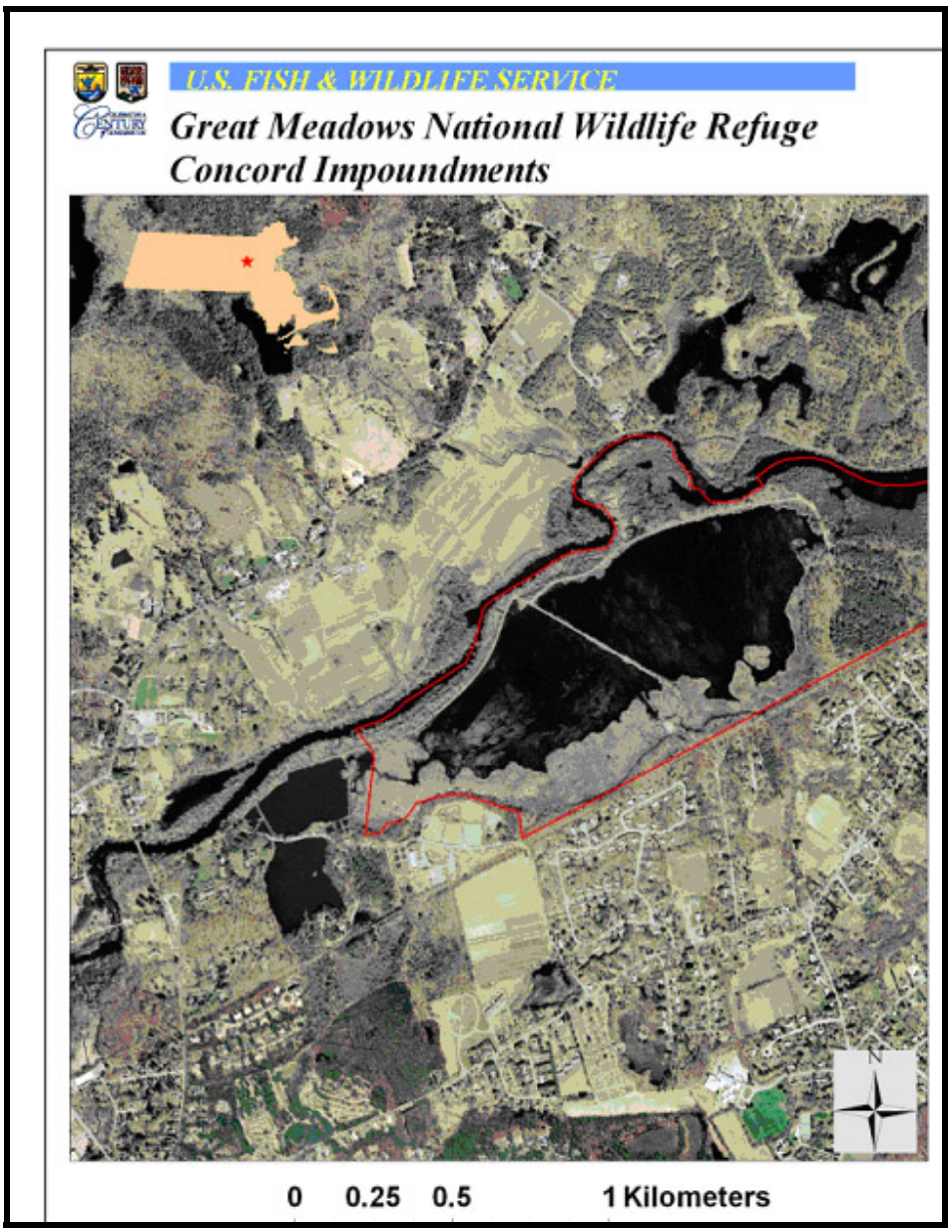

Figure 14. A 2.7 mile loop trail bisects and surrounds the two impoundments. The Upper Impoundment (the southwestern-most) and Lower Impoundment (northeastern-most).

Management

Water levels in both pools at the Concord Impoundments are managed intensively throughout the spring, summer, and fall to accommodate different guilds of bird species throughout the seasons. In very early spring, one pool is typically partially drained (temporarily) to provide habitat for northward migrating waterfowl. The pool is then refilled. Beginning in late spring, one of the pools is drained slowly with most water (except for the ditches) being drained by mid summer. In this pool, vegetation grows tall and often resembles field habitat. In early fall, this pool is re-flooded to provide habitat for southward migrating waterfowl. The second pool is also drained,

but later in the season, close to when the first pool is being refilled. Draining later in the season provides habitat as newly exposed mudflats for southward migrating shorebirds, as well as puddling habitat for foraging wading birds. By the end of the fall, both pools are completely filled and remain this way through the winter. Water level management also helps control spread of invasive species such as purple loosestrife (*Lythrum salicaria*) and water chestnut (*Trapa natans)*.

Nesting habitat for Blanding's turtles appears to be a limiting factor at the Concord Unit. Agricultural fields across the river (north) are routinely used for nesting, but this habitat may be a "sink" as crops (corn) grow taller after the nests are deposited. Roots and shade may cause egg mortality. The fields may also be plowed before the eggs hatch. The Town of Concord's Water and Sewer Division operates a facility on the southwest corner of the upper pool. The uplands in this area are used by nesting female Blanding's turtles and a nest protection program has been the focus of a collaborative effort between the Town, Refuge, and biologists (Windmiller, 2004).

Chapter 4 - Review of Translocation and Head-starting Technologies

Manipulative Population Management

As ecosystems become more and more impacted by human activities, natural processes become increasingly disrupted and the ability of species to compensate for these perturbations diminishes. As a result, species become more vulnerable to local extirpations and even range-wide extinction. Although non-intrusive management approaches such as habitat protection, restoration, and management are critical to maintaining biodiversity and ecosystem function, some species will require more intensive management measures, including population manipulations.

Types of Manipulations

A broad array of population manipulations have been used to manage species, including head-starting, repatriation, and augmentation (Seigel & Dodd, 2000). Below we describe some of the most common population manipulations that are used in species management. Because these terms are not always consistently used in the literature, the specific definitions as used in this report are provided below. The categories below are not mutually exclusive. Depending on the history of a project and the types of manipulations employed, a particular project can fall under more than one category.

> *Head-starting* – the rearing of hatchlings (either from natural nests or eggs incubated in the lab) in captivity until they have 'outgrown their period of greatest vulnerability to predators' (Spinks et al., 2003) in order to increase survivorship.
>
> *Relocation* – displacement of wild-caught animals from their habitat to avoid immediate threats such as development (Dodd & Seigel, 1991); relocation is not motivated by conservation goals but is focused on the welfare of individual animals in response to human-animal conflicts.

Translocation – the intentional release of individuals of a species at a *within-range* location different from their capture location in order to 'establish, reestablish, or augment a population' (Griffith et al. 1989); translocations typically use wild-caught individuals, although head-started animals may also be used.

Repatriation – a type of translocation in which individuals of a species are released at a location where the species formerly occurred but had been extirpated from; typically there is direct evidence of historical occupation by the species, although animals may also be released into appropriate within-range habitat where species were only suspected to have occurred; release animals can be wild-caught or head-started animals and the purpose is to re-establish a viable population of the species.

Population augmentation – release of individuals of a species at a location already occupied by the species but where the resident population is too small to be viable on its own; release animals may be wild-caught or captive-reared.

Introduction – release of individuals of a species outside their historical range either by accident (e.g., starlings in the continental U.S.) or in order to establish a population for conservation research (e.g., ringtailed lemur colony on a Georgia barrier island).

Re-introduction – although this term is often used interchangeably or in place of "repatriation," we will avoid the use of "re-introduction" because of its close affinity to the way "introductions" are defined here.

The project described in this proposal would attempt to repatriate Blanding's turtles to a national wildlife refuge using a combination of translocation and head-starting.

Concerns about Manipulating Populations

There is understandable reluctance or hesitation to employ manipulative techniques to manage species or individual populations. Much of the criticisms of manipulations such as translocation and head-starting stem from misguided attempts to portray such techniques as silver bullets—without considering alternative approaches or a combination of approaches (Seigel and Dodd 2000). In addition, these techniques are still largely viewed as experimental due to the lack of subsequent monitoring in individual projects to evaluate the techniques' effectiveness (Frazer 1992, Seigel and Dodd 2000).

Most importantly, when such techniques simply mask the symptoms of the problem (e.g., increasing the number of animals in a declining population) rather than solve the root problem itself (e.g., increased adult mortality on roads), they constitute half-way technologies that are unlikely to succeed (Frazer 1992). Without addressing the causes of the decline, released animals would be subjected to the same threats and no more likely to survive in the natural environment. However, population manipulations could be appropriate under circumstances when the threats and causes of decline have been removed but the populations are so small or so vulnerable that they are likely to disappear without temporary intervention (Frazer 1992; Heppell et al. 1996).

In short, population manipulation requires careful consideration and planning (IUCN 1998, Seigel and Dodd 2000) and should not be undertaken without:

1) understanding of the species' and system's ecology
2) considering the associated ecological, financial, or logistical constraints
3) considering other alternative management techniques in terms of their relative benefits and risks
4) verifying that the threats or causes of the original decline have been abated
5) developing detailed protocols
6) planning subsequent monitoring of affected populations
7) ensuring long-term security & management of habitat / site
8) coordinating with all stake holders

Review of Translocation Literature

Translocations are commonly used in the management of native birds and mammals, although success rates have differed between game (86%) and non-game species (46%). Variation in success rate has been attributed to number of animals released, habitat quality at the release site, location of the release site within the species' range, and the species' life history (Griffith et al. 1989, Wolf et al. 1996). The documented success rate for amphibian and reptile projects is lower (19%; Dodd & Seigel 1991) although little research and post-translocation monitoring has been conducted.

However, with reptiles and amphibians experiencing world-wide population declines (Alford and Richards 1999, Gibbons et al. 2000) and at least two-thirds of the world's turtle species considered threatened with extinction by the IUCN, translocations are considered critical conservation components for repatriation of the most threatened species (Turtle Conservation Fund 2002). Despite the controversy surrounding translocations and the dearth of post-translocation monitoring data available to evaluate its effectiveness for management of turtle populations, translocation may sometimes be the only option for re-establishing extirpated populations and reconnecting fragmented ones (Tuberville et al. 2005).

Most turtle translocation projects have been conducted with terrestrial turtles, particularly desert and gopher tortoises in the U.S. There have been a few studies on box turtles in the U.S. and with tortoise species elsewhere. Most post-monitoring focused on movement patterns and site fidelity and were usually only short term (1-2 yr) studies. The major findings of select published studies are provided below.

Terrestrial Turtles

Gopher tortoises

Gopher tortoises have been the subject of several translocation studies, which have varied in their conclusions regarding the successfulness of the technique. Post-translocation site fidelity and home ranges have varied among studies, sites, and individuals depending on release protocols, distance between capture and release site, and life stage and sex of the individual. Based on studies with adult animals, fidelity to the release site can be dramatically increased with long-term penning (9-12 months, Tuberville et al. 2005) and tortoises that do not disperse

from the release site during the first several months generally tend to settle in the release area for the duration of the study (2-17 years; Tuberville et al. 2005, Heise and Epperson 2005, Ashton and Burke, in press). Tortoises translocated on-site tend to exhibit greater fidelity than tortoises translocated off-site (Heise and Epperson 2005), especially if the release site is within homing range of the capture location. Contrary to expectations based on natural movement patterns, adult females exhibited lower site fidelity than did adult males and required longer penning durations (Tuberville et al. 2005). One study found that individuals that interacted with conspecifics during penning were more likely to remain in the release area than those that did not (C. Guyer, pers. comm.).

Home range sizes of translocated gopher tortoises can be dramatically larger than those of undisturbed tortoises, although home range sizes tend to decrease over time as the tortoises settle in to the release area (Tuberville et al. 2005). Home ranges are generally smaller in subadult than adult tortoises and in animals that were subjected to penning compared to those that weren't. However, some individuals show consistently larger home range sizes or repeatedly attempt to disperse (Tuberville et al. 2005). These behaviors may be due to differential response of individuals to the disturbance of translocation or may be due to natural variation among individuals in their propensity for long-distance movements, a phenomenon that has been observed in undisturbed gopher tortoises (S. Bennett, SCDNR, pers. comm.).

Survivorship of both juveniles and adult gopher tortoises is high (T. Tuberville & K. Buhlmann, unpublished data; T. Norton, unpublished data), except when individuals are unsuccessful in their attempts to cross high-traffic roads. Reproduction initially declined in females following translocation, but the effects appear to be temporary (MacDonald 1996, Small and MacDonald 2001; Tuberville, unpublished data).

Box turtles

In the Piedmont of North Carolina, eastern box turtles that were translocated to a site already occupied by resident box turtles had larger home range sizes (18 vs. 6.5 ha) and moved greater daily distances (18 vs. 8.6 m). Translocated box turtles also had a 40% mortality rate and 10% disappearance rate during the first year compared to resident box turtles, who had 0% mortality and no disappearances (J. Hester, unpublished data). In Missouri, translocated three toed-box turtles also had larger home ranges than residents (Rittenhouse et al., in press).

A seven year study of adult eastern box turtles translocated to a previously unoccupied site in New York found that approximately 25% of animals dispersed from the release site (Cook 2004). Of the 47% of animals that settled in the release area, most established home ranges within the first year. However, 28% of translocated box turtles died within the first year (due to road mortality & pneumonia), but subsequent survivorship was high (71% overall for first 5 years post-release). The study reported that growth, home range size, activity season, habitat use, annual reproductive output, and hatchling recruitment were comparable to natural populations of *T. carolina* (Cook 2004).

Aquatic Turtles

Although none of the introductions were intentional, nor have they been monitored, red-eared sliders (*Trachemys scripta elegans*) have become successfully established in many areas outside

of their native range, including Europe and Asia. To our knowledge, there are no published studies on translocation of wild-caught aquatic turtles.

General Conclusions

Movement patterns of translocated adult turtles can be quite different from undisturbed turtles in their native home range – they generally have larger home ranges and decreased site fidelity. However, these differences in most cases are short-lived, with turtles typically settling into the release area within the first few weeks or months following release. In addition, these differences in movement can be mitigated in some species by the release technique or by selecting juveniles for release programs.

Reproduction and survivorship also do not appear to be negatively affected in the long-term. At least some species may experience high mortality rates in the first year following translocation; wild-caught animals of these species should not be used in translocations.

Review of Head-starting Literature

Headstarting is a means of rearing hatchling turtles in captivity to a particular size or age before releasing them into the natural environment. Mortality rates of turtles are typically highest in the first year of life, and decreases with age as the turtles grow larger. Head-starting increases growth rates and presumably survivorship upon release, relative to wild-reared turtles of the same age. Hatchlings used in headstarting programs can be obtained from either field-incubated nests or eggs incubated in the lab.

In order to evaluate the success of head-starting, it must be documented that survivorship of head-started turtles is greater than that of wild-reared turtles and that the time in captivity does not result in significant alterations to the behavior and fitness of released turtles (e.g., foraging ability, predator avoidance; Heppell et al. 1996). In addition, to be deemed successful, head-starting must eventually result in recruitment to adult age classes, reproduction, and population growth. Unfortunately, there are generally few data available to evaluate the success of specific head-starting projects, often because monitoring does not continue long enough to document age of maturity and reproduction.

Head-start programs can garner much public support and participation, but they can also be very expensive, depending on the facilities and length of captivity required. And like with translocation, head-starting efforts are doomed to fail if the root causes of the initial population decline are not addressed (Frazer 1992, Seigel and Dodd 2000). Although head-starting can dramatically increase survivorship during early life stages, these increases cannot compensate for unnaturally high adult mortality (Heppell et al. 1996). Management efforts for declining populations are much more likely to succeed if focused on minimizing adult mortality, rather than supplementation with hatchlings and juveniles alone.

When used in augmentation programs, head-starting is most likely to be successful when the resident population is extremely small, the threats to adults have been minimized, large portions of the eggs laid are used in the head-starting program, and head-started turtles have higher survivorship than their wild counterparts (Heppell et al. 1996). Of potentially even greater

benefit than increased first year survivorship of juveniles is the potential for those increased growth rates to reduce the age at maturity, since maturity in some turtles is size-dependent rather than age-dependent (Frazer et al. 1990).

Marine Turtles

Most head-starting programs for turtles have been conducted with marine species, but none have proven successful. Undoubtedly some of the challenges unique to marine species are the extreme difficulty in sampling released turtles as a result of their incredibly long-distance movements, long generation time, and differential behavior between the sexes and between adults and juveniles. Current sampling focuses almost exclusively on nesting females, thus only survivorship of reproductive females returning to their natal beaches can be estimated. Additionally, early head-starting efforts incubated eggs at temperatures that were later determined to be male-producing temperatures.

Aquatic Turtles

Head-started European pond turtle (*Emys orbicularis*) hatchlings in Poland experienced five times the first year survivorship of their wild counterparts, and once released in the wild, capture rates of head-started turtles were equal to those of wild-reared hatchlings, suggesting that they fared equally well in the natural environment (Mitrus 2005). However, as predicted by previous models (Heppell et al. 1996), increased survivorship of head-started European pond turtles cannot compensate for adult mortality, although both studies predict that increasing the proportion of hatchlings that are head-started will eventually increase the number of adult females in the population under normal adult survival conditions.

In Massachusetts, survivorship of multiple cohorts of head-started northern red-bellied cooters (*Pseudemys rubriventris*) hatchlings were monitored following their release. Head starting significantly increased first year survivorship. Survivorship varied among same-aged head-started turtles released at different sizes – 36% for turtles with CL of 65mm or less, 66% for 66-95mm CL turtles, and 92% for turtles at least 96mm CL (Haskell et al. 1996). Differences in post-release survivorship decreased in subsequent years as surviving turtles grew larger. The study concluded that head-starting for one over-winter period was the most cost-effective. Survivorship was similar between head-started and wild-reared juveniles of similar sizes.

A study of western pond turtles (*Clemmys marmorata*) in California found that head-started turtles were no more likely to be captured than wild-reared turtles and concluded that captivity did not significantly alter the behavior of turtles towards humans (Spinks et al. 2003). Overall survivorship of head-started turtles was 63%.

Blanding's Turtles

Blanding's turtle head-start programs have been initiated in New York, Illinois, Massachusetts, and Ohio. New York reported 44% survivorship in the wild over two years of head-started hatchlings reared to the size of 4-yr-olds (A. Breisch, pers. comm. in Compton 2006). Head-started hatchlings grown to size of 3 yr olds and released at the Concord unit of the Great Meadows NWR had 100% survivorship during their first activity season (Windmiller 2004) but four of the five likely died due to anoxic winter conditions. There are no published data available to evaluate the success of the Ohio and Illinois head-starting programs.

General Findings

Head-starting is only likely to be beneficial when populations are small, adult survivorship is high, and a large portion of the hatchlings are head-started. Head-starting may be most appropriate as a stop-gap measure to prevent imminent extirpation of a population, when used in combination with efforts to reduce adult mortality (Frazer 1992, Heppell et al. 1996, Mitrus 2005). In addition to shepherding juveniles through the period they are most vulnerable to predation, head-starting may decrease age at first reproduction.

General Decision-making Tree for Population Manipulations

This "decision tree" is a series of questions that should be addressed when deciding whether or not translocation or other population manipulations are necessary and appropriate for a particular site. They are presented in roughly the order that they should be considered during the decision making process. At any point in the process, it may be decided that population manipulations should not be pursued, at least under the current conditions. We present only the series of questions here and have presented them in a general framework that is applicable to any number of species and scenarios. An analysis of the decision tree relative to the preferred alternative is provided at the end of Chapter 6.

Decision 1: Is the species secure in the region?

- Yes: No manipulation necessary
- No: Proceed to Decision 2

Decision 2: Is the proposed site within the natural geographic range of the species?

- Yes: Proceed to Decision 3
- No: Population manipulations are not appropriate

Decision 3: Does the proposed target site have a viable, resident population?

- Yes: No manipulation necessary
- No: Proceed to Decision 4

Decision 4: Does the target site have appropriate habitat of sufficient extent to support a resident population?

- Yes: Proceed to Decision 5
- No: Population manipulations are not appropriate at this time. If habitat can be improved through management, population manipulations could be reconsidered once restoration is complete.

Decision 5: Is the site secure and have potential or historical threats to the species been removed or mitigated?

- Yes: Proceed to Decision 6
- No: Population manipulations are not appropriate at this time and should not be reconsidered until threats have been abated.

Decision 6: What life stage is most appropriate for population manipulations? This decision will be influenced by the life history and ecology of the species, feasibility of working with particular life stages, and potential effects on source population(s).

- Hatchlings: If the proposed source population can donate individuals without jeopardizing its own viability, then population manipulations are appropriate.
- Juveniles: If the proposed source population can donate individuals without jeopardizing its own viability, then population manipulations are appropriate.
- Adults: If the proposed source population can donate individuals without jeopardizing its own viability, then population manipulations are appropriate.

The decision to proceed with population manipulations is only the first step. It is crucial that managers and researchers develop protocols detailing the goals of the project, the anticipated duration, number of animals to be used, and the exact methodology for conducting the manipulation, including the collection, handling, care, and release of animals. Most importantly, a commitment must be made to monitor the project to determine its success. In order to evaluate success, particularly for long-lived species, it will be necessary to have both short-term (e.g., site fidelity to release site) and long-term measures of success (e.g., successful reproduction of offspring born or hatched on-site). The indicators selected to measure success will determine the length of monitoring required and the specific type of data that should be collected.

Chapter 5 – Alternatives

Below are proposed alternatives for establishing a population of Blanding's turtles to Assabet River NWR, including monitoring recommendations for evaluating the effectiveness of each methodology.

Alternatives Considered but Eliminated from Detailed Analysis:

At this time, we are not considering movement of adult Blanding's turtles. A literature review of other turtle species suggests that movement patterns of translocated adult turtles can be quite different from undisturbed turtles in their native home range – they generally have larger home ranges and decreased site fidelity. And, Blanding's turtles naturally have a larger home range than many other turtle species which likely increases the probability of translocated adults wandering beyond the Refuge boundaries.

We are also not currently considering using the Concord Impoundments population of Blanding's turtles as a donor site. There are few Blanding's turtle nest attempts in the surrounding landscape each year, and there is already evidence that this population is declining. At a future time, it may be appropriate to consider this population as a donor or recipient population.

Alternative 1: No New Action

Refuge staff will not take any proactive measures towards establishing a population of Blanding's turtles at Assabet River NWR. Potential habitat would still be protected, but a self sustaining reproducing population would not likely establish.

Alternative 2: Translocation of Direct-release Hatchlings

Nest Protection

Hatchlings will be obtained from natural, field-collected nests protected with wire cages at Oxbow NWR. The number of nests used in the project will be determined by personnel resources that can be committed to nest-searching and availability of nests from Oxbow NWR, but would ideally be at least 20 nests per year for a minimum of 5 years. If results indicate that translocating hatchlings is successful (the level of survivorship is comparable with data from other studies referenced earlier in this document), the project should be extended at least an additional 5 years in order to build a demographically stable population.

Processing of Hatchlings

All hatchlings will be permanently marked with a unique notch code and appropriate morphological measurements will be taken (carapace and plastron lengths to the nearest mm, weight to the nearest 0.1 g) shortly after hatching. The identity of the nesting female will be recorded for each hatchling.

Release of Hatchlings

Half of the hatchlings from each clutch will be released at Assabet River NWR and the remaining half will be returned to Oxbow NWR. This will minimize any demographic effects on the donor (Oxbow NWR) population, minimize effects on reproductive success and genetic contribution of any given female, and allow for comparison of growth and survivorship between translocated and non-translocated hatchlings. Assuming a typical clutch size of at least 8 and 100% hatching success, at least 4 hatchlings per nest would be released at each site.

Turtles will likely be released at small, fairly permanent wetlands located centrally within the refuge (to reduce dispersal off-site), and within close proximity of other wetlands. Marshy ponds with leatherleaf and *Sphagnum* may provide the best juvenile habitat. Release sites will be selected in consultation with refuge personnel, researchers working with Blanding's turtles on the affected refuges, and other appropriate experts. More than one release site may be used in a given year or between years, based on current habitat conditions and initial observations of released hatchlings.

Monitoring

In order to evaluate the success of repatriation efforts, it will be necessary to monitor growth and survivorship of hatchlings translocated to Assabet River NWR compared to hatchlings returned to Oxbow NWR. Measuring hatchling survivorship early in the study will be difficult as small turtles may survive but go undetected until they are larger in size (perhaps 5 or more years old).

The most efficient means of sampling will be to conduct short-term intensive trapping (1-2 weeks) at the release wetlands. Due to their small size and secretive behavior, juvenile aquatic

turtles can be difficult to sample with traditional sampling techniques. We would likely utilize fine-mesh traps with frames small enough to allow placement in shallow water. Standardized dipnetting surveys could also be conducted to supplement trapping efforts. However, in spite of trapping efforts, these hatchlings may not be detectible for several years. Radio-telemetry is not feasible given the small size of hatchlings.

The exact timing of sampling will depend on the availability of personnel but should be consistent across years. Standardizing sampling effort, techniques, and timing as well as trapping both Assabet River NWR and Oxbow NWR will be important for interpreting the significance of capture rates for hatchlings released at Assabet River NWR. Because the hatchlings released at both refuges will be from the same source population and from the same nesting females, any differences observed between turtles at the two sites can be attributed to either the effects of translocation or site-specific conditions, rather than genetics.

Because hatchling releases will be conducted over multiple years, the smallest juveniles are difficult to sample, and Blanding's turtles take so long to reach maturity, multiple years of monitoring will be necessary. A minimum of 10 yrs of annual sampling will be necessary to evaluate success. Subsequent periodic monitoring at least every 3-5 years is also recommended to verify adult recruitment, reproduction and survivorship.

Habitat Management

Habitat management will be conducted as needed to ensure that appropriate juvenile habitat is maintained and that sufficient nesting areas are available. Manipulation of water levels at release wetlands should be minimized and monitored for potential effects on the turtles.

Alternative 3: Translocation of Head-started and Direct-release Hatchlings

While head-started hatchlings will likely have higher survivorship than direct released hatchlings, it must be determined if there is sufficient benefit to justify the costs associated with head-starting. Based on initial comparisons of direct released hatchlings to head-started yearlings, future releases may focus on only one approach.

Nest Protection

Hatchlings will be obtained from natural, field-collected nests protected with wire cages at Oxbow NWR. The number of nests used in the project will be determined by personnel resources that can be committed to nest-searching, but would ideally be at least 20 nests per year for a minimum of 5 years. This number could be adjusted annually depending on conditions at the donor site. If the initial results indicate that translocating head-started hatchlings is successful, the project should be extended at least an additional 5 years in order to build a demographically stable population.

Processing of Hatchlings

All hatchlings will be permanently marked with a unique notch code and appropriate morphological measurements will be taken (carapace and plastron lengths to the nearest mm, weight to the nearest 0.1 g) shortly after hatching. The identity of the nesting female will be recorded for each hatchling.

Captive Rearing and Release of Hatchlings

Hatchlings from each nest will be divided equally among the four groups: 1) direct release to Oxbow NWR, 2) head-started to Oxbow NWR, 3) direct-release to Assabet River NWR, and 4) head-started to Assabet River NWR. Head-started hatchlings will be quarantined from other turtles to avoid spreading disease and maintained on a commercially available diet formulated for aquatic turtles. Prior to their release, head-started hatchlings would be re-notched and re-measured. The time of year for release still needs to be determined but should be based on availability of facilities and personnel and on expert knowledge of the seasonal activity patterns of juvenile Blanding's turtles in the region.

Distributing hatchlings from each clutch among the four release groups will minimize any effects on the demography of the donor (Oxbow NWR) population and on the reproductive success and genetic contribution of any given female. This design also allows for simultaneous evaluation of the effects of translocation (by comparing hatchlings immediately released at Oxbow NWR and Assabet River NWR) and head-starting (by comparing Assabet River NWR immediately-released and head-started hatchlings) on growth and survivorship. Assuming a typical clutch size of at least 8 and 100% hatching success, at least 2 hatchlings per nest would be assigned to each release group.

Turtles will be released at small, fairly permanent wetlands, located centrally within the Assabet River and Oxbow refuges (to reduce dispersal off-site), and within close proximity of other wetlands. Marshy ponds with leatherleaf and *Sphagnum* may provide the best juvenile habitat. Release sites will be selected in consultation with refuge personnel, researchers working with Blanding's turtles on the affected refuges, and other appropriate experts. More than one release site may be used in a given year or between years, based on current habitat conditions and initial observations of released hatchlings.

Monitoring

Monitoring will be similar to Alternative 2. In addition, during at least the first two years, we will also attempt to radio-track a subset of head-started turtles (if large enough) in order to assess habitat use, which will provide valuable information necessary for refining the selection of release sites. Radio-telemetry will also allow more precise estimates of survivorship (which will be difficult to obtain in the early years under Alternative 2) and site fidelity, and recapture rates of telemetered animals during trapping sessions will allow evaluation of effectiveness of trapping efforts. Telemetered animals will be tracked once per week during the first several weeks following release when they are most likely to disperse, then less frequently once they establish home ranges (every two weeks) and during periods of winter inactivity (once per month).

Because hatchling releases will be conducted over multiple years, the smallest juveniles are difficult to sample, and Blanding's turtles take so long to reach maturity, multiple years of monitoring will be necessary to evaluate success. A minimum of 10 yrs of annual sampling will be necessary to evaluate success. Subsequent periodic monitoring at least every 3-5 years is also recommended to verify adult recruitment, reproduction and survivorship.

Habitat Management
Habitat management will be conducted as needed to ensure that appropriate juvenile habitat is maintained and that sufficient nesting areas are available. Habitat use data from radio-telemetered head-started turtles will help inform habitat management decisions. Manipulation of water levels at release wetlands should be minimized and monitored for potential effects on the turtles.

Alternative 4: Translocation of Juveniles

Collection and Translocation of Juveniles
It is also appropriate to consider translocation of juveniles (>1 year old) so that the repatriated population will reach maturity sooner. A small number of Blanding's turtle juveniles (<10 yrs old) would be obtained from Oxbow NWR by aquatic trapping. Captured juveniles would be marked (if not already marked), measured, aged, and fitted with a radio-transmitter with a 1 yr battery life. Translocating juveniles (rather than just hatchlings), if successful, would result in earlier recruitment of turtles into an adult breeding population and create a more balanced demography. However, because translocations with juvenile Blanding's turtles have not been attempted before, we would begin with a sample size of less than 10 animals during the initial attempt. Whether or not translocations are attempted in subsequent years or with more animals would be decided based on the results of the initial translocation experiment.

We would release turtles at small, fairly permanent wetlands (at least 9 mo. hydroperiod), located centrally within the refuge (to reduce dispersal off-site), and within close proximity of other wetlands. Marshy ponds with leatherleaf and *Sphagnum* may provide the best juvenile habitat. Release sites will be selected in consultation with refuge personnel, researchers working with Blanding's turtles on the affected refuges, and other appropriate experts.

Monitoring
Telemetered animals would be tracked once per week during the first several weeks following release when they are most likely to disperse, then less frequently once they establish home ranges (every two weeks) and during periods of winter inactivity (once per month). Radio-tracking the translocated juveniles would allow more precise estimation of survivorship, movement & dispersal behavior, and habitat use. Habitat use data could be used to guide release site selection and management in subsequent years.

Habitat Management
Habitat management will be conducted as needed to ensure that appropriate juvenile habitat is maintained and that sufficient nesting areas are available. Habitat use data from radio-telemetered translocated juveniles will help inform habitat management decisions. Manipulation of water levels at release wetlands should be minimized and monitored for potential effects on the turtles.

Alternative 5: Translocation of Direct-release, Head-started and Juvenile Turtles (Preferred)

Nest Protection

Hatchlings will be obtained from natural, field-collected nests protected with wire cages at Oxbow NWR. The number of nests used in the project will be determined by personnel resources that can be committed to nest-searching, but would ideally be at least 20 nests per year for a minimum of 5 years. This number could be adjusted annually depending on conditions at the donor site. If the initial results indicate that translocating direct-release and head-started hatchlings is successful (the level of survivorship is comparable with data from other studies referenced earlier in this document), the project should be extended at least an additional 5 years in order to build a demographically stable population.

Processing of Hatchlings, Captive Rearing and Release of Hatchlings

Hatchlings from each nest will be divided among the four groups: 1) direct release to Oxbow NWR, 2) head-started to Oxbow NWR, 3) direct-release to Assabet River NWR, and 4) head-started to Assabet River NWR.

All hatchlings will be permanently marked with a unique notch code and appropriate morphological measurements will be taken (carapace and plastron lengths to the nearest mm, weight to the nearest 0.1 g) shortly after hatching. The identity of the nesting female will be recorded for each hatchling. Head-started hatchlings will be quarantined from other turtles to avoid spreading disease and maintained on a commercially available diet formulated for aquatic turtles. Prior to their release, head-started hatchlings would be re-notched and re-measured. The time of year for release still needs to be determined but should be based on availability of facilities and personnel, and on expert knowledge of the seasonal activity patterns of juvenile Blanding's turtles in the region.

Distributing hatchlings from each clutch among the four release groups will minimize any effects on the demography of the donor (Oxbow NWR) population and on the reproductive success and genetic contribution of any given female. This design also allows for simultaneous evaluation of the effects of translocation (by comparing hatchlings immediately released at Oxbow NWR and Assabet River NWR) and head-starting (by comparing Assabet River NWR immediately-released and head-started hatchlings) on growth and survivorship. Assuming a typical clutch size of at least 8 and 100% hatching success, at least 2 hatchlings per nest could be assigned to each release group.

Turtles will be released at small, fairly permanent wetlands, located centrally within the Assabet River and Oxbow refuges (to reduce dispersal off-site), and within close proximity of other wetlands. Marshy ponds with leatherleaf and *Sphagnum* may provide the best juvenile habitat. Release sites will be selected in consultation with refuge personnel, researchers working with Blanding's turtles on the affected refuges, and other appropriate experts. More than one release site may be used in a given year or between years, based on current habitat conditions and initial observations of released hatchlings.

Collection and Translocation of Juveniles

A small number of Blanding's turtle juveniles (>1 yr and <10 yrs old) would be obtained from Oxbow NWR by aquatic trapping. Captured juveniles would be marked (if not already marked), measured, aged, and fitted with a radio-transmitter with a 1 yr battery life. Translocating juveniles (rather than just hatchlings), if successful, would result in earlier recruitment of turtles into an adult breeding population and create a more balanced demography. However, because translocations with juvenile Blanding's turtles have not been attempted before, we would begin with a sample size of less than 10 animals during the initial attempt. Whether or not translocations are attempted in subsequent years or with more animals would be decided based on the results of the initial translocation experiment. Juvenile turtles would be released at similar sites identified for hatchling turtles.

Monitoring

In order to evaluate the success of repatriation efforts, it will be necessary to monitor growth and survivorship of hatchlings (both direct-release and head-started) translocated to Assabet River NWR compared to hatchlings returned to Oxbow NWR. Radio-telemetry is not feasible for direct-release hatchlings because of their small size. Therefore, measuring hatchling survivorship early in the study will be difficult as small turtles may survive but go undetected until they are larger in size (perhaps 5 or more years old). The most efficient means of sampling will be to conduct short-term intensive trapping (1-2 weeks) at the release wetlands. Due to their small size and secretive behavior, juvenile aquatic turtles can be difficult to sample with traditional sampling techniques. We would likely utilize fine-mesh traps with frames small enough to allow placement in shallow water. Standardized dipnetting surveys could also be conducted to supplement trapping efforts. However, in spite of trapping efforts, these hatchlings may not be detectible for several years.

The exact timing of sampling will depend on the availability of personnel but should be consistent across years. Standardizing sampling effort, techniques, and timing as well as trapping both Assabet River NWR and Oxbow NWR will be important for interpreting the significance of capture rates for hatchlings released at Assabet River NWR. Because the hatchlings released at both refuges will be from the same source population and from the same nesting females, any differences observed between turtles at the two sites can be attributed to either the effects of translocation or site-specific conditions, rather than genetics.

Head-started hatchlings may be large enough to be outfitted with a transmitter, and during at least the first two years, we will attempt to radio-track a subset of head-started turtles (if large enough) in order to assess habitat use. This will provide valuable information necessary for refining the selection of release sites.

Radio-telemetry allows more precise estimates of survivorship and site fidelity, and recapture rates of telemetered animals during trapping sessions will allow evaluation of effectiveness of trapping efforts. Telemetered animals (juveniles and head-started hatchlings) will be tracked once per week during the first several weeks following release when they are most likely to disperse, then less frequently once they establish home ranges (every two weeks) and during periods of winter inactivity (once per month). Habitat use data could be used to guide release site selection and management in subsequent years.

Because hatchling releases will be conducted over multiple years, the smallest juveniles are difficult to sample, and Blanding's turtles take so long to reach maturity, multiple years of monitoring will be necessary. A minimum of 10 yrs of annual sampling will be necessary to evaluate success. Subsequent periodic monitoring at least every 3-5 years is also recommended to verify adult recruitment, reproduction and survivorship.

Habitat Management

Habitat management will be conducted as needed to ensure that appropriate juvenile habitat is maintained and that sufficient nesting areas are available. Habitat use data from radio-telemetered translocated juveniles will help inform habitat management decisions. Manipulation of water levels at release wetlands should be minimized and monitored for potential effects on the turtles.

This preferred alternative combines strategies from Alternatives 3 and 4, and likely provides the best chance of success for establishing a population, without causing harm to the donor population. This preferred alternative also provides the greatest flexibility to apply adaptive management, allowing Refuge staff to modify the approach each year based on previous years' findings. Nest protection at the donor site, processing of hatchlings, head-starting of captive turtles, capture of juvenile turtles, monitoring and habitat management would be conducted as outlined above. However, the nature and number of releases and translocated animals will be largely dependent on results of monitoring each year.

Under this alternative, pilot work in 2007 will consist of all three approaches. An estimated 300 hatchlings may be available from Oxbow NWR in 2007. Half of the total (150) would be available for Assabet River NWR and half (150) would be returned to Oxbow NWR. The majority of the hatchlings would be direct-released at each refuge, but some hatchlings (exact number depends on capacity of head-start facilities) would be kept in captivity and head-started through the winter, with a planned release in spring 2008. Additionally, 10 head-started hatchlings obtained from Oxbow NWR in 2006 will also be released. Lastly, approximately 6 juvenile turtles will be trapped from Oxbow NWR, outfitted with radios and released at Assabet River NWR. A commitment to long-term monitoring to evaluate survivorship of direct-release hatchlings, head-started hatchlings, and translocated juveniles, will be critical to adaptive management and increase the likelihood of success. Results from monitoring in 2007-2008 and future modeling work will help inform strategies for releases in 2008 and 2009.

Chapter 6 - Environmental Consequences

Introduction

In this section, we analyze and describe the environmental consequences likely to result from each of the alternatives. We consider potential impacts to the proposed donor site, the recipient site and the species in general. This section of the environmental assessment forms the scientific and analytical basis for comparisons of the alternatives.

Both indirect and direct effects are predicted for the foreseeable future. In the following discussion, the terms "positive", "negative", and "neutral" are used frequently as qualitative measures of how an action would likely affect resources of concern. In some of our discussions below, we are not able to quantify the effect. A "positive effect" means that the actions are predicted to enhance or benefit the resources under consideration and work towards accomplishing goals and objectives over the short or long term. A "negative effect" means that the actions are predicted to be detrimental to a resource over the short or long term, and work against achieving goals and objectives. A "neutral effect" means either a) there would be no discernible effect, positive or negative, on the resources under consideration; or B) predicted positive and negative effects cancel each other out.

Alternative 1: No New Action

Under the No New Action Alternative, Blanding's turtles would not be moved from the donor site to the recipient site, therefore, there would be little or no impact to the biological resources or visitor use at each site.

Under this alternative, the population of Blanding's Turtles at Oxbow NWR would still be protected on an annual basis and habitat management would continue to enhance Blanding's turtle nesting sites. Impacts resulting from habitat management include disturbance of vegetation, but since nesting areas are largely infested with spotted knapweed (a non-native invasive species), removal of this vegetation is likely to provide an overall positive impact to the biological resources. The nesting area will continue to be closed to public access, but with adequate trails already established on the Refuge, impacts to visitor use will be neutral.

Under this alternative, potential Blanding's turtle habitat at Assabet River NWR would also be managed, especially since it will likely be used by other resident turtle species including snapping turtle, painted turtle and spotted turtle. Impacts resulting from habitat management include disturbance of vegetation, but since nesting areas are largely infested with glossy buckthorn, autumn olive and other non-native invasive species, removal of this vegetation is likely to provide an overall positive impact to the biological resources. There are not likely to be any negative impacts to visitor use, since it is unlikely Blanding's turtles will naturally colonize Assabet River NWR

Despite neutral or positive impacts to biological resources and visitor use at the donor and recipient site under the No New Action Alternative, the cumulative impacts to the species of Blanding's turtle may be negative. Given the lack of nearby sizable populations of Blanding's turtles and the fragmented landscape between Assabet River NWR and other known populations, natural recolonization is unlikely.

Blanding's turtles are regarded as a species of conservation concern in every New England state in which they occur. The Blanding's turtle is a species that requires large, unfragmented blocks of diverse wetland and upland habitat in order for viable populations to exist. Such locations are becoming scarcer in human-dominated landscapes, especially in the northeastern United States. Most existing Blanding's turtle sites in the Northeast are likely remnants of once more extensive

habitats. Protecting these existing sites and adding to their acreage is critical for the future recovery of this species. It must also be noted that this objective becomes more difficult and expensive to achieve with each passing year. The persistence of this species on the landscape may ultimately depend in part on the establishment or reestablishment of populations on large tracts of suitable land already set aside for wildlife conservation.

Alternative 2: Translocation of Direct-release Hatchlings

Under Alternative 2, only Blanding's turtle hatchlings would be moved from the donor site to the recipient site. The exact number of hatchlings moved will vary each year depending on population modeling results, previous years' monitoring results of hatchling survival at Assabet River NWR, and nest success at Oxbow NWR.

Under this alternative, the population of Blanding's Turtles at Oxbow NWR is not likely to be negatively impacted. First year survivorship of Blanding's turtles is typically low, especially with increased predation pressures, and it's likely that many of the hatchlings moved to Assabet River NWR may have succumbed to predators anyway. However, since many of the predators at Oxbow NWR are also present at Assabet River NWR[1], direct-releasing hatchlings alone may not have a positive impact towards establishing a population. Also, because Blanding's turtles don't reach sexual maturity until 14-20 years of age (Congdon and van Loben Sels, 1993), and since first year survivorship is low, it is probable that the number of hatchlings available to be released every year for the next 10-15 years might not be enough to establish a viable population at Assabet River NWR. Although continuing to remove a portion of hatchlings may not negatively affect the donor site, at least in the short term, the effort expended on this Alternative may not be worthy of the results.

Impacts resulting from habitat management and protection will be the same as described under Alternative 1. Additionally, since establishment of a reproducing population at Assabet River NWR is not very likely under this alternative, at least not in the foreseeable future, negative impacts to the species will also be the same as described in Alternative 1.

Alternative 3: Translocation of Head-started and Direct-release Hatchlings

Under Alternative 3, head-started Blanding's turtles and direct release hatchlings would be moved from the donor site to the recipient site. The exact number of head-started and direct-released hatchlings moved will vary each year depending on population modeling results, previous years' monitoring results of survival at Assabet River NWR, and nest success at Oxbow NWR.

[1] Predation will be a factor anywhere for hatchling turtles but there is no evidence to suggest that predation rates would be higher at Assabet River NWR than at Oxbow NWR. Raccoons will be a factor for nesting success of Blanding's turtles in the future. There is a robust snapping turtle population at Assabet River NWR, but snapping turtles and Blanding's turtle co-occur in most localities.

Under Alternative 3, the population of Blanding's Turtles at Oxbow NWR is not likely to be negatively impacted. First year survivorship of Blanding's turtles is typically low, especially with increased predation pressures, and it's likely that many of the hatchlings moved to Assabet River NWR (either through direct-release or head-starting) may have succumbed to predators anyway. However, years of nest protection, hatchling collection, and direct releases of hatchlings into wetlands at Oxbow NWR has resulted in a much higher nest success and may have increased first year survival above what would naturally occur. In other areas**,** nest survivorship is highly variable and can range from 0% to 100% of all nests in a population in a given year. Over a 23-year period, 78% of all Blanding's turtle nests were destroyed by predators in a Michigan study, and in nine of those years 100% were destroyed (Congdon et al., 2000). Mammalian predation is the greatest cause of nest failure

However, since many of the predators at Oxbow NWR are also present at Assabet River NWR, direct-releasing hatchlings alone may not have a positive impact towards establishing a population. Head-started turtles have much higher survivorship following release than direct-released hatchlings. Releasing head-started turtles in addition to hatchlings will likely increase the chances of success and survival of turtles to reproductive maturity. Because Blanding's turtles don't reach sexual maturity until 14-20 years of age (Congdon and van Loben Sels, 1993), it will probably still be necessary to release turtles and monitor nearly every year for the next 10-15 years.

Impacts resulting from habitat management will be the same as described under Alternative 1. If a population of Blanding's turtles does eventually become established at Assabet River NWR, there may be some additional impacts to visitor use. For example, some fields and/or trails may be seasonally closed to prevent disturbance to moving or nesting Blanding's turtles. However, with 15 miles of trails already available for visitor use, closing small sections of Assabet River NWR will not have a negative cumulative impact on visitors. Additionally, establishment of a reproducing population of Blanding's turtles will result in increased opportunities for visitors to observe this species and learn about the natural history, management, and importance of protecting this species.

Alternative 4: Translocation of Juveniles

Under Alternative 4, juvenile turtles (>1 year old) would be translocated from Oxbow NWR to Assabet River NWR. Translocating juveniles, if successful, would result in earlier recruitment of turtles into an adult breeding population and create a more balanced demography. However, because translocations with juvenile Blanding's turtles have not been attempted before, we would begin with a sample size of less than 10 animals during the initial attempt. Whether or not translocations are attempted in subsequent years or with more animals would be decided based on the results of the initial translocation experiment and population modeling, so impacts are difficult to predict. It is likely that the number of juvenile turtles needed to establish a viable population at Assabet River NWR exceeds the threshold that can be removed from Oxbow NWR while still maintaining the vigor of this source population. Additionally, this may prove to be an unsuccessful method of population establishment if juvenile turtles consistently wander outside of Assabet River NWR, resulting in cumulative impacts similar to Alternative 1 and 2.

Alternative 5: Translocation of Direct-release, Head-started and Juvenile Turtles (Preferred)

Alternative 5 poses the best chance for successfully establishing a reproducing population of Blanding's turtles at Assabet River NWR because it allows the use of all release strategies in tandem. Translocating juveniles, if successful, would result in earlier recruitment of turtles into an adult breeding population and create a more balanced demography when combined with direct-release and head-started releases. Only a small number of juvenile turtles will be translocated initially and survival will be monitored to adequately assess the success of this strategy.

Impacts to biological resources and visitor use at Oxbow NWR are likely to be neutral. Many of the hatchlings direct-released or head-started and then released at Assabet River NWR would naturally not survive even if direct-released at Oxbow NWR. With a neutral impact to the Blanding's population at Oxbow NWR, visitor use will also be minimally impacted largely through seasonal closures on nesting areas.

Impacts to biological resources at Assabet River NWR are likely to be positive in the long term as this Alternative provides the best chance of successfully establishing a reproducing population of Blanding's turtles. As the turtle population approaches maturity, more areas may be identified for management to enhance nesting opportunities. Vegetation disturbance will be the largest biological impact, but many areas are already infested with non-native species, so this impact may be cumulatively positive. Visitor use may be seasonally negatively impacted as some high use nesting areas may be closed to prevent disturbance to turtles, but numerous miles of comparable trails will still be available for visitor use. Additionally, educational opportunities will be increased as visitors learn about Blanding's turtles natural history, management strategies, and niche in the New England landscape.

Cumulative impacts to the Blanding's turtle is also likely to be positive, as establishing another reproducing population in the developed northeast landscape will help ensure future survival of this species. Blanding's turtles are regarded as a species of conservation concern in every New England state in which they occur. More recently, concern at the federal level has resulted in multiple conservation assessments rangewide (e.g., Southwell, 2002; Congdon and Keinath, 2006; Compton, 2006). Blanding's turtles require large landscapes, relative to many other turtle species. They require a variety of wetland habitats, make frequent seasonal overland movements between them, and therefore suffer mortality not only from direct wetland habitat loss, but from upland landscape fragmentation as well. The persistence of certain species on the landscape may ultimately depend in part on the establishment or reestablishment of populations on large tracts of suitable land already set aside for wildlife conservation. In our assessment, the Assabet River NWR may represent such a site for Blanding's turtles. It is located within the heart of this species range within the New England landscape. The total acreage, 2230 acres, is large enough to support a population of these turtles, the site is currently managed for wildlife conservation, and Assabet River NWR is located roughly equi-distant between the two largest known Blanding's turtle populations in all of New England.

Analysis of Decision-making Tree for Preferred Alternative

In Chapter 4 we presented a series of questions that should be addressed when deciding whether or not translocation or other population manipulations are necessary and appropriate for a particular site. We present the decision-tree here with site and project specific answers to summarize selection of the preferred alternative. Answers to each decision question are denoted in bold text.

Decision 1: Is the species secure in the region?

- Yes: No manipulation necessary
- **No: Proceed to Decision 2**

Blanding's turtles are regarded as a species of conservation concern in every New England state in which they occur. More recently, concern at the federal level has resulted in multiple conservation assessments rangewide (e.g., Southwell, 2002; Congdon and Keinath, 2006; Compton, 2006). Increasing concern about populations in New England resulted in the formation of a Blanding's Turtle Working Group with state, federal, and academic participation. Blanding's turtles require large landscapes, relative to many other turtle species. They require a variety of wetland habitats, make frequent seasonal overland movements between them, and therefore suffer mortality not only from direct wetland habitat loss, but from upland landscape fragmentation as well. Protection of individual wetland sites has been difficult enough, but large-scale landscape conservation is even more daunting, especially in the expensive real estate market of the heavily-developed northeastern U.S.

Decision 2: Is the proposed site within the natural geographic range of the species?

- **Yes: Proceed to Decision 3**
- No: Population manipulations are not appropriate

The site is within the historical range of the species. The Assabet River NWR lies between the two largest known Blanding's turtle populations remaining in all of New England. Although there is no known evidence for a recent population at Assabet River NWR, isolated individuals have been documented on nearby roads since 2000 and populations probably historically occurred throughout the landscape.

Decision 3: Does the proposed target site have a viable, resident population?

- Yes: No manipulation necessary
- **No: Proceed to Decision 4**

To date, Blanding's turtles have not been discovered on the Assabet River NWR, but one road-killed individual was found adjacent to the refuge in 2000 (B. Butler, pers. comm) and the consensus among knowledgeable biologists is that the Assabet River NWR represents ideal habitat for Blanding's turtles.

Decision 4: Does the target site have appropriate habitat of sufficient extent to support a resident population?

- **Yes: Proceed to Decision 5**

- No: Population manipulations are not appropriate at this time. If habitat can be improved through management, population manipulations could be reconsidered once restoration is complete.

Appropriate habitat is present based on previous studies and surveys. See Appendix 1 for photographs and descriptions of habitats.

The overall size of the Assabet River NWR is approximately 10 km^2. Kiviat (1997) recommended working landscapes of 5-10 km^2 as the necessary size to maintain this species. Grgurovic and Sievert (2005) also concluded that there may be a relationship between roadless block size of habitat and home range, suggesting that habitats fragmented by roads contain only animals with small home ranges. The animals with larger home ranges have suffered road mortality. There will be some drift of adult Blanding's turtles across the landscape, and some mortality on roads surrounding Assabet River NWR is likely. The ES George Reserve, a site of a long-term Blanding's turtle study (Congdon et al., 1993) is 1400 acres in size and 50% of the Blanding's turtles travel off of the reserve to other state-managed lands.

There are forested, unfragmented travel corridors on Assabet River NWR between aquatic habitats. However, consideration of passageways under adjacent highways, such as Rt. 27 may be necessary if monitoring of head-started Blanding's turtles indicates that they travel off-Refuge as they grow older.

Nesting areas are present. Future habitat management can open the canopies in other areas. Provision of nesting sites will not be necessary for 14 or more years, if only hatchlings are translocated to Assabet River NWR. Eventually, maximizing availability of nesting sites within the refuge may limit off-refuge movement and road mortality.

Decision 5: Is the site secure and have potential or historical threats to the species been removed or mitigated?

- **Yes: Proceed to Decision 6**
- No: Population manipulations are not appropriate at this time and should not be reconsidered until threats have been abated.

The causes of original disappearance from the site may have included forest succession of open nesting habitats and heavy military disturbance of the site. Other land impacts from the time of military use included railroads, military bunkers, agriculture, commercial cranberry bogs, timber harvest, and mosquito control with malathion (Aneptek, 1991). There appears to be appropriate habitat at present and reduced human activities may be conducive for a population to become reestablished. Refuge staff have the ability to manage and create additional nesting habitat. In addition, road mortality is less likely to be a factor for Blanding's turtles residing at Assabet River NWR than some other populations in the northeast, due to the large size and low volume vehicular traffic. If vehicle traffic increases following construction of the visitor center at Assabet River NWR, efforts will be made to minimize impacts (culvert underpasses, slow speed limits, informational signage) and capitalize on a potential first-hand educational opportunity.

Decision 6: What life stage is most appropriate for population manipulations? This decision will be influenced by the life history and ecology of the species, feasibility of working with particular life stages, and potential effects on source population(s).

- **Hatchlings: If the proposed source population can donate individuals without jeopardizing its own viability, then population manipulations are appropriate.**
- **Juveniles: If the proposed source population can donate individuals without jeopardizing its own viability, then population manipulations are appropriate.**
- Adults: If the proposed source population can donate individuals without jeopardizing its own viability, then population manipulations are appropriate.

Translocating hatchlings as part of a repatriation program is beneficial because they will exhibit the highest site fidelity of all life stages and can be released in large numbers without impacting the source population. We are proposing a combination of direct-release and head-started hatchlings. Direct-release hatchlings will require fewer resources (personnel, money, facilities) and have less potential for captive diseases.[2] Releasing head-started hatchlings is also beneficial because they have increased growth rates, increased survivorship and decreased generation time compared to direct-released hatchlings.

Translocating juveniles as part of a repatriation program will result in quicker recruitment into the breeding population than released hatchlings alone because they will have higher survival rates and will be closer to breeding age.

Translocating adults is not being considered in this proposal because we believe adults are likely to move out of the relocation site and the donor population may be negatively impacted through the loss of adults.

Chapter 7 - Consultation and Coordination with Others

Refuge staff and Service biologists have been coordinating with Blanding's turtle researchers at Great Meadows and Oxbow NWRs for over 10 years. During 2004, Savannah River Ecology Laboratory (SREL) staff visited the Assabet River NWR on two occasions and visually surveyed all aquatic habitats present on the refuge. During 2005, SREL staff visited the Assabet River NWR again and trapped in several wetland habitats in efforts to detect Blanding's turtles on the

[2]Because there is no resident population on Assabet River NWR, transmission of diseases is not likely. In addition, captive reared hatchlings are less likely to transmit diseases than are wild-caught adults, unless they come into contact with diseased animals while in captivity. Head-started Blanding's turtles should be kept isolated from other turtles while in captivity. Genetic contamination and mixing is not a source of concern. Released animals are likely to be genetically adapted to the local climate since the source population is less than 10 miles away and occurs with the same genetic unit identified by Grgurovic and Sievert (2005). All affected sites are within the Merrimack River system. Overland distances that separate each of the three refuges (10 miles) is likely within the life time movement abilities of individual Blanding's turtles under pre-development conditions.

Photographs and descriptions of potential Blanding's turtle habitats on Assabet River NWR are found in Appendix 1.

Informal discussions between refuge biologists, researchers at universities and consulting companies, state wildlife managers, and federal regulatory staff, led to a discussion at the Blanding's Turtle Working Group meeting held in conjunction with the Partners for Amphibian and Reptile Conservation (PARC) Northeast meeting at the Session Woods WMA, Connecticut, in August 2006. At this time, interest was expressed in exploring the appropriateness of establishing a population of Blanding's turtles on the Assabet River NWR. During the preparation of the current EA, refuge staff continued informal discussions with interested partners and worked closely with researchers to gather pertinent information.

This EA will be made available for a 30-day public review and comment period prior to making any final decisions regarding the repatriation program. Notices of availability will be posted at refuge kiosks and the refuge headquarters, and a press release will be developed and mailed to all local and regional newspapers. The public will be able to review the EA at the refuge headquarters at 73 Weir Hill Road in Sudbury, Massachusetts. The EA will also be posted on the refuge website.

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APPENDIX 1

Potential Habitats for Blanding's turtles on Assabet River NWR

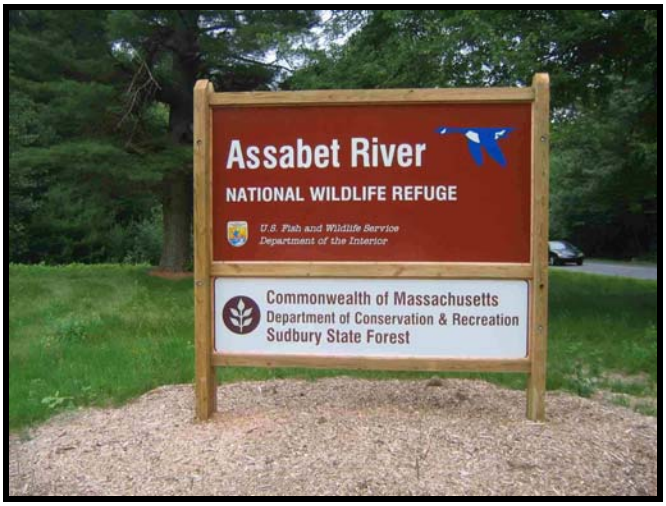

Figure 1. Assabet River NWR was established with a priority to provide habitat for neo-tropical migratory birds. The terrestrial habitat is primarily forested and dominated by white pine and mixed hardwoods. A diversity of wetland types includes bogs, shrub swamps, vernal pools, and a glacial lake with extensive marshes.

Figure 2. A vernal pool on the perimeter road. This site has a closed canopy and little emergent vegetation. It is dominated by buttonbush. The vernal pool represents typical spring foraging habitat used by adult Blanding's turtles in other localities.

Figure 3. Numerous seasonally flooded vernal pools are found throughout Assabet River NWR. Similar vernal pools in other studies provide spring time foraging areas for both spotted turtles and Blanding's turtles. These vernal pools are breeding sites for wood frogs (*Rana sylvatica*) and spotted salamanders (*Ambystoma maculatum*), whose larvae, as well as invertebrates, are the food sources that these turtles seek.

Figure 4. Shrub swamp on the south side of Perimeter Road. This site has abundant *Sphagnum*, grass tussocks, skunk cabbage, leatherleaf, sweet gale, high bush blueberry, and buttonbush. It contains a robust spotted turtle population. This site seems appropriate for juvenile Blanding's turtles.

Figures 5. An oligotrophic bog which is sphagnum-dominated and 1.5 m deep. It also contains a floating, quaking shrub mat of leatherleaf.

Figure 6. Another pond, along the perimeter road contains cranberry and a floating bog mat of vegetation.

Figure 7. White Pond is a *Vaccinium*-dominated shrub swamp with thick vegetation and *Sphagnum* underneath.

Figure 8. Powerline pole swamp. This habitat includes buttonbush and duckweed.

Figure 9. The cattail-dominated upper reaches of Puffer Pond appear to provide appropriate habitat for Blanding's turtles.

Figure 10. The marsh habitat along the southern reaches of Puffer Pond include buttonbush, pickerelweed, yellow bladderwort, and water lilies. October 2004.

Figure 11. The same photo of Puffer Pond marsh taken in June 2005. The habitat in this area include open water, cattails, phragmites, duckweed, and purple loosestrife. Puffer Pond is a glacial lake with extensive marsh edges that may be suitable for Blanding's Turtles. Management of *Phragmites* and Purple Loosestrife will help maintain habitat.

Figure 12. Taylor Brook drainage is completely within the Assabet River NWR and provides a corridor between Puffer Pond and the Assabet River NWR. Blanding's turtles are known to use rivers as travel corridors.

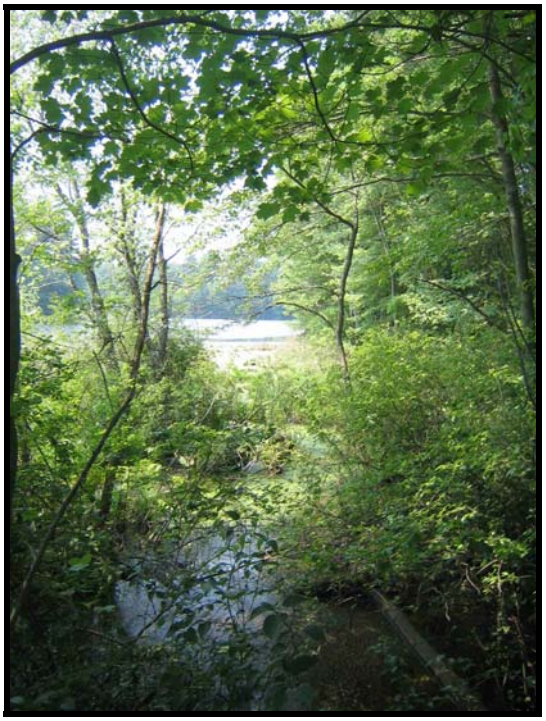

Figure 13. The marshes associated with larger ponds immediately adjacent to the Refuge, specifically Vose, Cutting, and Willis Ponds, appear to represent appropriate habitat for Blanding's turtles. The road-killed female Blanding's turtle (17 June 2000) may have come from one of these wetland systems.

Figure 14. Vose Pond Marsh includes dead and downed timber, and duckweed. The marsh is affected by beaver activity. Vose Pond is the closest Refuge body of water to the location of the road-killed Blanding's Turtle reported in 2001. This sedge and duckweed-dominated swamp along the SE corner of Assabet River NWR seems appropriate for adult Blanding's turtles.

Figures 15 and 16. Potential nesting areas for Blanding's turtles exist in an older gravel pit (borrow pit) located along the perimeter road. The open canopy and gravel and sand soils present ideal nesting habitat for turtles. This borrow pit is located approximately 200 m east of Puffer Pond. The intervening habitat consists of white pine, red pine, hemlock, and red maple forest. Hydroaxe work in 2005 has opened up the nesting site, and removed invasive (glossy buckthorn) and successional (white pine) vegetation. Numerous painted turtles and some snapping turtles currently nest at the site.

Figure 17. Smaller open sand areas exist throughout Assabet River NWR that could be managed as future nesting areas.

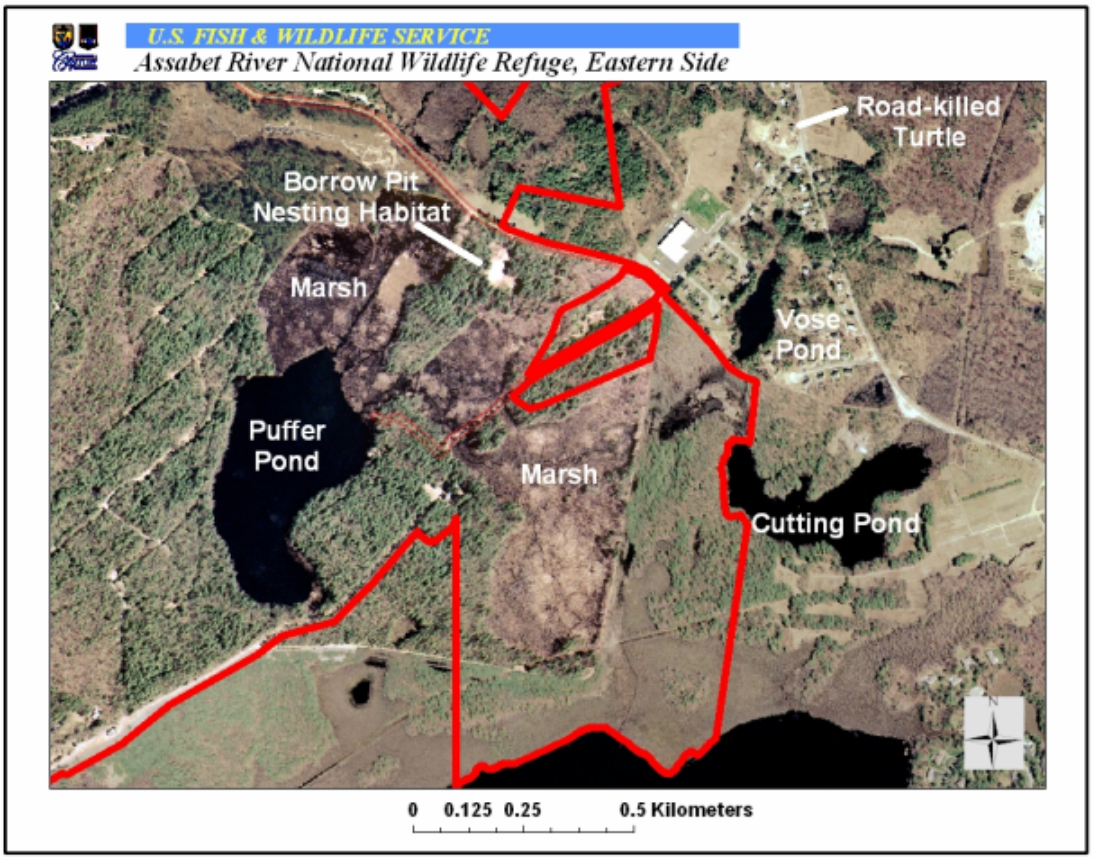

Figure 18. A mosaic of habitats on the eastern side of Assabet River NWR that could provide the habitat needs of Blanding's Turtles. The location of a road-killed Blanding's turtle found in 2000 (B. Butler, pers. comm.) is also indicated.

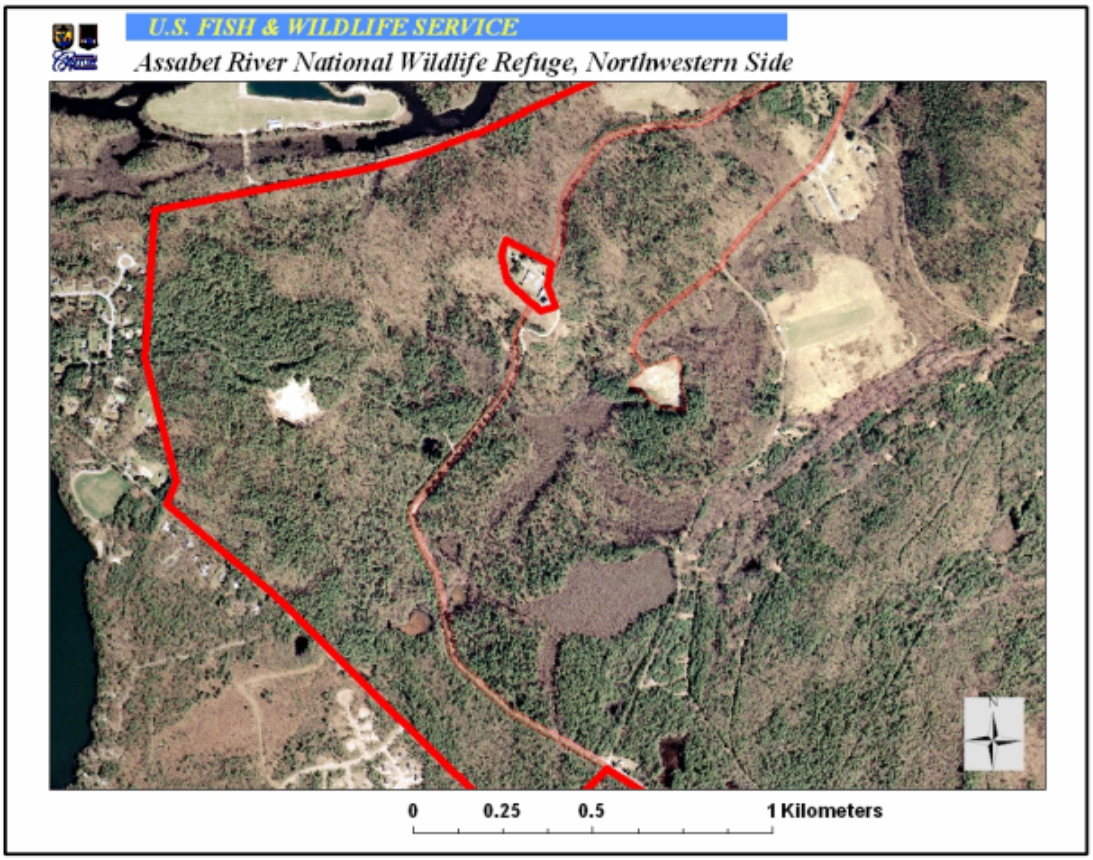

Figure 19. The northwestern portion of Assabet River NWR with several bogs and shrub swamps illustrated.

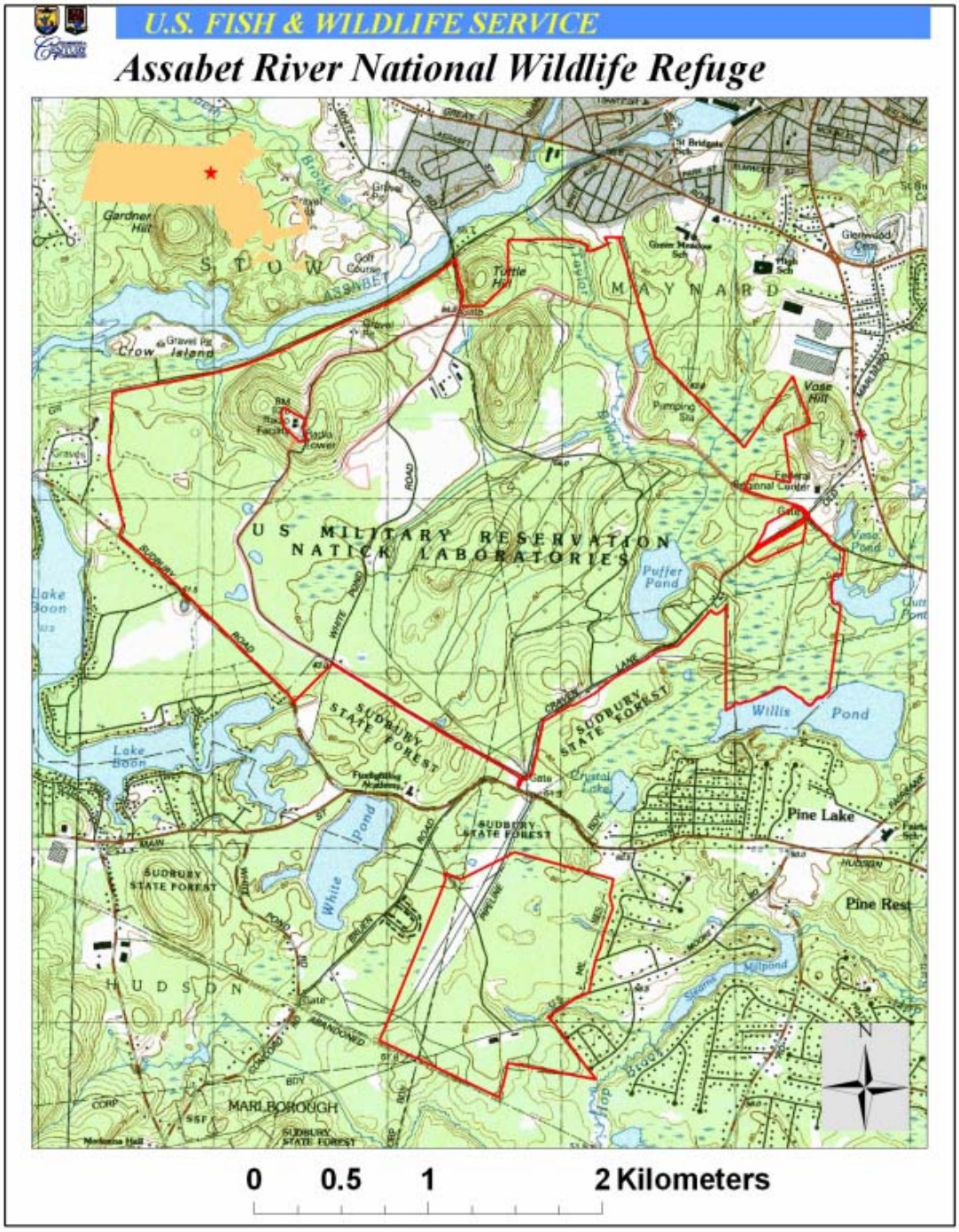

Figure 20. Color topo map illustrating ownership boundaries, neighbors, and major roads of the Assabet River NWR.