Appendix A: Reptiles

Spotted Turtle

Clemmys guttata

Federal Listing	N/A
State Listing	T
Global Rank	G5
State Rank	S2
Regional Status	Very High

Photo by Michael Marchand

Justification (Reason for Concern in NH)

The spotted turtle is declining throughout its range (Litzgus and Mousseau 2004) and is of conservation concern in the Northeast (NEPARC 2010, Therres 1999). In New England, spotted turtles are listed as endangered in Vermont, and threatened in Maine and New Hampshire. Spotted turtles use a large matrix of wetland and upland habitats, and because of life history characteristics (e.g., late age of maturity, low fecundity, and high adult survival) are extremely sensitive to small increases in mortality. Because their habitat overlaps with the highest human population densities in New Hampshire, spotted turtles are particularly vulnerable to rapid development, especially where road density and traffic volume is high. Because spotted turtles need large protected areas with relatively limited development, maintaining viable populations of spotted turtles should benefit many other rare and common organisms. For example, habitat use can overlap with that of Blanding's turtle (*Emydoidea blandingii*); both species were found in similar shallow-water habitats in southern New Hampshire (Jenkins and Babbitt 2003, Jones and Willey 2013).

Distribution

Populations range from southern Maine south along the Atlantic coast to Florida, as well as to southern Ontario, New York, Pennsylvania, Ohio, Indiana, Michigan, and Illinois (Ernst et al. 1994). In New Hampshire, Huse (1901) reported that spotted turtles were found 'everywhere'; however, Oliver and Bailey (1939) knew of only one documented occurrence. Towns with historic records (before 1994) but no recent verified records include Pembroke, Cornish, Webster, and Manchester. The majority of known spotted turtle locations are concentrated in southeastern New Hampshire. However, NHFG has received reports far from the core area in the southeast, including Ossipee and Sandwich, Richmond and Winchester, Grafton, and on the Enfield/Canaan border.

Habitat

Spotted turtles require large intact landscapes with a diversity of wetland types and sizes, and they tolerate only limited development of uplands and disturbance by humans (Fowle 2001, Joyal et al. 2001, Hinderliter 2003). Spotted turtle aquatic and wetland habitats include marshes, wet meadows, ponds, forested and shrub swamps, fens, shallow slow-moving streams and rivers, and vernal pools (Ernst et al. 1994, Fowle 2001, Jones and Willey 2013).

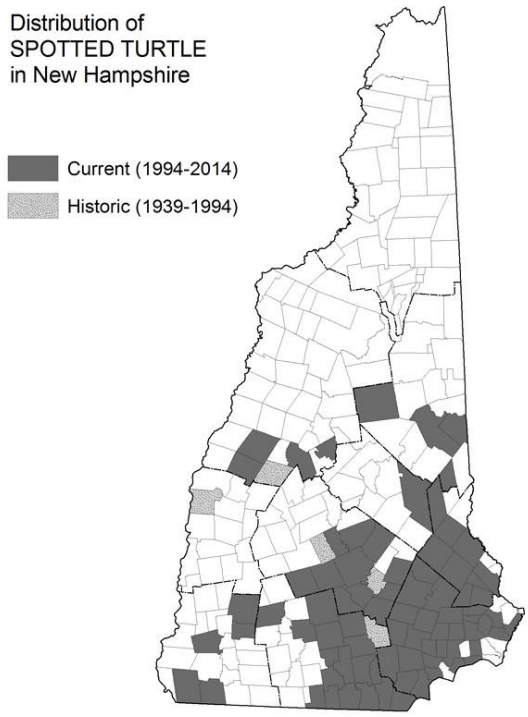
Habitat use shifts seasonally and varies geographically, and overland movements among wetlands may be greater than 500 m (Milam and Melvin 2001). In spring, spotted turtles are likely to use wetlands with abundant wood frog (*Lithobates sylvaticus*) egg masses, and in fall are likely to use wetlands with high sun exposure (Beaudry et al. 2009).Vernal pools often are used extensively in spring and early summer (Joyal et al. 2001, Milam and Melvin 2001). Female spotted turtles usually

lay eggs in open canopied uplands, generally between late May and early July (Ernst et al. 1994).

Human-altered sites (e.g., pastures, road edges, yards, and agricultural areas) are often used for nesting (Carroll 1991, Joyal 1999, Joyal et al. 2001), as are hummocks in emergent wetlands (Milam and Melvin 2001). When summer temperatures are high, spotted turtles may become relatively inactive, resting in the bottoms of wetlands (fens, swamps, marshes, ponds, and rivers) and seasonal pools (Fowle 2001, Milam and Melvin 2001, Hinderliter 2003).

NH Wildlife Action Plan Habitats

- Marsh and Shrub Wetlands
- Vernal Pools
- Floodplain Habitats
- Peatlands
- Temperate Swamps



Distribution Map

Current Species and Habitat Condition in New Hampshire

There is little information on the abundance and condition of spotted turtle populations in New Hampshire. There are only 141 records (Element Occurrences) in the Rare Species Database maintained by the NHNHB (as of 1 March 2015), fourteen of which are considered historic (before 1994). Most records consisted of 1 spotted turtle observation, and very few records in the database had greater than 10 observations. Many records were of individuals found only on roads.

Across the Northeast Region in 2012 and 2013, 148 wetland sites were surveyed for Blanding's and spotted turtles (Jones and Willey 2013). As a result of trapping in these wetlands, 102 spotted turtles were captured. In New Hampshire specifically, 45 spotted turtles were observed during this survey period (combined visual and trapping surveys).

Population Management Status

There is little management of spotted turtles in New Hampshire. Possession of spotted turtles,

including manipulation of individuals for research, requires a permit from NHFG. Several individuals have been permitted to conduct mark-recapture studies, and D. Carroll, who has extensive knowledge of turtle biology, has conducted long-term monitoring of a local New Hampshire population. A search for rare turtles (e.g., Blanding's, spotted, and wood, *Glyptemys insculpta*) was conducted in the Great Bay and Lamprey River areas, and 13 blocks of relatively extensive and contiguous suitable habitat were identified (Carroll 1999). In addition, 14 spotted turtles were monitored at sites in the coastal watershed as part of M. Hinderliter's graduate research.

A regional project supported by the Competitive State Wildlife Grant Program titled 'Conservation of Blanding's Turtle and Associated Wetland SGCN in the Northeast' was initiated in 2011 and consisted of a standardized and coordinated monitoring strategy for Blanding's turtle populations in the northeast region, which is ongoing (Jones and Willey 2013). Spotted turtles are one of the associated wetland SGCN that were assessed through this project, and are included in management plans written for Blanding's turtles and their habitats in NH.

Regulatory Protection (for explanations, see Appendix I)

- CITES - Convention on International Trade of Endangered Species of Wild Fauna and Flora
- NHFG Rule FIS 803.02. Importation.
- NHFG Rule FIS 804.02. Possession.
- NHFG Rule FIS 811.01 Sale of Reptiles.
- Endangered Species Conservation Act (RSA 212-A)
- NHFG FIS 1400 Nongame special rules
- Fill and Dredge in Wetlands - NHDES
- Comprehensive Shoreland Protection Act - NHDES
- Alteration of Terrain Permitting - NHDES

Quality of Habitat

Large, unfragmented habitats with a diversity of wetland types will be necessary to maintain viable populations of spotted turtles (Milam and Melvin 2001, Hinderliter 2003). In general, an undisturbed buffer of more than 400 m around wetland edges may be necessary to protect nesting, estivation, foraging, and travel sites of local spotted turtles (Milam and Melvin 2001), and 430 ha of wetlands and uplands may be needed for a population of 600 adult spotted turtles (Fowle 2001).
Roads are a major threat to spotted turtles. In southern New Hampshire, spotted turtles crossed roads in every month from April to August at all 3 study sites where roads were near wetlands (Hinderliter 2003). NHFG receives reports of vehicle collisions with spotted turtles every year through RAARP and Wildlife Sightings.

Habitat Protection Status

One hundred thirty seven (137) occupied habitat areas were mapped, ranging from 86 to 1,202 ha (mean 189 ha ± 170 SD), and a 500 m buffer around known spotted turtle records restricted possible sizes of occupied areas. The percentage of conservation land in spotted turtle habitat was 19 % ± 23 SD (range 0-94%); mean fee ownership was 13% ± 21 SD (range 0-94 %) and mean conservation easement was 6 % ± 12 SD (range 0-54 %). Ninety-four occupied areas had less than 20% of land protected, 123 areas had less than 50% protected, and only 7 occupied areas had more than 70% protection.

Of these 7 areas, all had road densities greater than 1.0 km/km2 and 2 were bisected by a major state route. The total area protected in occupied lands ranged from 0 to 412 ha (mean = 38 ha ± 62). Seven

mapped occupied areas were greater than 50% protected, had road densities less than 2 km/km2, and lacked major routes.

Habitat Management Status

There is little management of spotted turtles in New Hampshire. Artificial nesting areas have been created in some areas as part of mitigation during NHFG review of wetland impacts and on other lands, but use of these nesting areas is unknown. Thirty-one wetland impoundments are managed, primarily for waterfowl, by NHFG, and spotted turtles occur in some of these areas.

Threats to this Species or Habitat in NH

Threat rankings were calculated by groups of taxonomic or habitat experts using a multistep process (details in Chapter 4). Each threat was ranked for these factors: Spatial Extent, Severity, Immediacy, Certainty, and Reversibility (ability to address the threat). These combined scores produced one overall threat score. Only threats that received a "medium" or "high" score have accompanying text in this profile. Threats that have a low spatial extent, are unlikely to occur in the next ten years, or there is uncertainty in the data will be ranked lower due to these factors.

Habitat impacts from development of surrounding uplands (Threat Rank: High)

Reduction in habitat quality or availability may harm populations by causing indirect mortality due to increased dispersal across inhospitable habitat, increased predation, and increased desiccation. In late May to early July, female turtles leave wetlands in search of an area with an open canopy and bare ground to lay eggs. If nesting habitat is not connected to occupied wetland habitat, adult mortality may occur. Humans and their pets can disturb nesting females and their eggs. Also, succession over time of open areas to brushy or shaded areas can reduce the quality of nesting habitat and may result in reduced recruitment to local populations.

Spotted turtles may use human-modified areas such as gravel pits, residential lawns, and agricultural areas, for nesting. Thus, adults in these areas are vulnerable to predation, road mortality, disturbance, and mowing equipment (Marchand and Litvaitis 2004a). Nests near some ecological edges, such as those nearby to development, may also be more vulnerable to predation (Temple 1987).

Regional population declines have been exacerbated by upland habitat fragmentation and degradation by development. Large blocks of connected habitat are needed to adequately protect spotted turtles. Because spotted turtles often use vernal pools and uplands, protection only of large wetlands is not adequate to protect populations. New Hampshire is the fastest growing state in the northeast, and development in the southern part of the state is consuming open space at a rapid rate (SPNHF 2014). New Hampshire state regulations are currently ineffective at protecting species that use large wetland complexes, and building and disturbance setbacks from freshwater wetlands are not required under New Hampshire state wetland regulations (except for septic setbacks).

Mortality of individuals from vehicles on roadways (Threat Rank: High)

Human population density and development is rapidly increasing in southern New Hampshire (SPNHF 2014). Increases in road densities and traffic volume pose direct threats to turtles, which are slow to cross wide roads. Small annual losses of only a few adult spotted turtles may result in population extirpation.

Roads that intersect a turtle's home range will increase the chance of individuals being killed on roads. Many spotted turtle records (Element Occurrences) known from New Hampshire consist entirely of

individuals observed on roads. Additionally, low population densities and skewed age and sex ratios have raised concerns over the effect of road mortality on some turtle populations in the region (e.g., Joyal et al. 2000, Marchand and Litvaitis 2004a, Gibbs and Steen 2005).

Computer modeling suggests that road densities as low as 1 km/ km2 with fewer than 100 vehicles per lane per day will cause excessive loss of semiterrestrial turtles (Gibbs and Shriver 2002). Although density may be a good initial surrogate for investigating habitat quality, factors such as road width, traffic speed and volume, and position in the landscape should also be considered. Road shoulders, because of the availability of bare soil and open canopies, may attract nesting turtles, increasing the opportunity for road crossings of adult and hatchling turtles. Also, steep-sloping granite curbing can trap turtles on roadways and can decrease the chance of individuals successfully crossing roadways (Najjar, New Boston Air Force Base, personal communication).

Habitat conversion from the direct filling of wetlands for development (Threat Rank: Medium)

Filling of wetlands to produce flat, developable land directly removes spotted turtle habitat. Reduction in habitat quality or availability may harm populations by causing direct mortality of individuals or indirect mortality due to increased dispersal across inhospitable habitat, increased predation, and increased desiccation.

It's estimated that around 20,000 acres of wetlands have been historically lost from New Hampshire (Environmental Law Institute 2008). Under the Fill and Dredge in Wetlands Act, NHDES requires a permit for dredge, fill, or construction in any size wetland. NH DES receives around 2,600 permit applications each year for dredge, fill, or construction in wetlands, and approximately 95% are approved (Environmental Law Institute 2008). For projects that impact over 10,000 square feet of wetland, some mitigation is typically required.

As southern New Hampshire develops, wetlands will be threatened by myriad stressors (see Marsh and Shrub Wetland Profile). Although extensive marshes are not likely to be filled, small vernal pools can easily be overlooked during environmental reviews of dredge and fill permit applications (M.N. Marchand, personal observation).

New Hampshire state regulations are currently ineffective at protecting species that use large wetland complexes, and building and disturbance setbacks from freshwater wetlands are not required under New Hampshire state wetland regulations (except for septic setbacks).

Mortality from the commercial collection of individuals from the wild (Threat Rank: Medium)

Commercial collection of spotted turtles includes any capture of spotted turtles with intent to sell the animal. Individual turtles are removed from local populations, and because populations depend on high adult survival, removal can lead to local extinction. This can range in severity from one spotted turtle being sold within the state, to larger-scale collections that sell turtles elsewhere in the country or even overseas.

Large-scale commercial collection of spotted turtles appears to be low, but NHFG has evidence of commercial collection of spotted turtles in New Hampshire as recently as 2013. In the past, reptile dealers have advertised rare native turtles for sale in New Hampshire (Levell 2000). Adult spotted turtles are the most commonly collected, since they are easily captured particularly when on land. The loss of adult turtles from natural populations can have devastating effects for all species of turtles. Therefore, commercial collection in New Hampshire is worth further investigation and enforcement. Casual collection and relocation of individual spotted turtles is probably more common, and NHFG receives several reports of this every year.

Habitat conversion and mortality from the removal of beaver and human-made dams (Threat Rank: Medium)

The removal of beaver dams or human-made dams can result in reduced wetland habitat quality or availability. Often, beavers build dams in small streams or rivers that flood an area, creating a suitable shrub-wetland type of habitat that can be occupied by spotted and other turtles. When beaver dams are removed, flooded wetland area is typically reduced which reduces habitat suitability for spotted turtles. Removal of human dams may reduce or improve habitat quality depending on the availability of suitable wetland habitat before and after dam removal. When these or other human-made dams are removed, typically water flow is restored to an area and the habitat soon becomes unsuitable for spotted turtles. This reduction in habitat quality or availability may harm spotted turtle populations by causing indirect mortality due to increased dispersal across inhospitable habitat, increased predation, and increased desiccation. Removal of dams can also lead to direct mortality of individual turtles, especially if done during winter months when turtles are hibernating. If a wetland draw-down occurs during this time, turtles can be left without protection from the elements and may not survive through hibernation.

Spotted turtles move to overwintering sites in bogs, fens, marshes or ponds in late fall. Spotted turtles may use vernal pools, beaver ponds, or other wetlands for overwintering sites in NH. During hibernation, turtles are vulnerable to metabolic and respiratory failure, freezing, and predation (Edge et al. 2009). They remain mostly inactive in the substrate of these slow-moving, low oxygen environments until April or May, depending on the weather.

In New Hampshire, landowners may remove beaver dams to protect their property, often with minimal approval or review process. Wetland drawdowns, especially those conducted in fall, may expose turtles to predation, winterkill, and road mortality (Hall and Cuthbert 2000), especially where dispersing individuals are surrounded by dense development (Marchand and Litvaitis 2004a).

List of Lower Ranking Threats:

Mortality and species impacts (reduced fitness) from impervious surface run-off

Mortality and species impacts (decreased fitness) from various diseases (ranavirus)

Mortality from subsidized or introduced predators (egg and hatchling mortality)

Habitat degradation from introduced or invasive plants (nesting areas and wetlands)

Mortality from subsidized or introduced predators

Habitat conversion from succession and associated loss of nesting areas

Habitat degradation and mortality from lake and river drawdowns during winter

Habitat degradation due to wetlands manipulation

Mortality and degradation from legal and illegal OHRV activity

Mortality of individuals from forestry equipment

Mortality from casual collection of individuals from the wild or moving animals to a different location

Habitat degradation and conversion from forestry practices

Mortality from mowing and agricultural machinery and vehicles

Disturbance from increased cold temperatures that reduce embryonic development

Habitat and species impacts from fragmentation

Actions to benefit this Species or Habitat in NH

Design roads and other transportation networks (e.g., railways, bike trails, sidewalks) to reduce threats to spotted turtles and other rare wildlife.

Primary Threat Addressed: Mortality of individuals from vehicles on roadways

Specific Threat (IUCN Threat Levels): Transportation & service corridors

Objective:
Roads and associated structures may impede passage of aquatic organisms and change the natural flow and structure of streams or rivers. Upgrading or replacing ineffective structures (e.g., culverts and bridges) can benefit wetland species.

General Strategy:
Well-designed culverts, bridges, and other forms of stream or wetland crossing will enhance connectivity of wildlife populations and will increase population viability. NHFG will work with NHDOT, NHDES, towns, and other partners to minimize road mortality of spotted turtles on roadways. Specific targeted actions will include: avoid placement of new roads in high-quality spotted turtle landscapes, avoid upgrading unpaved roads to paved surfaces in spotted turtle landscapes, designing roadways to minimize mortality such as avoiding use of steep curbing, upgrading culverts/underpasses to increase opportunities for safe passage of turtles, place turtle crossing signs to educate motorists in spotted turtle areas, and manage vehicle speed by reducing speed limits or installing speed bumps. Trails should be directed away from wetlands and potential nesting areas to reduce disturbance (see recreation guidelines for Blanding's turtles at blandingsturtle.org, which apply to spotted turtles as well). Priority landscapes for implementation will need to be assessed using a combination of habitat modelling, turtle road crossing data, and local knowledge.

Political Location:
Belknap County, Carroll County, Cheshire County, Grafton County, Hillsborough County, Merrimack County, Rockingham County, Strafford County

Watershed Location:
Androscoggin-Saco Watershed, Lower CT Watershed, Pemi-Winni Watershed, Merrimack Watershed, Coastal Watershed

Reduce anthropogenic food sources for predators.

Primary Threat Addressed: Mortality from subsidized or introduced predators

Specific Threat (IUCN Threat Levels): Invasive & other problematic species, genes & diseases

Objective:
Reduce availability of anthropogenic food sources for predators of turtles & their eggs.

General Strategy:
Educate the public about sources of anthropogenic food and the influence it has on the presence of subsidized predators, and the impacts these predators can have on turtle recruitment into a population through predation on eggs.

Political Location:
Belknap County, Carroll County, Cheshire County, Grafton County, Hillsborough County, Merrimack County, Rockingham County

Watershed Location:
Androscoggin-Saco Watershed, Lower CT Watershed, Pemi-Winni Watershed, Merrimack Watershed, Coastal Watershed

Educate the public about rules and regulations pertaining to spotted turtles and other reptiles and amphibians (e.g., sale and possession).

Primary Threat Addressed: Mortality from casual collection of individuals from the wild or moving animals to a different location

Specific Threat (IUCN Threat Levels): Biological resource use

Objective:
Use media, such as updated NHFG website and other sources, to educate the public about rules and regulations that prohibit possessing native reptiles.

General Strategy:
NHFG will increase landowner knowledge of the species' status and threats by developing materials and messages on various media including Facebook, NHFG webpage, and press releases to other media outlets (newspaper, radio, television). Goals should include educating the public about the importance of beaver impoundments for wildlife and the risk of flooding if structures are built in areas with potential to become impounded. This helps landowners, managers, and others become aware of the importance of natural beaver colonization and abandonment to the persistence of shrub wetlands for spotted turtles and other species that use this habitat. The public should become aware that it is illegal to possess spotted turtles or any listed species, and that there are timing restrictions & possession limits for common turtles as well.

Political Location:
Belknap County, Carroll County, Cheshire County, Grafton County, Hillsborough County, Merrimack County, Rockingham County, Strafford County

Watershed Location:
Androscoggin-Saco Watershed, Lower CT Watershed, Pemi-Winni Watershed, Merrimack Watershed, Coastal Watershed

Minimize disturbance to spotted turtles from recreational activities.

Primary Threat Addressed: Mortality and degradation from legal and illegal OHRV activity

Specific Threat (IUCN Threat Levels): Human intrusions & disturbance

Objective:
Minimize impacts of recreation on spotted turtle populations by using recreation guidelines and incorporating species' needs into property management plans.

General Strategy:
The potential negative influence of recreational trails on spotted turtle populations may be reduced through a combination of management techniques. Although specific guidelines have not been developed for spotted turtles, the best management practices outlined in Guidelines for Recreational Areas within High Priority Blanding's Turtle Sites in the Northeastern United

States (available at blandingsturtle.org) are applicable for this species. Objectives and guidelines for recreational trails in high priority spotted turtle sites include: Prevent direct adult mortality caused by ATVs, OHRVs, trucks, bikes, etc.; minimize disturbance of adults, particularly nesting females; minimize mortality of nests, hatchlings, and juvenile turtles; and maintain the integrity of confirmed and potential nesting habitat. Specific actions could include: 1) Seasonal closures of ATV/OHRV trails bisecting sensitive wetland areas and turtle movement corridors; 2) seasonal (24 May to 4 July) or afternoon/evening (>16:00 h) closures to protect nesting females where trails bisect nesting habitat or nesting corridors;
3) Permanent closures of ATV/OHRV trails in known and potential nesting areas; 4) Increased, targeted law enforcement presence during sensitive time periods when turtle movements are frequent and relatively predictable (e.g., June); 5) Trail relocation to avoid bisecting sensitive wetland complexes and to avoid separating suitable wetland habitats from suitable nesting habitats; and 6) Avoid placing hiking trails or sports fields in or adjacent to nesting areas.

Political Location:
Belknap County, Carroll County, Cheshire County, Coos County, Grafton County, Hillsborough County, Merrimack County, Rockingham County, Strafford County

Watershed Location:
Androscoggin-Saco Watershed, Lower CT Watershed, Pemi-Winni Watershed, Merrimack Watershed, Coastal Watershed

Additional research and monitoring of spotted turtle populations, with a focus on a conducting a thorough threat assessment for the species.

Objective:
Collect and analyze data that will better inform how threats act on spotted turtle populations, and use this to mitigate impacts of threats where possible.

General Strategy:
Develop and implement long-term and rapid assessment monitoring using standardized protocol (see regional protocol for Blanding's turtle monitoring, Willey and Jones 2014). Long-term monitoring should be implemented at all high priority sites and repeated every 5 years. Additional monitoring could target nesting areas or habitat quality of particular wetlands. NHFG will participate in any regional conservation initiatives focused on spotted turtles and their wetland habitat. Further research should evaluate the effects of land management (e.g., water level manipulation, agriculture, and recreation) on spotted turtles. Identify populations that are isolated by an anthropogenic barrier (e.g., high traffic road) and identify options for increasing connectivity for spotted turtles. Any mitigation actions implemented should be monitored for effectiveness (e.g., by radio-telemetry).

Political Location:
Belknap County, Carroll County, Cheshire County, Grafton County, Hillsborough County, Merrimack County, Rockingham County, Strafford County

Watershed Location:
Androscoggin-Saco Watershed, Lower CT Watershed, Pemi-Winni Watershed, Merrimack Watershed, Coastal Watershed

Promote wetland restoration, enhancement, and creation projects in areas that will benefit spotted turtles

Primary Threat Addressed: Habitat and species impacts from fragmentation

Specific Threat (IUCN Threat Levels): Residential & commercial development

Objective:
Enhance, create, and restore wetlands and connecting uplands (for example, restore shallow, wet meadow in agricultural areas) to maintain and provide habitat for spotted turtles.

General Strategy:
Prioritize restoration funding that will benefit spotted turtles and other imperiled wetland fauna. Where feasible, maintain natural establishment, occupancy, and abandonment of beaver flowages in the landscape. Work with Wildlife Control Officers, NHFG, NHDES, and landowners to ensure that maintenance of beaver impoundments is a preferred option over removal. Woods roads and trails should be relocated outside of wetland areas and areas potentially flooded by beavers, to extent possible.

Political Location:
Belknap County, Carroll County, Cheshire County, Grafton County, Hillsborough County, Merrimack County, Rockingham County, Strafford County

Watershed Location:
Androscoggin-Saco Watershed, Lower CT Watershed, Pemi-Winni Watershed, Merrimack Watershed, Coastal Watershed

Participate in any national or international spotted turtle working groups.

Objective:
NHFG should participate in any national or international spotted turtle working group or forums and any regional initiatives for the species.

General Strategy:
NHFG will participate in any spotted turtle working groups that are formed. Similar to the structure of the Northeast Blanding's turtle working group, spotted turtle working groups may aim to complete a status assessment for the Northeast region, a conservation plan for spotted turtles, develop a standardized monitoring protocol, conduct a genetics assessment, and/or initiate implementation of actions across the northeast region.

Political Location:
Belknap County, Carroll County, Cheshire County, Grafton County, Hillsborough County, Merrimack County, Rockingham County, Strafford County

Watershed Location:
Androscoggin-Saco Watershed, Lower CT Watershed, Pemi-Winni Watershed, Merrimack Watershed, Coastal Watershed

Encourage alternatives to dewatering wetlands potentially occupied by spotted turtles.

Primary Threat Addressed: Habitat degradation due to wetlands manipulation

Specific Threat (IUCN Threat Levels): Natural system modifications

Objective:
Encourage alternatives to dewatering wetlands potentially occupied by spotted turtles.

General Strategy:
Spotted turtles use a variety of wetland types, many of which are influenced by beaver or human constructed dams. Dewatering wetlands occupied by spotted turtles can result in a reduction in habitat, reduced habitat quality, and mortality to individuals from desiccation, freezing, predation or road mortality associated with increased overland travel. Drawdowns or dam removal during hibernation months (October - April) could result in mortality to hibernating turtles. Therefore, alternatives that maintain suitable wetland habitat, especially during hibernation periods, are encouraged.

Political Location:
Belknap County, Carroll County, Cheshire County, Grafton County, Hillsborough County, Merrimack County, Rockingham County, Strafford County

Watershed Location:
Androscoggin-Saco Watershed, Lower CT Watershed, Pemi-Winni Watershed, Merrimack Watershed, Coastal Watershed

Enforce wildlife regulations pertaining to the illegal collection, possession, or sale of spotted turtles in New Hampshire.

Primary Threat Addressed: Mortality from the commercial collection of individuals from the wild

Specific Threat (IUCN Threat Levels): Biological resource use

Objective:
Enforce existing regulations on collection and possession of spotted turtles.

General Strategy:
In New Hampshire, it is illegal to kill, harm, possess, collect, or sell a spotted turtle without a permit from the NHFG. The species is also protected in every other state in the Northeast where it occurs, by the USFWS Lacey Act and internationally via CITES. Because the removal of one individual spotted turtle from the wild can impact local populations, enforcement of rules and laws pertaining to this species are particularly important. NHFG biologists will work with NHFG law enforcement staff to identify violations and enforcement actions. NHFG staff will also work with neighboring states to

identify origin of animals during confiscations.

Political Location:
Belknap County, Carroll County, Cheshire County, Grafton County, Hillsborough County, Merrimack County, Rockingham County, Strafford County

Watershed Location:
Androscoggin-Saco Watershed, Lower CT Watershed, Pemi-Winni Watershed, Merrimack Watershed, Coastal Watershed

Evaluate impacts and develop environmental review guidelines.

Primary Threat Addressed: Habitat impacts from development of surrounding uplands

Specific Threat (IUCN Threat Levels): Residential & commercial development

Objective:
Evaluate all projects that have potential to cause harm to Blanding's turtle populations and provide guidance to minimize impacts to those populations.

General Strategy:
Spotted turtles are listed as threatened in New Hampshire. As such, NHFG will review any proposed activities (residential and commercial development, recreation, habitat management, etc.) that has the potential to harm spotted turtles. NHFG will work with applicants and permitting staff from other state and federal agencies, primarily Department of Environmental Services (Wetlands Bureau) and U.S. Army Corps of Engineers, to identify avoidance and minimization conditions for permit applicants. NHFG will develop guidelines for consistent and effective review of projects potentially impacting spotted turtles. Guidelines will consider scenarios where impacts should be avoided and scenarios where impact minimization of mitigation may be appropriate. Pre- and post- construction monitoring of spotted turtles and associated habitat (e.g., vernal pools, nesting areas) should be considered as a component of project review. Although all spotted turtle populations have some protection by state law (RSA 212-A), NHFG should prioritize protection at higher quality sites.

Political Location:
Belknap County, Carroll County, Cheshire County, Grafton County, Hillsborough County, Merrimack County, Rockingham County, Strafford County

Watershed Location:
Androscoggin-Saco Watershed, Lower CT Watershed, Pemi-Winni Watershed, Merrimack Watershed, Coastal Watershed

Protect spotted turtle habitat through acquisition, easement, and regulation.

Primary Threat Addressed: Habitat conversion from the direct filling of wetlands for development

Specific Threat (IUCN Threat Levels): Residential & commercial development

Objective:
Protect large blocks of unfragmented habitat with a diversity of wetland complexes to provide and maintain areas for spotted turtles.

General Strategy:
Use spotted turtle habitat to prioritize conservation of land. This should include maintaining beaver flowages, minimizing threats to wetlands (such as vernal pools) used by spotted turtles, and maintaining vegetated buffers along the edges of wetlands and vernal pools. Many of the guidelines and land conservation priorities developed for Blanding's turtles are relevant to spotted turtles as well (available at blandingsturtle.org), but spotted turtle-specific guidelines should be developed for landowners, managers, and towns to enhance and protect resources important to the species. Priority sites will be incorporated into NH Wildlife Action Plan revision maps and incorporated into state land conservation funding consideration (e.g., Aquatic Resource Mitigation Fund, LCHIP). NHFG staff will provide technical assistance to land trusts and towns in identifying and conserving priority parcels. NHFG staff will also provide technical assistance in developing management objectives compatible with spotted turtle conservation.

Political Location:
Belknap County, Carroll County, Cheshire County, Grafton County, Hillsborough County, Merrimack County, Rockingham County, Strafford County

Watershed Location:
Androscoggin-Saco Watershed, Lower CT Watershed, Pemi-Winni Watershed, Merrimack Watershed, Coastal Watershed

Develop, implement and promote the use of forestry guidelines in areas where spotted turtles occur.

Primary Threat Addressed: Habitat degradation and conversion from forestry practices

Specific Threat (IUCN Threat Levels): Biological resource use

Objective:
Implement forestry guidelines to minimize impacts to spotted turtles during forestry activities.

General Strategy:
Although there are not guidelines created specifically for spotted turtles, a set of forestry guidelines has been developed for Blanding's turtle (available at blandingsturtle.org), that is applicable to this species. Objectives and guidelines for forestry activities in high priority spotted turtle sites include: Prevent direct adult mortality caused by machinery, skidders, trucks, etc., Minimize mortality of nests, hatchlings, and juvenile turtles, Improve, expand, or create new nesting habitat, avoid changes to wetland hydrology during overwintering season (October to April), Avoid disturbance to vernal pool habitats year-round, and Avoid introducing aquatic or terrestrial invasive plant species. Spotted Turtle Active Season: 1 March to 15 September in most years, may vary depending on weather. Spotted Turtle Dormant Season: 1 November to 28 February in most years, may vary depending on weather. NHFG will target large landowners within high priority spotted turtle sites for dissemination of guidelines and provide technical assistance to these landowners as warranted. NHFG will also disseminate guidelines to groups (e.g., NRCS, UNH Cooperative Extension, foresters) that work with private landowners and encourage use when developing management plans for properties.

Political Location:
Belknap County, Carroll County, Cheshire County, Grafton County, Hillsborough County,

Watershed Location:
Androscoggin-Saco Watershed, Lower CT Watershed, Pemi-Winni Watershed, Merrimack

Merrimack County, Rockingham County, Strafford County	Watershed, Coastal Watershed

References, Data Sources and Authors

Data Sources

Distribution information came largely from the Reptile and Amphibian Reporting Program (RAARP) and observations submitted to NH Wildlife Sightings Website (nhwildlifesightings.unh.edu). High quality records were submitted to New Hampshire Natural Heritage Bureau (NHNHB) and incorporated into the NH Rare Species Database. New Hampshire studies included an assessment by D. Carroll along the Lamprey River and a graduate research study by M. Hinderliter in 2003, and a Blanding's turtle assessment by NHFG that detected several spotted turtle occurrences during 2011-2014 (Willey and Jones 2014). These observations have also been incorporated into the NH Rare Species Database.

Threat assessments were conducted by a group of NHFG biologists (Michael Marchand, Brendan Clifford, Loren Valliere, Josh Megysey).

Data Quality

Most records consist of only 1 or a few observations, and many were encounters on roads. Wetland occupation and habitat use at a fine scale (e.g., wetland polygons) is poorly understood for most of the New Hampshire range of spotted turtles, though a few populations in southeastern New Hampshire have been studied in more detail (e.g., Hinderliter 2003). Because spotted turtles are secretive and difficult to detect, focused efforts will likely result in new town records.

2015 Authors:

Michael Marchand, NHFG; Loren Valliere, NHFG

2005 Authors:

Michael Marchand, NHFG

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Northern Black Racer

Coluber constrictor constrictor

Federal Listing	N/A
State Listing	T
Global Rank	G5
State Rank	S2
Regional Status	High

Photo by Brendan Clifford

Justification (Reason for Concern in NH)

Based on historic reports of large populations of black racers, substantial population declines have likely occurred in New Hampshire. Racers reach the northern extent of their geographic range in central New Hampshire and southern Maine, and are listed as Endangered in Maine and Threatened in Vermont. Early successional and shrub-dominated habitats are rapidly declining throughout the northeastern United States, largely as a result of commercial and residential development and forest maturation (Kjoss and Litvaitis 2000). In New Hampshire, remaining patches of early-successional habitat are small and patchily distributed (Kjoss and Litvaitis 2000). Severe habitat loss, alteration, and fragmentation throughout the species' distribution is exacerbated by the species extensive habitat requirements (Kjoss and Litvaitis 2000).

Distribution

A total of 11 subspecies of black racers are recognized, all of which range north of Mexico (Ernst and Ernst 2003). The Northern black racer occurs from southern Maine and central New York, southwest to eastern Tennessee, northwestern Georgia, and northeastern Alabama (Ernst and Ernst 2003). In New Hampshire, this species is restricted to areas south of the White Mountains, with the greatest number of verified records in the southeast. Within this region, black racers occur discontinuously, suggesting that populations may be confined to small pockets of optimal habitat (Klemens 1993). The species distribution map associated with this profile is based on data synthesized at the time of its creation. Distribution maps are continually being updated as new reports are received.

Habitat

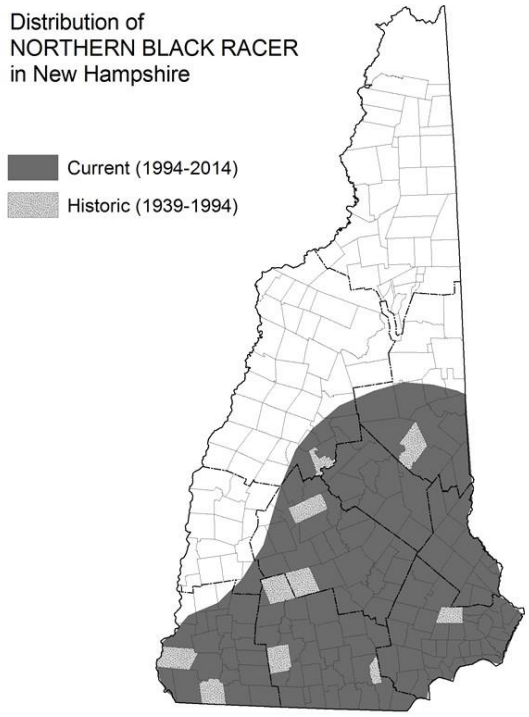
The Northern black racer (*Coluber constrictor constrictor*) is a long, slender snake associated with a wide variety of early successional habitats, including brushy areas; utility right-of-ways; grasslands; old fields; sand pits; rocky ridges and ledges; and the edges of agricultural fields (Hunter et al. 1999, Kjoss and Litvaitis 2000, Ernst and Ernst 2003, NHFG Data). As racers move between habitat patches they may use forested habitats, particularly those that have been altered from timber harvests (NHFG Data). In New Hampshire racers appear to have much larger home ranges than those reported from more southern populations. The home ranges of 25 tracked racers in NH averaged 112 ha for males and 70 ha for females but exceeded 200 ha for some individuals (NHFG Data). Similar home range sizes have been reported from a single population in Maine (Mays and Persons 2011).

Mammal burrows and rock crevices may be used as nest sites, retreats, and hibernacula (Ernst and Ernst 2003, NHFG Data). High hibernacula site fidelity is common as individuals may return to the exact crevice or a location close by (NHFG Data). These sites are normally used communally, either in

intra- or interspecific assemblages, during the months of October through April (Ernst and Ernst 2003, NHFG Data). Juvenile prey consists primarily of insects whereas adult prey consists of frogs, toads, birds and their eggs, small mammals, and snakes, with mammals being the dominant food item (Ernst and Ernst 2003). Nesting, which also may be communal, typically occurs from the end May through June in loose soil, litter, or hollow logs (Ernst and Ernst 2003, Mays and Persons 2011). Hatchlings emerge in August or September (Hunter et al. 1999, NHFG Data).

NH Wildlife Action Plan Habitats

- Shrublands
- Grasslands
- Appalachian Oak Pine Forest
- Developed Habitats
- Hemlock Hardwood Pine Forest
- Rocky Ridge
- Cliff
- and Talus



Distribution Map

Current Species and Habitat Condition in New Hampshire

Populations are likely smaller and more fragmented than historic levels based on historic reports and the current level of human development that have reduced habitat. In a historic report (1940-1950, specific date unknown) Donald Carle, professor of science at Keene Teachers College, noted that 112 black racers were found at one location in Keene. In a multi-year study on the movement and habitat-use of black racers in New Hampshire, 3 populations with greater than 25 individuals were documented with mark-recapture techniques and an additional 5 populations had greater than 10 individuals marked (NHFG Data). Still, most statewide records (Element Occurrences) consist of single individuals and no site or population information exists (NHB Data).

Population Management Status

During 2009-2015, NHFG surveyed 9 racer populations with mark-recapture techniques and radio-telemetry to document the population sizes and delineate the approximate site boundaries. Site-specific threats have been identified for several populations which will be incorporated into local management plans.

Regulatory Protection (for explanations, see Appendix I)

- NHFG Rule FIS 803.02. Importation.
- NHFG Rule FIS 804.02. Possession.
- NHFG Rule FIS 811.01 Sale of Reptiles.
- Endangered Species Conservation Act (RSA 212-A)
- NHFG FIS 1400 Nongame special rules
- Fill and Dredge in Wetlands - NHDES

Quality of Habitat

Data on the presence and condition of most shrubland habitats in New Hampshire is insufficient. The largest shrubland habitats in the state are likely associated with utility right-of-ways that are maintained as early-successional habitat. Large powerline corridors that have limited road crossings can provide suitable habitat for some populations (NHFG Data). Active sand and gravel pits may provide suitable habitat in some areas but are also likely to put individual snakes at risk to direct mortality (NHFG data). Abandoned pits that are left to re-vegetate naturally provide ideal habitat conditions that may exists for decades although these areas are often targeted for reclamation by landowners thereby reducing the habitat quality. The remaining shrubland habitats in the state are mostly small, disjunct patches associated with old fields, regenerating clearcuts, the edges of agricultural fields or un-kept sections of backyards. While racers will readily use these habitats they are often too small to hold individuals for extended periods. Habitat patches associated with backyards or the edges of industrial lots are likely to increase encounters with roads or people.

The habitat quality varied at nine racer sites that were surveyed by NHFG. Five sites had powerline right-of-ways where several individual racers spent the majority of the active season, although snakes were not confined to the right-of-way and moved back and forth to nearby fields (NHFG Data). Flood control structures (e.g., rip rap dikes) and the associated landscape were heavily used at two sites and are likely to provide stable and suitable habitat patches for those populations. Two sites were comprised primarily of smaller habitat patches associated with agricultural fields and backyards. However, despite some sites having larger and higher quality habitat patches, racers were documented using the edges of yards at eight of nine sites, although the frequency varied between sites.

Habitat Protection Status

The amount of conserved land at the NHFG survey sites (n = 9) ranged from less than 5% to greater than 90% of the site. At four sites less than 10% of the land is in conservation with none of the known hibernacula protected. More than 50% of the land is protected at five sites with the hibernacula on conserved land at four of these sites. Although the majority of Element Occurrence records in the Rare Species Database are on private lands, these records may be representative of long distance movements and the site boundaries and protection status cannot be determined without further investigation.

Habitat Management Status

There has been little habitat management conducted in New Hampshire specifically for black racers, but management for early-successional habitat that has been targeted toward other species (e.g., New England cottontail, American woodcock) has likely benefitted racers at some sites. Land-use activities such as timber harvesting and rotational mowing of utility right-of-ways are conducted statewide and are likely to enhance or maintain racer habitat where they occur.

Threats to this Species or Habitat in NH

Threat rankings were calculated by groups of taxonomic or habitat experts using a multistep process (details in Chapter 4). Each threat was ranked for these factors: Spatial Extent, Severity, Immediacy, Certainty, and Reversibility (ability to address the threat). These combined scores produced one overall threat score. Only threats that received a "medium" or "high" score have accompanying text in this profile. Threats that have a low spatial extent, are unlikely to occur in the next ten years, or there is uncertainty in the data will be ranked lower due to these factors.

Habitat conversion due to development of upland habitat (Threat Rank: High)

Racers have extensive home ranges and travel between several habitat patches during their active season. Patches that are lost to development force racers to shift their home ranges which may increase the risk of road crossings or human encounters. While the loss of small patches may not be immediately threatening to populations that are supported by extensive shrublands (i.e., powerlines), there may be immediate impacts to populations that are nestled within highly developing areas.

The majority of racer Element Occurrences exist in southeastern New Hampshire, the region with the highest human population and greatest development pressure. The home range sizes of racers in New Hampshire is larger than what has been reported in other populations in the United States (NHFG Data) and may be partly a result of already reduced habitat availability from existing development.

Habitat conversion and mortality from mining (sand & gravel) (Threat Rank: Medium)

Sand and gravel pits are attractive to racers because they typically provide large sections of early successional habitat, often adjacent to the active mining areas. Additionally, active pits may have industrial equipment or debris strewn about that provides attractive cover items for snakes. Females may nest under debris or anywhere in the loose soil associated with the pit. Racers are vulnerable to direct mortality when mining activities shift or expand to the areas that had previously been left idle, or when long-standing equipment is moved. Sand pits also provide attractive locations for ATVs and other human activities which may result in human-snake encounters.

The use of sand and gravel pits by radio-tracked racers was observed at three sites (NHFG Data). At one site the mortality of a radio-tracked individual from soil compaction was documented after expansion of the mining area. Two racers were killed by people uisng the sandpits as recreational areas (NHFG Data).

Mortality of individuals from vehicles on roadways (Threat Rank: Medium)

Roads fragment habitat, increasing mortality as snakes are forced to cross roads on a more frequent basis. Racers appear more willing than other snake species to attempt road crossings (Andrews and Gibbons 2005) and annual losses of adults, particularly gravid females, may lead to population declines or local extinctions. While some low-traffic roads that bisect habitat patches may allow for snakes to cross with only occasional mortality, high intensity roads may isolate habitat patches.

The majority of Element Occurrences exist in southeastern New Hampshire, the region with the highest human population and greatest development pressure. Radio-tracked snakes were documented crossing roads on numerous occasions at four different sites (NHFG Data) and several observations of road-killed snakes have been observed in New Hampshire in the past ten years (NHB Data). Given their extensive movement requirements, racers from many populations in the state are likely to cross a road at some point during their active season.

Mortality of individuals from vehicles on utility rights of way (Threat Rank: Medium)

Utility rights of way that are maintained in an early-successional stage often provide highly suitable habitat for racers. Racers are particularly vulnerable to disturbance or mortality from maintenance vehicles during the first couple weeks of spring emergence as snakes bask near den sites before dispersing, but also during the hibernation period if dens become compacted by heavy equipment and trap snakes underground. The risk of vehicle-mortality is likely to be lower during the warmer summer months when their ability to flee quickly is not restricted by cool temperatures.

Communal racer dens have been documented in powerline corridors at two sites in NH and likely occur at several other undocumented sites. At sites where dens are located in close proximity to powerlines, racers may move directly into powerline corridors upon emergence to bask (NHFG Data). Extensive use of powerline corridors was documented at several sites and some individuals remained in powerline corridors for the entire active season (NHFG Data).

Mortality from human persecution (Threat Rank: Medium)

Many people have an irrational fear or hatred for snakes. The large size and defensive behavior of racers may make them more vulnerable to human persecution than most other species. Their large home ranges and active movement habits may result in snakes visiting many backyards during their active season. Gravid females are particularly vulnerable as residential gardens or flower beds provide attractive nesting sites. Additionally, females may nest communally at some sites increasing the population impacts from human persecution.

Human persecution of racers was documented at three monitoring sites during a NHFG research project (NHFG Data) and anecdotal accounts of human persecution exist from several additional sites. Tracked snakes from all monitored populations came into contact with human establishments during different parts of the active season with some individuals spending several weeks in backyards.

Mortality and habitat conversion (compaction of dens and crevices) from forestry practices (Threat Rank: Medium)

Small mammal burrows (i.e., chipmunk burrows) in forested habitats are often used by racers as winter hibernacula. Individual burrows may hold single snakes or be communal and support greater than ten individuals (NHFG Data). Depending on the site, populations may use several burrows separated by long distances (i.e., different hillsides) or few burrows situated on a single hillside. Machinery used during winter timber harvests may compact the soil and trap snakes underground. Entire populations may be vulnerable to extirpation at sites where single burrows are used as hibernacula. Currently, landowners are encouraged but not always required to consult with NHFG before commencing forestry activities in the vicinity of rare species records.

Mammal burrows situated in forested habitats were used at five different monitoring sites during a NHFG study (NHFG Data). Although no direct impacts from forestry have been documented, the collapse of one chipmunk burrow (under undisturbed conditions) was documented when a radio-tracked racer and a second live snake were observed upon the excavation of the burrow two months after the emergence period (NHFG Data). Although the cause for the soil collapse is unknown this case illustrates the vulnerability of hibernacula associated with mammal burrows.

Mortality from the destruction of dens and crevices during various human activities (landscaping, vehicle compaction) (Threat Rank: Medium)

Racers may use a variety of habitat features for hibernacula. Although chipmunk burrows appear to be common, racers may use different types of rock formations such as natural rocky hillsides or various human-created features including back-filled rock and old farming stone piles when they are available. Once these areas are concealed in by soil and grasses they may be difficult to recognize and be inadvertently run-over with vehicles. Local populations may be extirpated in dens are compacted during the hibernation period.

Radio-tracked racers have been documented using areas of back-filled rock for hibernation at five sites with each site communal (NHFG Data). Two of the three largest known populations have dens associated with this type of structure. One den site with greater than ten individuals was inadvertently compacted by heavy machinery and required excavation to free the trapped snakes.

Habitat degradation and conversion due to the succession from grass and shrubs to forested areas (Threat Rank: Medium)

Shrubland-dependent wildlife shift in space and time in response to natural succession, disturbance and human land uses (Litvaitis 2005). As more open land is converted to development there is less overall space for shrubland –dependent species to shift into when natural forest succession or lack of active management makes their current habitat patch unsuitable.

Although over 80% of New Hampshire is reforested, second growth forests lack the structural diversity present in virgin forests. Forest maturation, coupled with suppression of natural disturbance (e.g., fire) has reduced the amount of early successional conditions (Litvaitis 2003). Concurrently, shrublands are being developed for residential and commercial purposes. Thus, early successional habitat is at or below historical levels (Brooks 2003). Human created shrublands (e.g., old fields, reverting gravel pits, rights-of-way) have increased in importance to shrubland-dependent wildlife. These human created shrublands tend to be ephemeral and require natural or human disturbance to retain their characteristics (Brooks 2003).

Mortality and species impacts (decreased fitness) of individuals from various diseases (snake fungal disease) (Threat Rank: Medium)

Since the mid-1990's an increasing number of snakes in the eastern United States have been observed with fungal skin infections. As the number of reported cases has grown the infections have now been termed snake fungal disease (SFD). A novel fungus (Ophidiomyces ophiodiicola) has been identified in many individuals with suspected SFD and is thought to be the cause of mortality although some questions remain as to whether this species is the primary or secondary pathogen.

O. ophiodiicola has now been documented in more than 10 different snake species from 11 different states ranging from New Hampshire to Florida and as far west as Arkansas and Minnesota. Evidence of potential SFD has been observed in several racer populations in New Hampshire. During mark-recapture surveys at 9 sites many individual snakes were observed with lesions including several with severe infections. One individual required euthanasia.

List of Lower Ranking Threats:

Disturbance and mortality from increased recreation (hiking, mountain biking, OHRV, dog walking)

Mortality from mowing and agricultural machinery and vehicles

Mortality from welded plastic erosion control blankets

Mortality from landscaping and land management activities

Actions to benefit this Species or Habitat in NH

Document communal den sites

Primary Threat Addressed: Mortality from the destruction of dens and crevices during various human activities (landscaping, vehicle compaction)

Specific Threat (IUCN Threat Levels): Residential & commercial development / Housing & urban areas / Landscaping and residential habitat management

Objective:
Identify and protect racer populations across the state

General Strategy:
Although racer records exist in many towns across the southern part of the state, no population information is known for most locations. Identifying and protecting den locations, particularly large communal dens that act as source populations will be critical to the long-term persistence of racers in the state. Even less is known of the presence of racers in the southwestern NH and areas north of Concord and these areas should be targeted for surveys. Where dens are known provide technical assistance to landowners to minimize impacts to populations.

Political Location:
Belknap County, Carroll County, Cheshire County, Grafton County, Hillsborough County, Merrimack County, Rockingham County, Strafford County, Sullivan County

Watershed Location:
Androscoggin-Saco Watershed, Lower CT Watershed, Pemi-Winni Watershed, Merrimack Watershed, Coastal Watershed

Update environmental review guidelines with racer threats

Primary Threat Addressed: Mortality and habitat conversion (compaction of dens and crevices) from forestry practices

Specific Threat (IUCN Threat Levels): Biological resource use

Objective:
Update environmental review guidelines with racer threats

General Strategy:
Black racers are listed as threatened in New Hampshire. As such, NHFG will review any proposed activities (residential and commercial development, recreation, habitat management, etc.) that has

the potential to harm racers. NHFG will work with applicants and permitting staff from other state and federal agencies, primarily Department of Environmental Services (Wetlands Bureau) and U.S. Army Corps of Engineers, to identify avoidance and minimization conditions for permit applicants. NHFG will develop guidelines for consistent and effective review of projects potentially impacting racers. Guidelines will consider scenarios where impacts should be avoided and scenarios where impact minimization of mitigation may be appropriate. Pre- and post- construction monitoring of racers and associated habitat (e.g., shrublands, nesting areas) should be considered as a component of project review. Although all racer populations have some protection by state law (RSA 212-A), NHFG should prioritize protection at higher quality sites

Political Location:
Belknap County, Carroll County, Cheshire County, Grafton County, Hillsborough County, Merrimack County, Rockingham County, Strafford County, Sullivan County

Watershed Location:
Androscoggin-Saco Watershed, Lower CT Watershed, Pemi-Winni Watershed, Merrimack Watershed, Coastal Watershed

Provide technical assistance to utility companies to minimize disturbance and mortality to individual snakes or populations

Primary Threat Addressed: Mortality of individuals from vehicles on utility rights of way

Specific Threat (IUCN Threat Levels): Transportation & service corridors

Objective:
Reduce the mortality of racers from human land-use practices

General Strategy:
Utility rights-of-way are typically maintained as large tracts of early successional habitat that is attractive to racers. Work with utility companies to develop BMPs for maintenance activities. Important factors to consider include timing (done during the active or inactive period for snakes), the potential of disturbing den sites and the removal of vegetation. Recommendations may differ depending on a known population and the vicinity of the den site to the right-of-way.

Political Location:
Belknap County, Carroll County, Cheshire County, Grafton County, Hillsborough County, Merrimack County, Rockingham County, Strafford County, Sullivan County

Watershed Location:
Androscoggin-Saco Watershed, Pemi-Winni Watershed, Merrimack Watershed, Coastal Watershed

Discourage landowners from reclaiming abandoned sand and gravel pits

Primary Threat Addressed: Habitat conversion due to development of upland habitat

Specific Threat (IUCN Threat Levels): Residential & commercial development

Objective:
Maintain long-standing viable habitat patches for racers

General Strategy:
Abandoned sand pits are often viewed as eyesore and targeted for reclamation. However these disturbed sites have important habitat components for several wildlife species include nesting and basking habitat for racers. Provide technical assistance to town conservation commissions and private landowners about the benefits to leaving sites to re-vegetate naturally.

Political Location:
Belknap County, Carroll County, Cheshire County, Grafton County, Hillsborough County, Merrimack County, Rockingham County, Strafford County, Sullivan County

Watershed Location:
Androscoggin-Saco Watershed, Lower CT Watershed, Pemi-Winni Watershed, Merrimack Watershed, Coastal Watershed

Provide strategies to landowners to reduce the potential impacts of mowing and agricultural work to snakes.

Primary Threat Addressed: Mortality from mowing and agricultural machinery and vehicles

Specific Threat (IUCN Threat Levels): Agriculture & aquaculture

Objective:
Reduce the mortality of racers from human land-use practices

General Strategy:
Contact landowners that have large hay fields in the vicinity of known racer populations to explain the threat and actions that may reduce mortality.

Political Location:
Belknap County, Carroll County, Cheshire County, Grafton County, Hillsborough County, Merrimack County, Rockingham County, Strafford County, Sullivan County

Watershed Location:
Androscoggin-Saco Watershed, Lower CT Watershed, Pemi-Winni Watershed, Merrimack Watershed, Coastal Watershed

Enhance or create early successional habitats at known racer sites

Primary Threat Addressed: Habitat degradation and conversion due to the succession from grass and shrubs to forested areas

Specific Threat (IUCN Threat Levels): Natural system modifications

Objective:
Conduct habitat management at known sites to maintain or enhance the population viability

General Strategy:
Racers were documented traveling long distances through forested habitats to reach preferred early successional habitats (NHFG Data). Incorporate racers into existing habitat management plans (e.g., state lands) and work with landowners to develop management plans where racers are known to occur.

Political Location:
Belknap County, Carroll County, Cheshire County, Grafton County, Hillsborough County, Merrimack County, Rockingham County, Strafford County, Sullivan County

Watershed Location:
Androscoggin-Saco Watershed, Lower CT Watershed, Pemi-Winni Watershed, Merrimack Watershed, Coastal Watershed

Add language and actions into existing and new management plans that benefit or reduce impacts to racers

Primary Threat Addressed: Disturbance and mortality from increased recreation (hiking, mountain biking, OHRV, dog walking)

Specific Threat (IUCN Threat Levels): Human intrusions & disturbance

Objective:
Reduce potential threats and increase habitat suitablity by incorporating racers into management plans

General Strategy:
Black racers, and other rare reptiles and amphibians, should be incorporated into habitat inventories as well as management and restoration efforts on state lands and private lands when possible. Prioritize the incorporation of racers into plans that may impact known populations.

Political Location:
Belknap County, Carroll County, Cheshire County, Grafton County, Hillsborough County, Merrimack County, Rockingham County, Strafford County, Sullivan County

Watershed Location:
Androscoggin-Saco Watershed, Pemi-Winni Watershed, Merrimack Watershed, Coastal Watershed

Determine the state-wide distribution of racers

Primary Threat Addressed: Habitat conversion due to development of upland habitat

Specific Threat (IUCN Threat Levels): Residential & commercial development

Objective:
Improve the understanding of racer distribution in NH

General Strategy:
Target RAARP volunteers to produce verified reports of black racer locations, especially in those areas where records are scarce particularly in the southwest and central part of the state. Conduct targeted surveys based on reports and the presence of suitable habitat (e.g., den, basking and nesting habitats) to document extant populations.

Political Location:
Belknap County, Carroll County, Cheshire County, Grafton County, Hillsborough County, Merrimack County, Rockingham County, Strafford County, Sullivan County

Watershed Location:
Androscoggin-Saco Watershed, Lower CT Watershed, Pemi-Winni Watershed, Merrimack Watershed, Coastal Watershed

Inform landowners surrounding known populations about protection status of racers

Primary Threat Addressed: Mortality from human persecution

Specific Threat (IUCN Threat Levels): Biological resource use / Hunting & collecting terrestrial animals / Persecution/control

Objective:
Build awareness for racer conservation

General Strategy:
Conduct targeted outreach to landowners surrounding known populations, particularly at sites that have been surveyed extensively and where human-snake encounters have been documented. Outreach should include flyers or brochures as well as in-person visits in areas known to be frequented by snakes. Involve NHFG Conservation Officers as necessary to reinforce the legal protections.

Political Location:
Belknap County, Carroll County, Cheshire County, Grafton County, Hillsborough County, Merrimack County, Rockingham County, Strafford County, Sullivan County

Watershed Location:
Androscoggin-Saco Watershed, Pemi-Winni Watershed, Merrimack Watershed, Coastal Watershed

Incorporate actions to reduce impacts to racers in Best Management Practices (BMP's) for forestry

Primary Threat Addressed: Mortality and habitat conversion (compaction of dens and crevices) from forestry practices

Specific Threat (IUCN Threat Levels): Biological resource use

Objective:
Reduce the mortality of racers from forestry operations.

General Strategy:
Timber harvesting can have population-level impacts if communal den sites (i.e., chipmunk burrows) are located in forests and the entrances are compacted by vehicles. Encourage landowners and foresters to consult with NHFG to determine the likelihood of communal den sites in harvest areas.

Political Location:
Belknap County, Carroll County, Cheshire County, Grafton County, Hillsborough County, Merrimack County, Rockingham County, Strafford County, Sullivan County

Watershed Location:
Androscoggin-Saco Watershed, Lower CT Watershed, Pemi-Winni Watershed, Merrimack Watershed, Coastal Watershed

Inform and educate landowners (industrial) about the threats to racers and actions that can be taken to mitigate threats

Primary Threat Addressed: Habitat conversion and mortality from mining (sand & gravel)

Specific Threat (IUCN Threat Levels): Energy production & mining

Objective:
Reduce the mortality of racers from human land-use practices

General Strategy:
Racers may use the disturbed edges of industrial lands (e.g., active sandpits, lumber yards) for basking or nesting habitat. Scattered debris surrounding these lands may provide attractive cover objects. Inform landowners in the vicinity of known racer populations about the potential for snake encounters and strategies for minimizing mortality.

Political Location:
Belknap County, Carroll County, Cheshire County, Grafton County, Hillsborough County, Merrimack County, Rockingham County, Strafford County

Watershed Location:
Androscoggin-Saco Watershed, Pemi-Winni Watershed, Merrimack Watershed, Coastal Watershed

Inform and educate landowners (residential) about the threats to racers and actions that can be taken to mitigate threats

Primary Threat Addressed: Mortality from landscaping and land management activities

Specific Threat (IUCN Threat Levels): Residential & commercial development / Housing & urban areas / Landscaping and residential habitat management

Objective:
Reduce the mortality of racers from human land-use practices

General Strategy:
Protection of the den or summer habitats does not ensure the protection of the species. Racers travel long distances and therefore may be affected by many land-use practices and may regularly come in contact with humans. Based on the documented movement and habitat use at several sites, potential threats have been identified at each site and should be targeted with educational and outreach materials. Strategies might include creating brochures that target landowners that are likely to come across racers in their yard or direct visits to targeted parcels (e.g., known communal nesting areas).

Political Location:
Belknap County, Carroll County, Cheshire County, Grafton County, Hillsborough County, Merrimack County, Rockingham County, Strafford County, Sullivan County

Watershed Location:
Androscoggin-Saco Watershed, Lower CT Watershed, Pemi-Winni Watershed, Merrimack Watershed, Coastal Watershed

Protect critical racer habitat at priority populations

Primary Threat Addressed: Habitat conversion due to development of upland habitat

Specific Threat (IUCN Threat Levels): Residential & commercial development

Objective:
Maintain healthy populations at known racer sites.

General Strategy:
The den locations and critical habitats have been documented for nine populations. Some populations have sufficient protection of den sites and/or summer habitats but others are completely unprotected. Conservation actions should first target known den areas followed by the surrounding habitat patches. Identify critical habitats at new sites with the use of GIS, visual surveys or radio- telemetry.

Political Location:
Belknap County, Carroll County, Cheshire County, Grafton County, Hillsborough County, Merrimack County, Rockingham County, Strafford County, Sullivan County

Watershed Location:
Middle CT Watershed, Lower CT Watershed, Pemi-Winni Watershed, Merrimack Watershed, Coastal Watershed

Monitor the health of known populations

Primary Threat Addressed: Mortality and species impacts (decreased fitness) of individuals from various diseases (snake fungal disease)

Specific Threat (IUCN Threat Levels): Invasive & other problematic species, genes & diseases

Objective:
Identify potential health concerns in known populations so the appropriate conservation actions can be taken

General Strategy:
Potential snake fungal disease was observed in every population that was monitored. Given the baseline data that has been collected for each population (i.e., mark-recapture data) there may be opportunity to track the prevalence of SFD over time. Additionally, three populations that were monitored represent source populations and are therefore high priorities for conservation. Long-term monitoring of these populations will be important in mitigating new threats that arise.

Political Location:
Belknap County, Carroll County, Cheshire County, Grafton County, Hillsborough County, Merrimack County, Rockingham County, Strafford County, Sullivan County

Watershed Location:
Androscoggin-Saco Watershed, Lower CT Watershed, Pemi-Winni Watershed, Merrimack Watershed, Coastal Watershed

Promote wildlife friendly erosion control matting to reduce mortality of snakes.

Primary Threat Addressed: Mortality from welded plastic erosion control blankets

Specific Threat (IUCN Threat Levels): Residential & commercial development

Objective:
Reduce the mortality of racers and other snakes

General Strategy:
Some erosion control matting has a welded plastic netting that captures and kills snakes and birds. Wildlife friendly options are available and will be favored and promoted during environmental reviews, technical assistance with landowners, and technical assistance to other land managers.

Political Location:
Belknap County, Carroll County, Cheshire County, Grafton County, Hillsborough County, Merrimack County, Rockingham County, Strafford County, Sullivan County

Watershed Location:
Androscoggin-Saco Watershed, Lower CT Watershed, Pemi-Winni Watershed, Merrimack Watershed, Coastal Watershed

References, Data Sources and Authors

Data Sources
The major source of distribution information for New Hampshire was from the Reptile and Amphibian Reporting Program (RAARP) and NH Wildlife Sightings website coordinated by the Nongame and Endangered Wildlife Program at NHFG, the rare species database maintained by the NHNHB, records and Taylor (1993) and literature reviews and unpublished reports and professional knowledge of the authors. State and global heritage ranks were taken from NatureServe 2015. Habitat and life history information was collected from scientific literature and a multi-year radio-telemetry study conducted by NHFG.
NHFG conducted population and habitat-use research at 9 racer sites from 2010-2013 (NHFG data). All racer records are maintained as Element Occurrences in the NH Natural Heritage Bureau Rare Species Database. Conservation lands were identified with GIS.Threat assessments were conducted by a group of NHFG biologists (Michael Marchand, Brendan Clifford, Loren Valliere, Josh Megysey).

Data Quality
NHFG conducted a four-year radio-telemetry study of nine racer populations to evaluate movement patterns and habitat preferences in New Hampshire. Home range sizes were calculated for 25 individual snakes and habitat selection was evaluated at multiple spatial scales. Population size was estimated for each site using mark-recapture methods.
The movement and habitat requirements of racers in New Hampshire have been documented by NHFG. Based on the multi-site assessment this data is likely to be applicable to most sites in New Hampshire.

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Brendan Clifford, NHFG, Michael Marchand, NHFG

2005 Authors:
Celine Goulet and Michael Marchand, NHFG

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Timber Rattlesnake

Crotalus horridus

Federal Listing	N/A
State Listing	E
Global Rank	
State Rank	S1
Regional Status	Very High

Photo by Brendan Clifford

Justification (Reason for Concern in NH)

The Northeast Endangered Species and Wildlife Diversity Technical Committee determined that the timber rattlesnake is a species of regional concern in the northeastern United States (Therres 1999). This species warrants federal endangered or threatened species listing consideration, including prelisting status reviews (Therres 1999). In New England, timber rattlesnakes are listed as extirpated in Maine and Rhode Island, and endangered in Connecticut, Massachusetts, Vermont, and New Hampshire. In New Hampshire, the timber rattlesnake is likely the most endangered of any wildlife species, as there is only one known extant population. Timber rattlesnakes have large home ranges, especially males, and individuals may be killed as they cross roads or as human-snake encounters increase. Southern New Hampshire is rapidly developing, and large undeveloped tracts of land needed to sustain timber rattlesnake populations are dwindling rapidly. As a result, opportunities for natural recolonization or restoration have been substantially reduced. More recently, an emerging snake fungal disease has been implicated in population declines of timber rattlesnakes in multiple northeastern states including the NH population.

Distribution

Rattlesnakes have been historically reported from scattered locations throughout the southern half of the state, extending into the White Mountains. Clusters of reports came from along the Connecticut River in the southwest corner of the state, along the Merrimack River, the Lakes Region, and from the edge of the White Mountains. Historic locations for timber rattlesnakes included Rattlesnake Island in Lake Winnipesaukee (reportedly the site of heavy nineteenth century persecution for the manufacture of rattlesnake oil (Oliver and Bailey 1939)), and other locations near the lake; the Mt. Thorn area in Bartlett (Allen 1899); Dan Hole Pond (Carle 1953) in Tuftonboro; Bear Brook State Park area of Allenstown and Hooksett; the Mt Wantastiquet and Rattlesnake Mountain areas of Hinsdale, Chesterfield, Swanzey and Winchester; and Fall Mountain in Walpole. Oliver and Bailey (1939) note that a NHFG Conservation Officer reported that rattlesnakes were occasionally killed in the Mt. Monadnock area, although these reports may not be confirmed.
In addition, there are many geographic features named for rattlesnakes in New Hampshire. Some of these were indeed probably named for the animal being present there, although one must bear in mind that almost all reports of rattlesnakes in recent times referred to milk snakes (Lampropeltis triangulum), a harmless snake which 'rattles' its tail against the ground when disturbed, making a sound that people may mistake for that of a rattlesnake.

There is now only one known extant population. No rattlesnakes were reported in NH from 1981 to 1991, despite efforts to search for them at locations that they had traditionally inhabited, e.g., Mt. Wantastiquet in Chesterfield, Dan Hole Pond in Tuftonboro (Carle 1958). In 1991, a forester

accurately reported a rattlesnake to Jim Taylor of the University of New Hampshire, and the den site was located in 1992.

Habitat

Timber rattlesnakes in the northeast spend the winter in a communal den, a rocky area with crevices leading to a hibernaculum below frost line (Brown 1993). They emerge from the den in May, and proceed to transient habitat, a relatively exposed rocky area where they can alternately bask and seek shelter from the sun; this may or may not be the den site. Males and non-gravid females often bask until the skin is shed, before making extensive movements into summer range habitat, often mixed deciduous forest. Gravid females are relatively sedentary and remain near exposed slopes and protective rocks until parturition, usually in September (Brown et al. 1982). Males pursue reproductive females by scent pheromone trails in order to mate with them, usually mid to late summer. The resulting copulations provide sperm that is retained through hibernation for next years' ovulation.

The timber rattlesnake is a sit-and-wait predator, primarily preying on small mammals and birds to a lesser extent (Ernst and Ernst 2003). All individuals of the population return to the den in September or October (NHFG Data). Depending on weather conditions, they may bask at the den, but they often go into the den immediately upon return. Young snakes may follow the scent trails of adults to find communal den sites (Reinert and Zappalorti 1988).

NH Wildlife Action Plan Habitats

- Appalachian Oak Pine Forest
- Rocky Ridge, Cliff, and Talus
- Hemlock Hardwood Pine Forest
- Shrublands

Distribution Map

Current Species and Habitat Condition in New Hampshire

The condition and viability of the one extant population has been studied extensively since 2006 by NHFG biologists. Greater than 30 individuals were identified and uniquely marked during the initial monitoring year. However, multiple snakes were observed basking late into the fall of 2006 with facial and body lesions that is suspected to have been an emerging fungal disease that resulted in mortality to some individuals (Clark et al. 2011). Since 2007 biologists have only observed an average of 9 individuals per year (range 4-14) despite a more intensive monitoring effort than 2006. Since the initiation of annual monitoring, facial and body lesions have been observed on several individuals (some lesions persisting for several years). Biopsies have been collected from some infected individuals for fungal and bacterial testing. In a genetic analysis, the NH population was found to have lower genetic diversity than multiple populations from New York (Clark et al. 2011).

Population Management Status

The population is monitored annually by NHFG to evaluate the population size, reproduction and the health of individual snakes. Several individuals have been treated for bacterial and fungal infections and released back into the wild. Radio telemetry has been used to monitor the recovery of treated individuals and to assess the general habitat-use and movement patterns of healthy individuals. A population recovery plan has been drafted.

Regulatory Protection (for explanations, see Appendix I)

- NHFG Rule FIS 803.02. Importation.
- NHFG Rule FIS 804.02. Possession.
- NHFG Rule FIS 811.01 Sale of Reptiles.
- Endangered Species Conservation Act (RSA 212-A)
- NHFG FIS 1400 Nongame special rules
- Fill and Dredge in Wetlands - NHDES
- Alteration of Terrain Permitting - NHDES

Quality of Habitat

At the known extant site, existing habitat quality is relatively high. Most of the summer range is undeveloped continuous mixed deciduous forest, some of which is in protected as conservation land, and road density is low. However, some extensive tracts of summer range habitat are on private land. Because rattlesnakes roam widely (> 5 km) (Brown 1993), one occasionally leaves the forested summer range and enters human development, where it may encounter humans.
Historically, several sites bearing the rattlesnake name were destroyed by gravel extraction activities or development.

Habitat Protection Status

The known den and many of the critical basking areas (as identified by NHFG) have been permanently protected. However, some of the remaining summer-range habitat remains unprotected.

Habitat Management Status

Habitat protection is a top priority for this species in New Hampshire. A site management plan is being drafted. Through targeted small-scale harvests, several potential basking areas (i.e., south-facing rocky hillsides) have been enhanced.

Threats to this Species or Habitat in NH

Threat rankings were calculated by groups of taxonomic or habitat experts using a multistep process (details in Chapter 4). Each threat was ranked for these factors: Spatial Extent, Severity, Immediacy, Certainty, and Reversibility (ability to address the threat). These combined scores produced one overall threat score. Only threats that received a "medium" or "high" score have accompanying text in this profile. Threats that have a low spatial extent, are unlikely to occur in the next ten years, or there is uncertainty in the data will be ranked lower due to these factors.

Disturbance from development that has resulted in reduced genetic variation (Threat Rank: High)

Healthy timber rattlesnake populations typically exist in a metapopulation structure where several over-wintering dens are used and snakes interact during the mating season in the summer habitat in-between. Developments that fragment dens reduces the genetic flow between den sites. Over time isolated populations may lose genetic diversity and show the effects of inbreeding depression.

Historically the remaining known site was likely part of a larger metapopulation. Over time, developments and human persecution have eliminated all former dens leaving the one remaining den which has been isolated for several decades (NHFG Data). In a genetics assessment the NH population was found to have lower genetic diversity than multiple populations from New York (Clark et al. 2011). Morphological abnormalities have been observed in some individuals suggesting inbreeding depression.

Mortality from human persecution and removal from population for collection (Threat Rank: High)

People tend to fear snakes, especially venomous species, and will kill snakes when they are encountered. In addition, because snakes congregate at den sites, knowledgeable collectors (commercial pet trade, personal use) are capable of depleting or eliminating local populations (Tyning 1992, Klemens 1993). In fact, one individual, Rudy Komarek, has reportedly greatly contributed to population depletions, including populations in New York and Massachusetts (Brown et al. 1994). The current New Hampshire population is vulnerable to illegal killing and collection. As a survivorship-limited species, loss of a single reproductive female from the remaining population may be enough to reduce the net reproductive rate below what is sustainable, leading to local and state extinction.

Unregulated take and persecution are undoubtedly the reasons behind extirpation of populations at traditional locations. Legislation once encouraged the killing of rattlesnakes, and zealous collectors and "bounty" hunters have decimated populations in the state. Several types of recreational activities have been observed on summer-range habitat including use by ATVs, hiking, biking, hunting and target shooting. Occasional human-snake encounters on trails surrounding the site have been reported.

Mortality and species impacts (decreased fitness) of individuals from various diseases (snake fungal disease) (Threat Rank: High)

Since the mid-1990's an increasing number of snakes in the Eastern United States have been observed with an apparent fungal skin infection that was often referred to as 'hibernation blisters'. As the number of reported cases has grown the infections have now been termed snake fungal disease (SFD). A novel fungus (*Ophidiomyces ophiodiicola*) has been identified in many individuals with suspected SFD and is thought to be the cause of mortality although some questions remain as to whether this species is the primary or secondary pathogen.

O. ophiodiicola has now been documented in more than 10 different snake species from 11 different states ranging from New Hampshire to Florida and as far west as Arkansas and Minnesota. The infections have been most commonly reported in rattlesnakes and as having a high mortality rate,

although some tracked individuals have survived multiple years and responded to treatment (NEPARC SFD Fact Sheet; NHFG Data). The single remaining NH timber rattlesnake population is estimated to have declined by 50% in the years following the initial observations of SFD in 2006 and 2007 (Clark et al. 2011). A northern ringneck snake and an eastern milk snake from the same site have also tested positive for *O. Ophiodiicola* in recent years (NHFG Data). This disease has also been a conservation concern for rattlesnake populations in Massachusetts (Tom French, personal communication) and Vermont (Doug Blodget, personal communication) and the disease has been fatal for infected massasuga rattlesnakes in Illinois (Matt Allender, personal communication).

Habitat conversion due to development of den and summer habitat (Threat Rank: Medium)

Residential and commercial developments may directly destroy habitat (den sites, basking sites, transient, summer range) required by local rattlesnake populations. As a result, prey sources may be reduced, preferred vegetation may be altered, and snakes may become more vulnerable to humans and other predators. NHFG may have to dedicate significant time to relocating snakes that are found in human developments. Automobiles can result in direct mortality of individuals (Aldridge and Brown 1995), and road construction near rattlesnake populations will increase access to those areas. Recreational demands (e.g., ATV, bike, and hiking trails) on private and public lands may also impact rattlesnake populations by increasing snake-human encounters.

Male rattlesnakes are especially vulnerable during mating season, when they are more likely to encounter humans and cross roads (Aldridge and Brown 1995). Multiple individuals have been found in residential developments in New Hampshire, at least two snakes being killed by local residents. A large portion of the summer-range habitat surrounding the known den is on unprotected land and residential and/or commercial developments will likely be proposed over time if these lands are not permanently protected.

Habitat conversion due to mining occurring at summer, den, or basking areas (Threat Rank: Medium)

Timber rattlesnakes congregate in den sites during winter. Extracting of gravel or rock at the den site will destroy a critical habitat component for local rattlesnake populations. In addition, large vehicles carrying rock and gravel could kill individual snakes if within transient or summer range habitat. In New Hampshire, there is only one known den site, so any disturbance to the den site or surrounding habitats could be catastrophic.

Several sites in New Hampshire having “rattlesnake” names have been destroyed by commercial mining extractions (e.g., Rattlesnake Mountain, Concord; Rattlesnake Hill, Hooksett).

Disturbance from increased precipitation in spring and summer that reduces basking opportunities (Threat Rank: Medium)

Increased precipitation over the course of the active season reduces basking opportunities, particularly for gravid or unhealthy snakes. Because timber rattlesnakes often bask for several weeks after emergence from hibernation, increased or heavy precipitation events in May or June are particularly problematic. Gravid females spend most of the summer basking on exposed rocky outcrops so a reduction in thermal quality may prolong the basking period or cause reproductive failure.

Record precipitation events for New Hampshire in 2005 and 2006 combined with an emerging snake fungal disease are suspected to have caused a significant decline in the NH population (Clark et al., 2011). The record rain in 2006 (commonly referred to as the Mother’s Day flood) occurred during spring emergence where precipitation was recorded every day for two consecutive weeks (NHFG

Data). In the month following the record precipitation, several snakes were observed basking for extended periods and many were observed with sores on the head and neck. Frequent precipitation that reduced basking opportunities is suspected to have contributed to the failure of three gravid females to produce live young from 2008-2010. Each female was documented giving birth to undeveloped ova (NHFG Data).

Mortality of individuals from vehicles on roadways (Threat Rank: Medium)

Roads fragment habitat, increasing mortality as snakes are forced to cross roads on a more frequent basis. Rattlesnakes are thick, heavy-bodied snakes and therefore are slow to cross roads (Andrews and Gibbons 2005). The loss of any adult from the NH population, particularly females, may have a dramatic effect on the population. While some low-traffic roads that bisect habitat patches may allow for snakes to cross with only occasional mortality, high intensity roads may isolate habitat patches.

Currently there are few public roads surrounding the extant site that could serve as potential threats. However, the private lands surrounding the site are susceptible to development and new roads.

Mortality of individuals from forestry equipment (Threat Rank: Medium)

Timber rattlesnakes have large home ranges and most summer activity is spent in mature deciduous or mixed forests. The vehicles used in commercial harvests may cause direct mortality of snakes.

Snakes have been routinely observed in forested habitat through incidental observations and the use of radio telemetry, with some locations more than one mile from the known den. In recent years forestry operations have been observed on private and conserved public lands within one mile of the den.

Mortality and disturbance from increased recreation (hiking, mountain biking, OHRV) (Threat Rank: Medium)

Brown (1993) found that snakes avoided basking sites that were disturbed by humans. Disturbance to gravid females may reduce reproductive success (Parent and Weatherhead 2000). Recreational activities that result in human-snake encounters may end with snakes being killed. Many people have an irrational fear or hatred toward snakes, and this me be amplified when encountering a venomous species.

Multiple types of recreational activities have been documented within the dispersal range of the known population. Activities include the use of ATVs, mountain-biking, hiking, camping, hunting and target shooting. Human-snake encounters are known to have occurred with ATV riders and hikers. Through radio telemetry several individuals have been observed crossing or basking near trails that are frequented by ATV's (NHFG Data). Hikers have reported rattlesnakes to NHFG from a known basking area and several recreational trails.

List of Lower Ranking Threats:

Actions to benefit this Species or Habitat in NH

Conduct habitat management at the extant site to improve basking opportunities.

Primary Threat Addressed: Disturbance from increased precipitation in spring and summer that reduces basking opportunities

Specific Threat (IUCN Threat Levels): Climate change & severe weather

Objective:
Conduct targeted habitat management to improve basking opportunities for gravid females.

General Strategy:
Suitable basking areas at the den or surrounding sites are critical to gravid females. Non-gravid individuals also use these sites while shedding their skin or to combat the effects of fungal infections. In lieu of natural disturbances (e.g., fire, hurricanes) basking areas may become shaded through natural forest succession. Once identified, these sites should be maintained with an open canopy with the use of hand-felling to minimize disturbance to basking rocks. Management on rocky hillsides should occur during the inactive period (November-March) to avoid disturbing basking snakes. During the summer months rattlesnakes spend the majority of their time in mature hardwood or mixed forests. Timber harvests that occur in these areas should leave at least a 50% canopy cover.

Political Location:
Statewide

Watershed Location:
Statewide

Increase the genetic diversity at the extant site

Primary Threat Addressed: Disturbance from development that has resulted in reduced genetic variation

Specific Threat (IUCN Threat Levels): Residential & commercial development

Objective:
Conduct population management to maintain a viable population

General Strategy:
Captive breeding has been successfully initiated for other endangered fauna in New Hampshire (e.g., New England cottontail, Karner blue butterfly) and could be applied to timber rattlesnake conservation. Goals of captive breeding would include maintaining a genetic stock of New Hampshire rattlesnakes, in the event that a catastrophic event occurs in the natural population. Captive-bred individuals could also be used to augment the natural population, both in terms of number of individuals and genetic material. Appropriate methodology for breeding and releasing individual snakes would require detailed discussion prior to taking any actions.

Political Location:
Statewide

Watershed Location:
Statewide

Monitor the known population for prevalence and impact of SFD and other wildlife diseases.

Primary Threat Addressed: Mortality and species impacts (decreased fitness) of individuals from various diseases (snake fungal disease)

Specific Threat (IUCN Threat Levels): Invasive & other problematic species, genes & diseases

Objective:
Evaluate the health of individual snakes and provide treatment as necessary.

General Strategy:
Evidence of SFD has been observed in the NH population since 2006. All snakes that are encountered should be visually inspected with binoculars or by hand and photographed to determine the presence of lesions. Collect samples for disease testing and rehabilitate individual snakes as necessary. Follow rehabilitated snakes with radio-telemetry to determine behavior and survival.

Political Location:
Statewide

Watershed Location:
Statewide

Annually monitor the population to access the population structure, reproductive output and health of individuals.

Objective:
Monitor the population to detect changes that may require conservation actions

General Strategy:
Conduct annual den surveys (visual surveys, time-lapse photography) in the spring and fall to document the population size. Mark all encountered individuals with PIT tags to determine survival. Identify gravid females that become established at basking areas and document reproductive success. Use radio-telemetry to follow adult and juvenile snakes to document habitat use and to monitor the health of individuals.

Political Location:
Statewide

Watershed Location:
Statewide

Monitor the known site for illegal activity and enforce violations of the NH ESA

Primary Threat Addressed: Mortality from human persecution and removal from population for collection

Specific Threat (IUCN Threat Levels): Biological resource use

Objective:
Protect the population from human persecution.

General Strategy:
Continue to actively pursue and enforce violations that involve humans illegally killing rattlesnakes. Monitoring of the local population will help determine what habitat should be reviewed and protected during NHFG's review of proposed developments.

Political Location:
Statewide

Watershed Location:
Statewide

Provide education and technical assistance to landowners in close proximity to the extant population

Primary Threat Addressed: Mortality and disturbance from increased recreation (hiking, mountain biking, OHRV)

Specific Threat (IUCN Threat Levels): Human intrusions & disturbance

Objective:
Protect individual snakes from human persecution.

General Strategy:
Information about the perilous state of the rattlesnake in New Hampshire should be made available to those close to (e.g., residential neighborhoods) or working in the summer range of occupied timber rattlesnake habitat (e.g., foresters), and the general public (NHFG website, press releases), along with information about rattlesnake biology, contact information in case a rattlesnake is encountered, and penalties for harming, harassing, or killing a rattlesnake. However, secrecy about the exact location is critical in preventing unscrupulous people from destroying individuals or critical habitat components (Brown 1993).

Political Location:
Statewide

Watershed Location:
Statewide

Work with landowners and foresters to implement forestry BMPs to minimize impacts to rattlesnakes

Primary Threat Addressed: Mortality of individuals from forestry equipment

Specific Threat (IUCN Threat Levels): Biological resource use

Objective:
Protect individual snakes from mortality during forestry operations.

General Strategy:
Snakes from the existing site may spend extended periods during the summer months on private lands where forestry may occur. Timber rattlesnakes are slow moving and vulnerable to being hit by forestry equipment. NHFG should keep in contact with landowners and foresters regarding plans for timber harvests and conduct site walks as necessary. Mid-October through March are preferred time periods for forestry operations to avoid mortality to individual snakes.

Political Location:
Statewide

Watershed Location:
Statewide

Restore historic den sites within snake dispersal distance from the extant den

Primary Threat Addressed: Disturbance from development that has resulted in reduced genetic variation

Specific Threat (IUCN Threat Levels): Residential & commercial development

Objective:
Create a metapopulation structure to increase the viability of the population

General Strategy:
Timber rattlesnake populations are known to exist in a metapopulation structure, with several den sites within dispersal distances of each other. Although only one known den remains there is enough suitable habitat to support a metapopulation. Historic den sites within this complex are known and should be targets of restoration.

Political Location:
Statewide

Watershed Location:
Statewide

Conduct presence surveys at known historic sites

Primary Threat Addressed: Habitat conversion due to mining occurring at summer, den, or basking areas

Specific Threat (IUCN Threat Levels): Residential & commercial development

Objective:
Identify populations so conservation measures can be taken.

General Strategy:
Some sites that historically supported rattlesnake populations have high quality habitat that remains. Timber rattlesnakes are long-lived species with an average life span of 20-25 years (Brown 1993) and have been documented to live over 40 years in the wild (Bill Brown, personal communication). Small remnant populations located in remote or difficult to navigate areas (i.e., talus slopes) with large tract of undeveloped land may go unnoticed. Multiple surveys conducted during spring and fall may be needed to document an extant population.

Political Location:
Statewide

Watershed Location:
Statewide

Protect all the known basking areas and summer range habitat of the extant population

Primary Threat Addressed: Habitat conversion due to development of den and summer habitat

Specific Threat (IUCN Threat Levels): Residential & commercial development

Objective:
Protect suffcient habitat to maintain natural movement corridors and minimize snake-human encounters

General Strategy:
Habitat protection will be critical to the future survival of timber rattlesnakes in New Hampshire. Ideally, all habitat used by female rattlesnakes should be protected, along with known habitat used by male snakes, and dispersal corridors to other historic or potential den locations. The den site and

some basking areas are protected at the remaining extant site but several hundred acres of potential basking and summer habitat surrounding the den remain unprotected. Land values in southern New Hampshire are high, and a large land purchase will require a coordinated effort among state agencies, conservation agencies, municipalities, and private funding.

Political Location:
Statewide

Watershed Location:
Statewide

References, Data Sources and Authors

Data Sources

The major sources of information included the authors' professional experiences, scientific literature, historic newspaper articles, and personal communications with current experts and laymen.
The site has been annually monitored by NHFG biologists, expert naturalists, and conservation officers since 2006. Other sources of information include a timber rattlesnake assessment for the White Mountain National Forest (Sweeney and Marchand 2002), historical documents (Oliver and Bailey 1939, Carle 1958), and an on-site assessment conducted by Bill Brown (Brown 2002). A genetics assessment of the known populations was conducted in 2010 (Clark et al 2011).Threat assessments were conducted by a group of NHFG biologists (Michael Marchand, Brendan Clifford, Loren Valliere, Josh Megysey).

Data Quality

Historical occurrence data are good, although the extent to which geographic features with 'rattlesnake' in their names actually attest to existence of the animals at that location is uncertain. In addition, not all historic den sites within larger known metapopulations are likely documented. Several individual rattlesnakes from the extant population have been monitored with radio-telemetry in recent years but data on extensive summer range movements is lacking, especially for males. Hibernacula and important basking sites are known, but unknown sites may exist. The condition of several historically occupied den sites has been evaluated, but other sites need further field surveys.

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2005 Authors:

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Blanding's Turtle

Emydoidea blandingii

Federal Listing	N/A
State Listing	E
Global Rank	G4
State Rank	S1
Regional Status	Very High

Photo by Loren Valliere

Justification (Reason for Concern in NH)

The Blanding's turtle is of conservation concern throughout its range (NEPARC 2010, Jones and Willey 2013). Most eastern populations appear to number under 50 adult turtles (Compton 2007), with very few exceeding 100 adults. Blanding's turtles are listed as threatened in Massachusetts and New York, and endangered in Maine and New Hampshire. In 2012, Blanding's turtles were included in a multi-species petition to the USFWS for Federal listing under the ESA (Center for Biological Diversity 2012). In 2013 the IUCN upgraded the species from "Near Threatened" to "Endangered" (Willey and Jones 2014). Within New Hampshire, Blanding's turtle habitat overlaps with the highest human population densities. Therefore, turtles are extremely vulnerable to rapid development, especially where road density and traffic volume is high. Like most turtles, Blanding's turtles are long-lived (up to 77 years in the wild; Brecke and Moriarty 1989) and are characterized by a late age of sexual maturity (14-20 years for female Blanding's turtles; Congdon and van Loben Sels 1993), relatively low fecundity (average 13 eggs per year, DePari et al. 1987, Congdon et al. 1983), and high rates of adult survival. Small increases in annual adult mortality (as little as 2-3%, Congdon et al. 1993, Gibbs and Shriver 2002), especially among females, can have catastrophic effects on populations. Because Blanding's turtles require large mosaics of wetland and upland habitats with relatively limited development, they are an important umbrella species for wetland habitat and species protection in the Northeast (Willey and Jones 2014). Associated SGCN and more common wetland species will benefit from conservation actions for Blanding's turtles. **Distribution**

Populations of Blanding's turtle exist outside of the northeast, from southern Ontario, south through Wisconsin, to Michigan, Minnesota, Ohio, Indiana, Illinois, Iowa, and Nebraska. Peripheral populations exist in Missouri and Pennsylvania and isolated populations of Blanding's turtles occur in Nova Scotia, New York, and New England (Ernst et al. 1994). In New England, Blanding's turtles are restricted to eastern Massachusetts, southeast and south-central New Hampshire, and south-coastal Maine. The core of the northeast Blanding's turtle population (approximately 40%) is southeastern and south-central New Hampshire, where most towns have multiple records.

NH populations are scattered in areas of suitable, connected wetland habitats. Populations in the southeast part of the state are commonly fragmented by roadways. Surveys conducted in 2011-2014 detected Blanding's populations from Kingston and Exeter north to Barrington and Strafford; west to Dunbarton and New Boston; and south to areas of Londonderry, Litchfield, Hollis and Brookline. Most towns within Rockingham, Stafford, Merrimack, and Hillsborough counties have at least one verified report of Blanding's turtle. More information is needed to assess the occurrence of Blanding's turtlepopulations in Cheshire, Belknap, and Carroll counties.

Occasional reports are received from periphery towns, such as areas of the Lakes Region, but recent surveys did not detect any individuals. Two reports came from the town of Sandwich in 2014, representing the furthest verified northern report of Blanding's turtle to date. Reports from the towns

of Fitzwilliam and Jaffrey represent the farthest westerly-reaching reports to date. Historic reports (before 1993) without any recent documentation include the towns of Moultonborough, Boscawen, and Seabrook.

Habitat

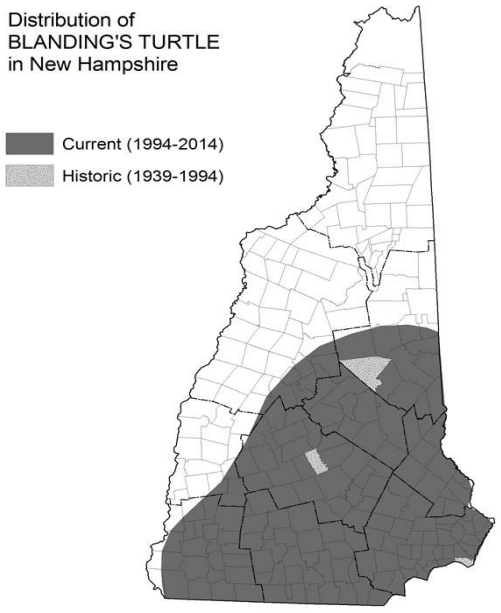
Blanding's turtles require large intact landscapes consisting of a diversity of wetland types and sizes, sandy open areas for nesting, and limited human disturbance (such as roads and associated threats) (Joyal 1996, Jenkins and Babbitt 2003). Preferred aquatic habitats include marshes, vegetated ponds, forested and shrub swamps, fens, oxbows, and vernal pools (Ernst et al. 1994, Fowle 2001). Blanding's turtles are often associated with buttonbush swamps, highbush blueberry-winterberry shrub thickets, and deep marshes with emergent vegetation, particularly duckweed (Lemna) (Sperduto 2004, Jenkins and Babbit 2003, Ross and Lovich 1992). Slow moving streams and rivers may be important for dispersal and travel between wetlands (Southwell 2002). Adults prefer clean water with a soft organic bottom and abundant aquatic vegetation (Ross and Anderson 1990, Ernst et al. 1994).

Habitat use may shift seasonally and vary geographically. Vernal pools are used extensively in spring and summer (Joyal 1996), and when summer temperatures are high, Blanding's turtles may become relatively inactive. During this time, turtles may be resting in the bottoms of vernal pools, shrub swamps, marshes, and ponds (Joyal 1996, Graham 1999, Fowle 2001).

Female turtles lay eggs in upland habitats, usually between late May and early July. Suitable nest sites include an open canopy with sand, loam, or gravelly substrate (Graham 1999). Human-altered sites (e.g, pastures, road edges, yards, gardens, gravel pits, and power line right of ways) are often used (Linck et al. 1989, Joyal 1996, Jenkins and Babbitt 2003, Beaudry et al. 2010). Hatchlings may rest in moss, leaf litter, and grass tussocks prior to migrating from nesting areas to aquatic habitats (Butler and Graham 1995). Juveniles may use shallower habitats, utilizing marsh edges and shrubby wetlands that provide refugia from predators (Pappas and Brecke 1992, Congdon and Kenaith 2006).

NH Wildlife Action Plan Habitats

- Marsh and Shrub Wetlands
- Vernal Pools
- Floodplain Habitats
- Peatlands
- Temperate Swamps



Distribution Map

Current Species and Habitat Condition in New Hampshire

Generally, larger populations of Blanding's turtles are found in the more extensive wetland complexes

than in smaller, more fragmented wetland areas. Turtles captured during surveys were marked with a unique identification code, so that individual turtles can be tracked, and populations can be evaluated in subsequent years. In-hand assessments of individual Blanding's turtle health occasionally revealed healed-over shell cracks from being hit by vehicles, and missing limbs presumably from escaping a predator. Vehicle injuries were observed even at sites that appeared less fragmented. The majority of Blanding's turtles captured were adults (greater than 14 years old), but small turtles may have been able to escape traps easier than larger adult turtles, or may use different areas than adult turtles (Congdon and Kenaith 2006).

NHFG also received many reports through the Reptile and Amphibian Reporting Program (RAARP) that helped fill in population information. Among 828 records (Element Occurrences) in the NHNHB Rare Species Database (as of 12 March 2015), 63 are considered historic (before 1995). Many of these are reports of Blanding's turtles on roadways. See 'Quality of Habitat' section for additional information.

Population Management Status

Possession of Blanding's turtles, including manipulation of individuals for research, requires a permit from NHFG. Previous population studies have occurred in New Hampshire: D. Carroll conducted a field investigation for rare turtles (i.e., Blanding's, spotted, Clemmys guttata, and wood, Glyptemys insculpta) in the Great Bay and Lamprey River areas; and an extensive multi-year Blanding's turtle research project was conducted in two areas of New Hampshire: central New Hampshire (Dunbarton, Weare, Hopkinton) and southeastern New Hampshire (Lee, Durham, Newmarket; Jenkins and Babbitt 2003). The New Boston Air Force Station has investigated habitat use and movement of Blanding's turtles on their property (Najjar and Drake 2014).

The Competitive State Wildlife Grant-funded regional project launched in 2011 provided NH and cooperating states with present-day baseline information on Blanding's turtle's distribution and abundance in the Northeast. This project allowed NH to rank and prioritize Blanding's turtle sites for conservation actions and site-specific plans, and evaluated the influence of habitat and landscape characteristics on population size and structure (Willey and Jones 2014). Priority sites were determined based on the habitat quality and the number of Blanding's turtles observed at the site. For high-priority sites, management plans were created that detail the baseline data collected, include population management goals, and suggest best management practices for conserving Blanding's turtles and their habitat on-site. Management plans include ongoing intervals of population assessment, habitat assessment, and threat assessment. The Northeast Blanding's Turtle Working Group is facilitating implementation of management plans.

Protective screening has been placed over Blanding's turtle nests to prevent predation in some areas, but this effort has not been practiced at a large scale. NHFG and partners have created sandy nesting openings in certain areas near suitable wetlands to reduce the need for adult turtles to cross roads and dangerous terrain to access nesting areas.

NHFG purchased 'turtle crossing' signs to place at areas where roads cross or are adjacent to suitable wetlands. A pilot project was launched in the town of Newmarket in 2014, where signs were strategically placed in these areas. The effectiveness of the signs to alert motorists and reduce vehicle speed still needs to be assessed.

Regulatory Protection (for explanations, see Appendix I)

- CITES - Convention on International Trade of Endangered Species of Wild Fauna and Flora

- NHFG Rule FIS 803.02. Importation.
- NHFG Rule FIS 804.02. Possession.
- NHFG Rule FIS 811.01 Sale of Reptiles.
- Endangered Species Conservation Act (RSA 212-A)
- NHFG FIS 1400 Nongame special rules
- Fill and Dredge in Wetlands - NHDES
- Clean Water Act-Section 404
- Alteration of Terrain Permitting - NHDES

Quality of Habitat

Known Blanding's turtle sites were ranked using factors such as site area, within-site habitat fragmentation, within-site habitat abundance and quality, surrounding landscape context, percent of the site that is protected and other conservation measures already underway (Willey and Jones 2014). Within-site habitat fragmentation was calculated by looking at the percent of site area that had at least low intensity development, the percent of impervious surface cover, and road density within the site. The presence and intensity of roads is a major threat and influences the quality of an area for Blanding's turtles. These sites were then fit into one of four categories: high priority, mid-priority, supporting landscape (those sites offering connectivity between high priority sites), and non-priority sites – consisting of unknown (single observation) sites and fragmented sites. Genetically distinct sites were also included as high priority sites, as well as those that are geographically isolated. Thirty-two percent of New Hampshire's Blanding's turtle habitat is considered high priority. Forty percent of the state's habitat area falls into the mid-priority category, and 18% of the state's habitat area falls into the 'supporting landscape' category.
Approximately 38% of the known Blanding's turtle habitat in the Northeast region falls within the 36 high priority sites and 31% falls within the 85 mid-category sites. All sites are important to the long-term conservation of Blanding's turtles in the region (Willey and Jones 2014) but actions will need to be prioritized among sites.

Habitat Protection Status

Within High Priority Blanding's turtle habitats, 37% of this habitat is currently protected. 14% of Mid-tier sites are currently protected, and 9% of Supporting Landscape habitats are protected (Willey and Jones 2014). Statewide, out of 143,586 hectares of known Blanding's turtle habitat, 20% of this is conserved.

Habitat Management Status

Habitat management specifically for Blanding's turtles has increased in recent years, as their distribution and needs have become better understood. The species has been targeted for management on some lands protected by groups such as the Great Bay Partnership and Southeast Land Trust.

Artificial nesting areas have been created in some areas as part of mitigation during NHFG review of wetland impacts. Nesting areas were created at two NH Blanding's turtle sites in 2012, and monitoring of suitable nesting areas has occurred at mid- and high-priority sites. Nesting areas have been created on other lands, including some owned by the Army Corps of Engineers and the Natural Resource Conservation Service, but use of these nesting areas is unknown. A nesting study in Maine found that Blanding's turtles were more likely to use anthropogenic nest sites where they were available, and some turtles will use new nesting areas as they become available (Beaudry et al. 2010). A set of best management practices for Blanding's turtles was created for land managers. Nest Site Management and Creation Guidelines, Forestry Guidelines, and Recreation Guidelines are available at

www.blandingsturtle.org. A Blanding's-specific brochure developed in coordination with UNH Cooperative Extension highlights these practices and is available for landowners at http://extension.unh.edu/WildlifeBrochures.

As part of the Blanding's turtle project, site-specific management plans were created for high-priority sites in southern New Hampshire. NHFG will continue to coordinate with site managers to implement habitat management including increasing connectivity of wetlands, promoting attention to the timing of wetland drawdowns (avoiding winter months), reducing road mortality by upgrading road culverts and bridges, and creating nesting areas.

Threats to this Species or Habitat in NH

Threat rankings were calculated by groups of taxonomic or habitat experts using a multistep process (details in Chapter 4). Each threat was ranked for these factors: Spatial Extent, Severity, Immediacy, Certainty, and Reversibility (ability to address the threat). These combined scores produced one overall threat score. Only threats that received a "medium" or "high" score have accompanying text in this profile. Threats that have a low spatial extent, are unlikely to occur in the next ten years, or there is uncertainty in the data will be ranked lower due to these factors.

Habitat impacts from development of surrounding uplands (Threat Rank: High)

Blanding's turtles use a mosaic of wetland, aquatic, and upland habitats, often traveling a mile or more among them. Thus, a large amount of land is required to protect a population. Reduction in habitat quality or availability may harm populations by causing indirect mortality due to increased dispersal across inhospitable habitat, increased predation, and increased desiccation.

In late May to early July, female turtles leave wetlands in search of an area with an open canopy and bare ground to lay eggs. If nesting habitat is not connected to occupied wetland habitat, adult mortality may occur. Humans and their pets can disturb nesting females and their eggs, and although turtle populations are less sensitive to egg survival than to adult survival, high nest mortality or lack of nesting habitat may harm populations.

Blanding's turtles may use human-modified areas such as gravel pits, residential lawns, and agricultural areas, for nesting. Thus, adults in these areas are vulnerable to predation, road mortality, disturbance, and mowing equipment (Marchand and Litvaitis 2004a). Nests near some ecological edges, such as those nearby to development, may also be more vulnerable to predation (Temple 1987).

Regional population declines have been exacerbated by upland habitat fragmentation and degradation by development (Compton 2007). An estimated 21,000 ha (51,000 acres) were required to maintain viable populations of Blanding's turtles in Maine (McCollough 1999). Although smaller areas may protect species where populations are denser (Fowle 2001), large blocks of connected habitat are needed to protect Blanding's turtles.

Because Blanding's turtles often use vernal pools and uplands, protection only of large wetlands is not adequate to protect Blanding's turtles (Southwell 2002). New Hampshire has been the fastest growing state in the northeast in recent decades, and development in the southern part of the state is consuming open space at a rapid rate (SPNHF 2014). New Hampshire state regulations are currently ineffective at protecting species that use large wetland complexes, and building and disturbance setbacks from freshwater wetlands are not required under New Hampshire state wetland regulations (except for septic setbacks). Where setbacks or buffers do occur at the town level, they are not sufficient to protect wide ranging species such as Blanding's turtles without a larger scale planning effort.

Mortality of individuals from vehicles on roadways (Threat Rank: High)

Human population density and development is rapidly increasing in southern New Hampshire (SPNHF 2014). Increases in road densities and traffic volume pose direct threats to turtles, which are slow to cross wide roads. Small annual losses of only a few adult Blanding's turtles may result in population extirpation.

Blanding's turtles are capable of dispersing long distances through upland habitats (Joyal et al. 2001, Jenkins and Babbitt 2003), and roads that intersect turtle home ranges will increase the chance of individuals being killed on roads. Many Blanding's turtle records (Element Occurrences) known from New Hampshire consist entirely of individuals observed on roads. Additionally, low population densities and skewed age and sex ratios have raised concerns over the effect of road mortality on some turtle populations in the region (e.g., Joyal et al. 2000, Marchand and Litvaitis 2004a, Gibbs and Steen 2005).

Computer modeling suggests that road densities as low as 1 km/ km2 with fewer than 100 vehicles per lane per day will cause excessive loss of semiterrestrial turtles (e.g., *Emydoidea*, Gibbs and Shriver 2002). Although density may be a good initial surrogate for investigating habitat quality, factors such as road width, traffic speed and volume, and position in the landscape should also be considered. Road shoulders, because of the availability of bare soil and open canopies, may attract nesting turtles, increasing the opportunity for road crossings of adult and hatchling turtles. Also, steep-sloping granite curbing can trap turtles on roadways and can decrease the chance of individuals successfully crossing roadways (Najjar, New Boston Air Force Base, personal communication).

Habitat conversion from the direct filling of wetlands for development (Threat Rank: Medium)

Filling of wetlands to produce flat, developable land directly removes Blanding's turtle habitat. Reduction in habitat quality or availability may harm populations by causing direct mortality of individuals or indirect mortality due to increased dispersal across inhospitable habitat, increased predation, and increased desiccation.

It's estimated that around 20,000 acres of wetlands have been historically lost from New Hampshire (Environmental Law Institute 2008). Under the Fill and Dredge in Wetlands Act, NHDES requires a permit for dredge, fill, or construction in any size wetland. NH DES receives around 2,600 permit applications each year for dredge, fill, or construction in wetlands, and approximately 95% are approved (Environmental Law Institute 2008). For projects that impact over 10,000 square feet of wetland, some mitigation is typically required.

An estimated 21,000 ha (51,000 acres) were required to maintain viable populations of Blanding's turtles in Maine (McCollough 1999). Although smaller areas may protect species where populations are denser (Fowle 2001), large blocks of connected habitat are needed to protect Blanding's turtles. As southern New Hampshire develops, wetlands will be threatened by myriad stressors (see Marsh and Shrub Wetland Profile). Although extensive marshes are not likely to be filled, small vernal pools can easily be overlooked during environmental reviews of dredge and fill permit applications (M.N. Marchand, personal observation).

Mortality from casual collection of individuals from the wild or moving animals to a different location (Threat Rank: Medium)

Individual turtles are removed from local populations, and because populations depend on high adult survival, removal can lead to local extinction. This can range in severity from individuals picking up a Blanding's turtle to take home as a pet, or picking up a Blanding's turtle and unknowingly moving it to

unsuitable habitat in a different area.

NHFG has evidence of casual collection of Blanding's turtles in New Hampshire. Casual collection and relocation of individual Blanding's turtles is probably more common than is documented, and NHFG receives several reports of this every year. People may move turtles to distant wetlands, ponds, or lakes, and may occasionally keep Blanding's turtles as pets. Lakes, rivers, and open water ponds are unsuitable for Blanding's turtles, and moving turtles to these habitats likely causes dispersal in search of a suitable wetland, leaving the turtle vulnerable to other threats like road mortality and predation.

Mortality from the commercial collection of individuals from the wild (Threat Rank: Medium)

Commercial collection of Blanding's turtles includes any capture of Blanding's turtles with intent to sell the animal. Individual turtles are removed from local populations, and because populations depend on high adult survival, removal can lead to local extinction. This can range in severity from one Blanding's turtle being sold within the state, to larger-scale collections that sell turtles elsewhere in the country or even overseas.

Large-scale commercial collection of Blanding's turtles appears to be low, but NHFG has evidence of commercial collection of Blanding's turtles in New Hampshire as recently as 2013. In the past, reptile dealers have advertised Blanding's turtles for sale in New Hampshire (Levell 2000). Adult Blanding's turtles are probably the most commonly collected, since they are easily captured particularly when on land. Commercial collection in New Hampshire is worth further investigation and enforcement.

Habitat conversion and mortality from the removal of beaver and human-made dams (Threat Rank: Medium)

The removal of beaver dams or some human-made dams can result in reduced wetland habitat quality or availability. Often, beavers build dams in small streams or rivers that flood an area, creating a suitable shrub-wetland type of habitat that can be occupied by Blanding's and other turtles. When beaver dams are removed, flooded wetland area is typically reduced which reduces habitat suitability for Blanding's turtles. Removal of human dams may reduce or improve habitat quality depending on the availability of suitable wetland habitat before and after dam removal. This reduction in habitat quality or availability may harm Blanding's turtle populations by causing indirect mortality due to increased dispersal across inhospitable habitat, increased predation, and increased desiccation. Removal of dams can also lead to direct mortality of individual turtles, especially if done during winter months when turtles are hibernating. If a wetland draw-down occurs during this time, turtles can be left without protection from the elements and may not survive through hibernation.

Blanding's turtles move to overwintering sites in bogs, fens, marshes or ponds in September and October (Edge et al 2009). Blanding's turtles have been observed using vernal pools and beaver ponds for overwintering sites in NH. During hibernation, turtles are vulnerable to metabolic and respiratory failure, freezing, and predation (Edge et al. 2009). They remain mostly inactive in the substrate of these slow-moving, low oxygen environments until April or May, depending on the weather.
In New Hampshire, landowners may remove beaver dams to protect their property often with minimal approval or review process. Wetland drawdowns, especially those conducted in fall, may expose Blanding's turtles to predation, winterkill, and road mortality (Hall and Cuthbert 2000), especially where dispersing individuals are surrounded by dense development (Marchand and Litvaitis 2004a).

List of Lower Ranking Threats:

Mortality and species impacts (reduced fitness) from impervious surface run-off

Mortality and species impacts (decreased fitness) from various diseases (ranavirus)

Mortality from subsidized or introduced predators

Habitat degradation from introduced or invasive plants

Mortality from subsidized or introduced predators

Habitat degradation due to wetlands manipulation

Habitat conversion and mortality from the removal of beaver and human-made dams

Habitat conversion and mortality from drawdowns of lakes and ponds

Mortality and degradation from legal and illegal OHRV activity

Mortality of individuals from forestry equipment

Habitat degradation and conversion from forestry practices

Mortality from mowing and agricultural machinery and vehicles

Species impacts from increased temperatures that reduce suitability for temperature-intolerant species

Disturbance from increased cold temperatures that reduce embryonic development

Habitat and species impacts from fragmentation

Actions to benefit this Species or Habitat in NH

Enforce wildlife regulations

Primary Threat Addressed: Mortality from the commercial collection of individuals from the wild

Specific Threat (IUCN Threat Levels): Biological resource use

Objective:
Enforce wildlife regulations pertaining to the illegal collection, possession, or sale of Blanding's turtles in New Hampshire.

General Strategy:
In NH, it is illegal to kill, harm, possess, collect, or sell a Blanding's turtle without a permit from the NHFG. The species is also protected in every other state in the Northeast where it occurs, by the USFWS Lacey Act and internationally via CITES. Because the removal of one individual Blanding's turtle from the wild can impact local populations, enforcement of rules and laws pertaining to this species are particularly important. NHFG biologists will work with NHFG law enforcement staff to identify violations and enforcement actions. NHFG staff will also work with neighboring states to identify origin of animals during confiscations.

Political Location:
Statewide

Watershed Location:
Statewide

Location Description:
Species is illegal to possess statewide even though it may not occur in wild statewide.

Outreach to landowners

Primary Threat Addressed: Mortality from casual collection of individuals from the wild or moving animals to a different location

Specific Threat (IUCN Threat Levels): Biological resource use

Objective:
Provide information on the status and risks of species via various media outlets to educate public on importance of not collecting or moving turtles.

General Strategy:
NHFG will increase landowner knowledge of the species' status and threats by developing materials and messages on various media including Facebook, NHFG webpage, and press releases to other media outlets (newspaper, radio, television).

Political Location:
Hillsborough County, Merrimack County, Rockingham County, Strafford County

Watershed Location:
Merrimack Watershed, Coastal Watershed

Location Description:
Species range in NH.

Minimize road mortality to Blanding's turtles

Primary Threat Addressed: Mortality of individuals from vehicles on roadways

Specific Threat (IUCN Threat Levels): Transportation & service corridors

Objective:
Minimize mortality of Blanding's turtles on roadways.

General Strategy:
NHFG will work with NHDOT, NHDES, towns, and other partners to minimize road mortality of Blanding's turtles on roadways. Specific targeted actions will include: avoid placement of new roads in priority Blanding's turtle landscapes, avoid upgrading unpaved roads to paved surfaces in priority Blanding's turtle landscapes, designing roadways to minimize mortality such as avoiding use of steep curbing, upgrading culverts/underpasses to increase opportunities for safe passage of turtles, place turtle crossing signs to educate motorists in priority Blanding's turtle areas, and manage vehicle speed by reducing speed limits or installing speed bumps. Priority landscapes for implementation will need to be assessed using a combination of habitat modelling, turtle road crossing data, and local knowledge.

Political Location:
Hillsborough County, Merrimack County,

Watershed Location:
Merrimack Watershed, Coastal Watershed

Rockingham County, Strafford County

Location Description:
Blanding's turtle range within NH

Encourage alternatives to dewatering wetlands potentially occupied by Blanding's turtles.

Primary Threat Addressed: Habitat conversion and mortality from the removal of beaver and human-made dams

Specific Threat (IUCN Threat Levels): Natural system modifications

Objective:
Encourage alternatives to dewatering wetlands potentially occupied by Blanding's turtles.

General Strategy:
Blanding's turtles use a variety of wetland types, many of which are influenced by beaver or human constructed dams. Dewatering wetlands occupied by Blanding's turtles can result in a reduction in habitat, reduced habitat quality, and mortality to individuals from desiccation, freezing, predation, or road mortality associated with increased overland travel. Drawdowns or dam removal during hibernation months (October - April) could result in mortality to hibernating turtles. Therefore, alternatives that maintain suitable wetland habitat, especially during hibernation periods, are encouraged.

Political Location:
Grafton County, Hillsborough County, Merrimack County, Rockingham County, Strafford County

Watershed Location:
Merrimack Watershed, Coastal Watershed

Location Description:
Blanding's range in NH

Identify priority habitat at Blanding's turtle sites.

Objective:
Identify priority Blanding's turtle areas.

General Strategy:
Use a combination of habitat modelling, radiotelmetry, and site assessments to evaluate site conditions and importance for Blanding's turtle populations. At priority sites where nesting areas not known, mature females should be tracked via radiotlemetry.

Political Location:
Hillsborough County, Merrimack County, Rockingham County, Strafford County

Watershed Location:
Merrimack Watershed, Coastal Watershed

Conserve priority Blanding's turtle parcels

Primary Threat Addressed: Habitat and species impacts from fragmentation

Specific Threat (IUCN Threat Levels): Residential & commercial development

Objective:
Conserve priority Blanding's turtle parcels.

General Strategy:
A conservation plan has been developed (Willey and Jones 2014) that identified priority Blanding's turtle sites and parcels. These sites will be updated over time as new information becomes available. Priority sites will be incorporated into NH Wildlife Action Plan revision maps and incorporated into state land conservation funding consideration (e.g., Aquatic Resource Mitigation Fund, LCHIP). NHFG staff will provide technical assistance to land trusts and towns in identifying and conserving priority parcels. NHFG staff will also provide technical assistance in developing management objectives compatible with Blanding's turtle conservation.

Political Location:
Grafton County, Hillsborough County, Merrimack County, Rockingham County, Strafford County

Watershed Location:
Merrimack Watershed, Coastal Watershed

Northeast Blanding's turtle working group

Objective:
NHFG should continue participation in Northeast Blanding's turtle working group and other national or internal initiatives to conserve the species.

General Strategy:
A Northeast Blanding's turtle working group has been active since 2003. As a result, the group has completed a status assessment for the Northeast region, a Blanding's turtle conservation plan, a standardized monitoring protocol, a genetics assessment, and initiated implementation of actions across the northeast region. This group will continue to facilitate and track the implementation of the Northeast conservation plan. The Northeast Blanding's turtle working group intends to increase communication to the mid-west United States and Canada in order to develop a global communication network for the species.

Political Location:
Northeast

Watershed Location:
Statewide

Monitor Blanding's turtle populations

Objective:
Implement long-term and rapid assessment monitoring using standardized regional protocol.

General Strategy:
Implement long-term and rapid assessment monitoring using standardized regional protocol (Willey and Jones 2014). Long-term monitoring should be implemented at all high priority sites and repeated every 5 years. Additional targeted monitoring could target nesting areas or habitat quality of particular wetlands.

Political Location:
Belknap County, Carroll County, Cheshire County, Grafton County, Hillsborough County, Merrimack County, Rockingham County, Strafford County

Watershed Location:
Androscoggin-Saco Watershed, Lower CT Watershed, Pemi-Winni Watershed, Merrimack Watershed, Coastal Watershed

Location Description:
Blanding's turtle range in NH.

Minimize disturbance to Blanding's turtles from recreational activities.

Primary Threat Addressed: Mortality and degradation from legal and illegal OHRV activity

Specific Threat (IUCN Threat Levels): Human intrusions & disturbance

Objective:
Minimize impacts of recreation on Blanding's turtle populations by using recreation guidelines and incorporating species' needs into property management plans

General Strategy:
The potential negative influence of recreational trails on Blanding's turtle populations may be reduced through a combination of management techniques outlined in Guidelines for Recreational Areas within High Priority Blanding's Turtle Sites in the Northeastern United States available at blandingsturtle.org. Objectives and Guidelines for Recreational Trails in High Priority Blanding's Turtle Sites include: 1) Prevent direct adult mortality caused by ATVs, OHRVs, trucks, bikes, etc.; 2) Minimize disturbance of adults, particularly nesting females; 3) Minimize mortality of nests, hatchlings, and juvenile turtles; and 4) Maintain the integrity of confirmed and potential nesting habitat. Specific actions could include: 1) Seasonal closures of ATV/OHRV trails bisecting sensitive wetland areas and turtle movement corridors; 2) seasonal (24 May to 4 July) or afternoon/evening (>16:00 h) closures to protect nesting females where trails bisect nesting habitat or nesting corridors; 3) Permanent closures of ATV/OHRV trails in known and potential nesting areas; 4) Increased, targeted law enforcement presence during sensitive time periods when turtle movements are frequent and relatively
predictable (e.g., June); 5) Trail relocation to avoid bisecting sensitive wetland complexes and to avoid separating suitable wetland habitats from suitable nesting habitats; and 6) Avoid placing hiking trails or sports fields in or adjacent to nesting areas.

Political Location:
Grafton County, Hillsborough County, Merrimack County, Rockingham County, Strafford County

Watershed Location:
Merrimack Watershed, Coastal Watershed

Location Description:
Blanding's turtle range in NH

Implement and promote the use of forestry guidelines in areas where Blanding's turtles occur

Primary Threat Addressed: Habitat degradation and conversion from forestry practices

Specific Threat (IUCN Threat Levels): Biological resource use

Objective:
Encourage use of Blanding's turtle forestry guidelines to minimize impacts to Blanding's turtle populations.

General Strategy:
'Guidelines for Forestry Activities within High Priority Blanding's Turtle Sites in the Northeastern United States' have been developed by the Northeast Blanding's turtle working group and are available at blandingsturtle.org. Objectives and guidelines for forestry activities in high priority Blanding's turtle sites include: 1) Prevent direct adult mortality caused by machinery, skidders, trucks, etc.; 2) Minimize mortality of nests, hatchlings, and juvenile turtles; 3) Improve, expand, or create new nesting habitat; 4) Avoid changes to wetland hydrology during overwintering season (October to April); 5) Avoid disturbance to vernal pool habitats year-round; and 6) Avoid introducing aquatic or terrestrial invasive plant species. The Blanding's turtle active season is 1 March to 15 September in most years, but may vary depending on weather. The Blanding's turtle dormant season is typically 1 November to 28 February. These guidelines are targeted at high priority Blanding's turtle sites in the northeast United States, but could be useful in conserving Blanding's turtles at any occupied site where landowners are willing to implement. NHFG will target large landowners within high priority Blanding's turtle sites for dissemination of guidelines and provide technical assistance to these landowners as warranted. NHFG will also disseminate guidelines to groups (e.g., NRCS, UNH Cooperative Extension, foresters, etc.) that work with private landowners and encourage use when developing management plans for properties.

Political Location:
Belknap County, Carroll County, Cheshire County, Grafton County, Hillsborough County, Merrimack County, Rockingham County, Strafford County

Watershed Location:
Androscoggin-Saco Watershed, Lower CT Watershed, Pemi-Winni Watershed, Merrimack Watershed, Coastal Watershed

Maintain & enhance nesting habitat

Primary Threat Addressed: Mortality from subsidized or introduced predators

Specific Threat (IUCN Threat Levels): Invasive & other problematic species, genes & diseases

Objective:
Create, enhance, and maintain multiple nesting areas at each priority Blanding's turtle site.

General Strategy:
A complete overview of nest enhancement guidelines can be found in 'Guidelines for Nest Site Management and Creation within High Priority Blanding's Turtle Sites in the Northeastern United States' available at blandingsturtle.org. Existing nesting areas should be identified, protected, and enhanced as necessary. Large disturbed areas, including active and abandoned excavation areas, are

often important nesting areas for turtles when they occur in proximity to suitable wetlands. Loaming and planting excavated areas often reduces their suitability for nesting turtles and many other wildlife species (e.g., black racers, eastern hognose snake, New England cottontail, bank swallow, kingfisher, shrubland and grassland birds). Managers should use extreme caution when augmenting or restoring known nesting habitat for Blanding's turtles and management should occur outside of the nesting and incubation period. In areas where nesting opportunities appear to be few, far from wetlands, or when turtles must cross roads to reach, new nesting areas may be created. Landowners and land managers are encouraged to work with NH Fish & Game to identify nest enhancement projects, especially in priority Blanding's turtle sites. Nesting area creation or management should be monitored using visual surveys or camera surveys to assess use and document threats to nesting turtles, eggs, or young (predation, disturbance, etc.). Nesting areas should be systematically surveyed every five years to ensure that tree species are not shading the area.

Political Location:

Belknap County, Carroll County, Cheshire County, Grafton County, Hillsborough County, Merrimack County, Rockingham County, Strafford County

Watershed Location:

Androscoggin-Saco Watershed, Lower CT Watershed, Pemi-Winni Watershed, Merrimack Watershed, Coastal Watershed

Location Description:
Focused at priority Blanding's turtle sites.

Evaluate impacts and develop environmental review guidelines

Primary Threat Addressed: Habitat impacts from development of surrounding uplands

Specific Threat (IUCN Threat Levels): Residential & commercial development

Objective:

Evaluate all projects that have potential to cause harm to Blanding's turtle populations and provide guidance to minimize impacts to those populations.

General Strategy:

Blanding's turtles are listed as endangered in New Hampshire. As such, NHFG will review any proposed activities (residential and commercial development, recreation, habitat management, etc.) that has the potential to harm Blanding's turtles. NHFG will work with applicants and permitting staff from other state and federal agencies, primarily Department of Environmental Services (Wetlands Bureau) and U.S. Army Corps of Engineers, to identify avoidance and minimization conditions for permit applicants. NHFG will develop guidelines for consistent and effective review of projects potentially impacting Blanding's turtles. Guidelines will consider scenarios where impacts should be avoided and scenarios where impact minimization of mitigation may be appropriate. Pre- and post-construction monitoring of Blanding's turtles and associated habitat (e.g., vernal pools, nesting areas) should be considered as a component of project review. Although all Blanding's turtle populations have some protection by state law (RSA 212-A), NHFG should prioritize protection at higher quality sites (See Actions in Willey and Jones 2014).

Political Location:
Belknap County, Carroll County, Cheshire Merrimack County, Grafton County, Hillsborough County, Merrimack County, Rockingham County, Strafford County

Watershed Location:
Watershed Location:
Coastal Watershed, Androscoggin-Saco Watershed, Lower CT Watershed, Pemi-Winni Watershed

Location Description:
Throughout range of Blanding's turtle in NH.

References, Data Sources and Authors

Data Sources

Initial information on the condition of Blanding's turtle populations largely was a result of reports received from RAARP and several localized research and inventory efforts focused along the Lamprey River, Great Bay, and the Concord area (Carroll 1999, Jenkins and Babbitt 2003). A regional project supported by the Competitive State Wildlife Grant Program titled 'Conservation of Blanding's Turtle and Associated Wetland SGCN in the Northeast' was initiated in 2011 and consisted of a standardized and coordinated monitoring strategy for Blanding's turtle populations in the northeast region, which is ongoing (Willey and Jones 2014). Blanding's turtles were observed and captured as part of this study during 2011-2014, and this information has been incorporated into the New Hampshire Rare Species Database. Before this study, distribution information came largely from the New Hampshire Reptile and Amphibian Reporting Program (RAARP). High quality records were submitted to New Hampshire Natural Heritage Bureau (NHNHB) and were incorporated into the Rare Species Database. Although most towns where Blanding's turtles currently occur probably have been reported, several towns in the center and periphery of the New Hampshire Blanding's turtle distribution have not verified the species presence to date.
Threat assessments were conducted by a group of NHFG biologists (Michael Marchand, Brendan Clifford, Loren Valliere, Josh Megysey).

Data Quality

Information was collected from visual surveys, trapping in suitable wetlands, and radio-telemetry studies of Blanding's turtles in 32 NH towns. NH information came from 293 nights of trapping in suitable wetlands, and 60 springtime visual surveys for Blanding's turtles. These surveys resulted in 315 Blanding's turtles captured during trapping surveys, 137 observed during visual surveys, and 223 individual genetic samples collected for analysis. Genetic samples collected from individual Blanding's turtles helped delineate site boundaries and provided some insight into the connectivity of Blanding's turtle habitats in the state.
Most records consist of one or a few observations, many of which were encounters on roads.
Wetland occupation and habitat use at a fine scale is poorly understood for most of the New Hampshire range of Blanding's turtles, though several sites near Concord and Great Bay have been studied in greater detail (Jenkins and Babbitt 2003).

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2005 Authors:
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Wood Turtle

Glyptemys insculpta

Federal Listing	N/A
State Listing	SC
Global Rank	
State Rank	S3
Regional Status	Very High

Photo by Ethan Nedeau

Justification (Reason for Concern in NH)

The wood turtle is a species of high regional concern (conservation concern and high regional responsibility) in the northeast that warrants federal endangered or threatened species listing considerations (NEPARC 2010, Therres 1999). Many states across the species range have reported declines, population structures with a disproportionate number of adults, or local extirpations (Ross et al. 1991, Garber and Burger 1995, Ernst 2001a, Daigle and Jutras 2005, Willoughby et al. 2013). In New England, the wood turtle is listed as a species of special concern in Maine (Hunter et al. 1999), Massachusetts (Massachusetts Natural Heritage and Endangered Species Program 2007), Connecticut (Connecticut Department of Energy and Environmental Protection 2014), New Hampshire, and Vermont (Vermont Nongame and Natural Heritage Program 2013). Historically, wood turtles were considered one of the most common turtle species in New Hampshire (Oliver and Bailey 1939). A petition to list the wood turtle as threatened under the Endangered Species Act by the Federal government was declined in the mid-1990s; the U.S. Fish and Wildlife Service stated the petition did not present "substantial scientific or commercial information indicating that listing the species is warranted" (USFWS 1995). Life history traits including late sexual maturation (Ontario: 17-18 years, Brooks et al. 1992) and limited fecundity (Garber 1989, Farrell and Graham 1991, Ross et al. 1991, Brooks et al. 1992) make wood turtles extremely vulnerable to increased adult mortality. Wood turtles depend on high rates of adult survival to compensate for a large mortality in the early stages of life. A model developed by Compton (1999) predicted that the annual removal of only 2 adult wood turtles from a stable population of 100 individuals would result in the extirpation of the population in less than 80 years. Human populations are rapidly expanding in New Hampshire (Society for the Protection of New Hampshire Forests 2005). As a result, residential and commercial development and human recreation opportunities are increasing, likely reducing the local viability of wood turtle populations (Tuttle and Carroll 1997, M. N. Marchand, personal observation).

Distribution

The wood turtles range extends from Maine to Minnesota, south to Virginia and Iowa in the United States, as well as southern Canada from Nova Scotia to Ontario (Ernst et al. 1994). The northeast United States comprises a significant portion of the wood turtle's global range (Therres 1999). Wood turtles appear to be distributed throughout New England, but are less common in coastal zones (Klemens 1993) and absent from offshore islands (Jones 2007).
In New Hampshire, wood turtles likely occur throughout much of the state excluding higher altitudes such as the White Mountains Region (Taylor 1993, New Hampshire Natural Heritage Bureau 2005). High elevation records for southern New England include 442 m (1450 ft) at Norfolk, Connecticut, 497 m (1630 ft) Becket, Massachusetts, and 518 m (1700 ft) Plainfield, Massachusetts (Klemens 1993).

Scarcity of deep, low gradient streams may be the limiting factor at high elevation as opposed to altitude (Klemens 1993).

Habitat

Wood turtles (Glyptemys insculpta) are associated with rivers and streams with hard sand or gravel substrate (Ernst et al. 1994), but make extensive use of surrounding uplands during the summer (Compton et al. 2002, Tuttle and Carroll 2003, Arvisais et al. 2004). Most wood turtle terrestrial activity often is within 300 m of streams and rivers (Kaufmann 1992, Arvisais et al. 2002, Remsberg et al. 2006). Habitat use and home range may vary among individuals of a local population (Kaufmann 1992, Compton 2002) with females generally moving greater distances than males (Jones et al. 2014). A mosaic of river or streams, forest, dense shrub thickets, and bare sandy substrate, may attract turtles and provide habitat for a higher density of turtles in these areas (Kaufmann 1992). In Maine, activity areas of wood turtles were near streams and rivers and had moderate forest cover (Compton et al. 2002). Within activity areas, wood turtles in Maine selected areas that were near water, non-forested, and with low canopy cover (Compton et al. 2002). Compton et al. (2002) and Arvisais et al. (2004) attributed this difference in selection at the 2 spatial scales to a preference for forest edges, where sunlight penetration and plant growth favors abundant basking and feeding opportunities. Some anthropogenic disturbances (e.g., agriculture, hayfields, abandoned gravel pits) may also provide habitat heterogeneity that wood turtles prefer.

Wood turtles can be found closer to the river after emerging from hibernation in late April and May (Tuttle 1995). At this time and throughout the summer, dense riparian and early successional shrub thickets are extremely important cover (Kaufmann 1992, Compton 2002, Arvisais et al. 2004). Alder (*Alnus spp.),* dogwoods (*Cornus spp*.), and arrowwood (*Viburnum spp*.) are good cover plants along riparian areas and other edges (D. Carroll, personal communication). A mixture of herbs and grasses (e.g., meadow-sweet, *Spiraea latifolia*, goldenrod *Solidago spp*.), shrubs (e.g., dogwoods), and vines (e.g., Virginia creeper *Parthenocissus quinquefolia*, grape *Vitis spp*.) reduce detection from humans and other predators and provides an abundance of food for the turtles (D. Carroll, personal communication). Food resources include green leaves, algae, mosses, fruit, fungi, seeds, insects and a variety of animal matter, including carrion, eggs, earthworms, mollusks, tadpoles, and newborn mice (Oliver and Bailey 1939, Harding and Bloomer 1979, Ernst et al. 1994, Niederberer and Siedel 1999). Emergent marshes, swamps, and vernal pools may be used during spring and summer (Hunter et al. 1999, Arvisais et al. 2004). At night wood turtles enter shallow forms under grass, leaves and brush, fallen logs, and flood debris (Harding and Bloomer 1979, Ernst 1986, Farrell and Graham 1991). For thermoregulation, Dubois et al. (2009) illustrated that wood turtles energetically benefit from a semi-aquatic lifestyle, entering rivers at night when terrestrial air temperatures fall below that of water temperatures.

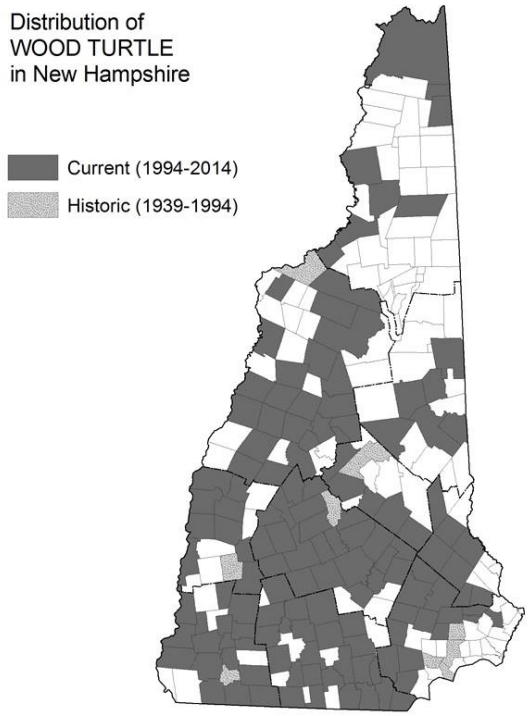
Female wood turtles lay eggs during late May to early July in sparsely vegetated, sandy-gravelly well-drained soils, often near water (Harding and Bloomer 1979, Klemens 1993, Buech et al.1997). Natural (e.g., sandbars, sandy banks) and anthropogenic (e.g., gravel and sand pits, railroad beds) sites may be used to excavate nests (Brooks et al. 1992, Tuttle and Carroll 1997, Buech et al. 1997). Hatchlings emerge from the nest chamber between mid-August and early October (Ernst et al. 1994) and tend to move down-slope to the safety of rivers or shaded canopy using vision, olfaction, auditory cues, and positive geotaxis (Tuttle and Carroll 2005).

Turtles begin to return to the river daily in September and October before settling into hibernation before mid-November (Tuttle 1995). Hibernation sites include undercut banks, submerged tree snags and woody debris in rivers, wildlife burrows, and deep pools (Garber 1989, Ernst and McBreen 1991). Most wood turtles hibernate in the same location annually (Garber 1988) and may hibernate

communally (Harding and Bloomer 1979).

NH Wildlife Action Plan Habitats

- Coldwater Rivers and Streams
- Floodplain Habitats
- Grasslands
- Shrublands
- Warmwater Rivers and Streams



Distribution Map

Current Species and Habitat Condition in New Hampshire

There have been 88 corroborated occurrences of wood turtles in NH and 4,627 km of modeled stream habitat. Statewide, 33% of the landscape is in optimal habitat condition and 36% of stream habitat is potentially impaired (Jones et al. 2014).

Population Management Status

NHFG will participate in the Northeast Regional Conservation Needs Program (Status and Conservation of the Wood Turtle in the Northeastern United States) through State Wildlife Grants. Statewide surveys will be conducted starting in 2015 to assess the condition of wood turtle populations in the state. Independent researchers (e.g., David Carroll, Mike Jones) and universities (Umass, St. Anselm College, Plymouth State) have conducted local monitoring, mark-recapture, and radio telemetry studies.

Regulatory Protection (for explanations, see Appendix I)

- CITES - Convention on International Trade of Endangered Species of Wild Fauna and Flora
- NHFG Rule FIS 803.02. Importation.
- NHFG Rule FIS 804.02. Possession.
- NHFG Rule FIS 811.01 Sale of Reptiles.
- NHFG FIS 1400 Nongame special rules
- Fill and Dredge in Wetlands - NHDES

- Rivers Management and Protection Program - NHDES
- Comprehensive Shoreland Protection Act - NHDES
- Alteration of Terrain Permitting - NHDES

Quality of Habitat

The following estimates are the percentages of wood turtle habitat in optimal landscape condition by county in New Hampshire: 34% in Belknap, 46% in Carroll, 42% in Cheshire, 45% in Coos, 45% in Grafton, 25% in Hillsborough, 34% in Merrimack, 4% in Rockingham, 7% in Strafford, and 44% in Sullivan (Jones et al. 2014). The following estimates are the percentages of wood turtle habitat that is potentially impaired by county in New Hampshire: 28% in Belknap, 22% in Carroll, 25% in Cheshire, 19% in Coos, 25% in Grafton, 48% in Hillsborough, 29% in Merrimack, 74% in Rockingham, 62% in Strafford, and 23% in Sullivan (Jones et al. 2014).

Habitat Protection Status

The total area of known and potential wood turtle habitat protected in occupied watersheds ranged from 0 to 2,193 ha (mean = 518 ha). Only 29% (27 of 93) of occupied watersheds had more than 20% protection of wood turtle habitat, though a number of watersheds where wood turtles have not been documented have a greater degree of protection. The actual habitat quality of these protected areas is not known and should be ascertained. Also, areas listed as conservation land may not be protecting wood turtles because of permitted land or recreational uses. Therefore, protection status for wood turtles may be much lower than what is represented in the conservation lands data layer used for these analyses.

Habitat Management Status

There is no habitat management being conducted for the wood turtle by NHFG, although recommendations pertaining to wood turtles have been made to private landowners by NHFG. Habitat management will be initiated at priority wood turtle sites in future years under an existing USFWS multi-state competitive state wildlife grant.

Threats to this Species or Habitat in NH

Threat rankings were calculated by groups of taxonomic or habitat experts using a multistep process (details in Chapter 4). Each threat was ranked for these factors: Spatial Extent, Severity, Immediacy, Certainty, and Reversibility (ability to address the threat). These combined scores produced one overall threat score. Only threats that received a "medium" or "high" score have accompanying text in this profile. Threats that have a low spatial extent, are unlikely to occur in the next ten years, or there is uncertainty in the data will be ranked lower due to these factors.

Habitat impacts from development of surrounding uplands (Threat Rank: High)

Residential and commercial development results in impervious surface and removal of natural vegetation, both of which result in loss of upland habitat for wood turtles. Conversion of disturbed sites (e.g., gravel pits) to impervious surfaces or manicured lawns reduces the quality of nesting habitat. Increased recreational opportunities (e.g., hiking trails, canoeing, and kayaking trails) along streams and rivers can result in removal of dense riparian vegetation and trampling of sandbars and other potential nesting areas.

Habitat loss and fragmentation is listed as the main threat for the decline of the wood turtle

throughout its range (Kaufmann 1992, Ernst 2001a). Wood turtles utilize broad, level valleys in the northeast which are commercially and agriculturally converted at a high rate, thus facilitating population declines (Jones et al. 2014). In New Hampshire, large wetland systems are being bisected by development, especially in the southern portion of the state (Tuttle 1995) and the human population and associated development is rapidly expanding (Society for the Protection of New Hampshire Forests 2005). Wood turtles use upland habitats extensively during the summer (Ernst 1986, Kaufmann 1992, Tuttle and Carroll 2003, Arvisais et al. 2004). Development and other habitat alterations within the summer activity range of wood turtles may result in mortality and injuries to wood turtles (Harding and Bloomer 1979, Saumure and Bider 1998, Marchand and Litvaitis 2004) and loss of vegetative cover making turtles more visible to predators and collectors.

Mortality from mowing and agricultural machinery and vehicles (Threat Rank: High)

The maintenance of agricultural crops and hayfields may result in collision with adult turtles using the area during the summer. The loss of individuals, especially adult females, can have a severe impact on the population due to the low recruitment of juveniles into the breeding population. However, compatible (i.e., individual turtles not killed) management of agricultural lands and hayfields near riparian areas may provide some beneficial foraging and nesting resources.

Observed impacts of agriculture on a wood turtle population, as compared to a forested population, include: lower numbers of juveniles, decreased growth during the second decade of life, and increased shell injury (Saumure and Bider 1998). A study by Erb and Jones (2011) found that mower blade height and style (i.e., sickle bar or rotary) have differential effects on turtle strikes, but crushing from mower tires may be the most significant cause of agricultural related mortality. Numerous wood turtles in New Hampshire have been found in hay pastures dead from apparent collision (M. Marchand, personal observation). Female wood turtles have been observed nesting in agricultural fields (Kaufmann 1992) increasing their risk for collision and potential loss of the nest.

Mortality of individuals from vehicles on roadways (Threat Rank: High)

New Hampshire's human population density and associated development is rapidly increasing (Society for Protection of New Hampshire Forests 2005). Increasing human population densities are associated with increasing road densities and traffic volume, and road widening. Turtles are relatively slow when traveling through upland habitat, and individual turtles are extremely vulnerable when crossing moderate to high traffic roads. Small annual losses of only 1 to several adult wood turtles may result in population extirpation.

Roads located near local turtle populations can lead to population declines via mortality of individuals and altered population structures, including skewed age or sex ratios (Ernst and McBreen 1991, Klemens 1989, Garber 1989, Marchand and Litvaitis 2004, Steen and Gibbs 2004). Sixty-seven percent of dead wood turtles reported in New Hampshire were located on roads (New Hampshire Natural Heritage Bureau 2005). There are 23 watersheds with no major roads in potential wood turtle habitat, but only 1 known occupied watershed without major roads. The mean number of stream road crossings per occupied watershed is 30. Jones et al. (2014) assert that despite a lack of baseline data, road mortality is likely the primary cause of population declines in the urbanized east coast.

Habitat degradation from dams that impound rivers and alter hydrology (Threat Rank: High)

The construction of dams may alter the natural flow of a stream. The impoundment of water and regulated release may reduce natural erosion processes that create nest sites, and flood any nests

that are laid when water levels are low. Also, turtles hibernating in the undercut banks of streams may freeze when water discharge is stopped. Dams or ineffective culverts under roadways may impede the movement of turtles, fragmenting populations and reducing gene flow. Channelization of streams may also alter natural stream flow by increasing water velocity causing sections of river to be unusable for the wood turtle. Dredging may cause sediment loading in rivers, degrading water quality.

At a dam site in Maine, female wood turtles delayed nesting and eventually relocated their nest sites due to lack of water flow needed to maintain nesting areas (Compton 1999). Water releases resulted in the flooding of 25% of nests at the site each year. Flooding later in the season could result in a higher mortality rate of developing wood turtle embryos. In Québec, Canada, Saumure et al. (2007) observed dead juveniles entombed in a streambank after a dredging project with subsequent bank collapses and stabilizations.

Mortality from increased flooding of rivers and streams (Threat Rank: Medium)

Severe hot or cold temperatures can result in breeding, nesting, and overwintering phenology disruptions. Severe storms and flooding can degrade wood turtle habitat as well as cause the removal of individuals from a population via direct mortality or washing downstream.

The specific environmental triggers for breeding, nesting, and overwintering are not well understood, but thermal triggers and river ice-out are most widely assumed. Greaves and Litzgus (2007) reported that wood turtles in Ontario, Canada entered and exited hibernation between 4°C and 5°C. Erratic temperature swings and unusual weather patterns may be problematic for a species dependent on thermal cues, but this threat is poorly understood for wood turtles in New Hampshire.
Flooding from severe storms may have similar impacts to wood turtles as that of Natural Systems Modifications (7.2 Dams and Water Management/Use) where erosion degrades habitat and increased stream flow may wash individuals downstream removing them from local populations (see Compton 1999, Saumure et al. 2007).

Mortality from casual collection of individuals from the wild or moving animals to a different location (Threat Rank: Medium)

Commercial collection of wood turtles for the pet trade has a profound influence on the extirpation of a wood turtle population. Wood turtles often hibernate in groups making them easy for collectors to target in the early spring when they bask on the banks of the river close to the water's edge before wandering into their summer ranges.

Illegal collection has eliminated entire populations of wood turtles in some areas and is considered a serious threat for the species (NatureServe 2014). The NHFG has no evidence of commercial collection of wood turtles in New Hampshire. However, reptile dealers have advertised wood turtles in New Hampshire in the past (Levell 2000). In 1992 a wood turtle sold for $75, in 1994 a pair sold for $275 (RESTORE: The North Woods et al. 1994). In the United States, the price of wood turtles has climbed from $20 in the 1960's to over $300 today (Jones et al. 2014). As the species becomes less common it is likely that the market value of illegally collected turtles will increase. Most states in the northeast have documented commercial collection of wood turtles with widespread evidence across the species range (Jones et al. 2014). Adults are collected more often because they are easiest to find, reducing the ability of the population to reproduce (Ernst 2001b).

Mortality from the commercial collection of individuals from the wild (Threat Rank: Medium)

Commercial collection of wood turtles for the pet trade has a profound influence on the extirpation of a wood turtle population. Wood turtles often hibernate in groups making them easy for collectors to target in the early spring when they bask on the banks of the river close to the water's edge before wandering into their summer ranges.

Illegal collection has eliminated entire populations of wood turtles in some areas and is considered a serious threat for the species (NatureServe 2014). The NHFG has no evidence of commercial collection of wood turtles in New Hampshire. However, reptile dealers have advertised wood turtles in New Hampshire in the past (Levell 2000). In 1992 a wood turtle sold for $75, in 1994 a pair sold for $275 (RESTORE: The North Woods et al. 1994). In the United States, the price of wood turtles has climbed from $20 in the 1960's to over $300 today (Jones et al. 2014). As the species becomes less common it is likely that the market value of illegally collected turtles will increase. Most states in the northeast have documented commercial collection of wood turtles with widespread evidence across the species range (Jones et al. 2014). Adults are collected more often because they are easiest to find, reducing the ability of the population to reproduce (Ernst 2001b).

Mortality from subsidized or introduced predators (Threat Rank: Medium)

Adult, hatchling, and egg depredation is a major conservation concern for wood turtles. Hatchlings and nests seem to be the most frequently targeted my mid-sized mammalian predators and some birds.

In New Hampshire, Tuttle and Carroll (2005) documented hatchling predation by both an eastern chipmunk (Tamias striatus) and an avian species – possibly great blue heron (*Ardea herodias*). Other predators may include, but are not limited to; raccoon (*Procyon lotor*), gray fox (*Urocyon cinereoargenteus*), fisher (*Martes pennanti*), skunk (*Mephitis mephitis*), bullfrog (*Lithobates catesbeianus*), raven (*Corvus corax*), and coyote (*Canis latrans*) (Harding and Bloomer 1979, Marchand et al. 2002, Wirsing et al. 2012, Jones et al. 2014, Paterson et al. 2014). Areas where human activity is high (i.e., recreation or landscape alteration), subsidized meso-predators, such as raccoons, may be higher in density and may increase predation pressure (Wirsing et al. 2012). Further, rivers and creeks have been shown to have higher predator densities, which may explain a study conducted by Paterson et al. (2012), where they found higher predation of hatchling wood turtles than swamp/marsh associated Blanding's turtles (*Emydoidea blandingii*). Adult depredation seems to be less common, but evidence of attempts has been documented in turtles with scarring, and missing limbs and tails (Hunter et al. 1999).

List of Lower Ranking Threats:

Mortality and species impacts from impervious surface run-off

Species impacts from competition (with introduced species)

Habitat degradation from introduced or invasive plants (Phragmites and Japanese knotweed)

Habitat conversion and degradation from bank stabilization

Mortality and disturbance from increased recreation (hiking, mountain biking, OHRV)

Mortality of individuals from forestry equipment

Habitat conversion due to development of nesting habitat

Actions to benefit this Species or Habitat in NH

Conserve priority wood turtle parcels

Primary Threat Addressed: Habitat impacts from development of surrounding uplands

Specific Threat (IUCN Threat Levels): Residential & commercial development

Objective:
Conserve priority wood turtle parcels

General Strategy:
Several priority wood turtle sites have been identified (Jones and Willey 2013) and additional monitoring is being conducted to inform a regional conservation plan. These sites will be updated over time as new information becomes available. Priority sites will be incorporated into NH Wildlife Action Plan revision maps and incorporated into state land conservation funding consideration (e.g., Aquatic Resource Mitigation Fund, LCHIP). NHFG staff will provide technical assistance to land trusts, NRCS, and towns in identifying and conserving priority parcels. NHFG staff will also provide technical assistance in developing management objectives compatible with wood turtle conservation.

Political Location:
Statewide

Watershed Location:
Statewide

Monitor wood turtle populations

Objective:
Implement long-term and rapid assessment monitoring using standardized regional protocol.

General Strategy:
Implement long-term and rapid assessment monitoring using standardized regional protocol (Jones et al. 2014). Rapid surveys should be used to gather additional information for sites with minimal information. Long-term monitoring should be implemented at all high priority sites and repeated every 5-10 years. Additional targeted monitoring could target nesting areas or habitat quality of particular stream reaches.

Political Location:
Statewide

Watershed Location:
Statewide

Mowing guidelines development and implementation

Primary Threat Addressed: Mortality from mowing and agricultural machinery and vehicles

Specific Threat (IUCN Threat Levels): Agriculture & aquaculture

Objective:
Develop guidelines for minimizing harm to wood turtles in areas where agricultural activities occur

and implement guidelines by providing technical assistance to landowners.

General Strategy:
Mowing guidelines have been developed for wood turtles in other states. Guidelines should be developed for NH or NH should adopt guidelines developed within other states or the northeast region. Once guidelines are developed, NHFG should work with landowners at priority wood turtle sites to enhance habitat quality or minimize risk of mortality to turtles. NHFG should provide guidelines to partners (e.g,. NRCS) that work with landowners.

Political Location:
Statewide

Watershed Location:
Statewide

Identify priority habitat at wood turtle sites.

Objective:
Identify priority wood turtle areas.

General Strategy:
Use a combination of habitat modelling, radiotelemetry, and site assessments to evaluate site conditions and importance for wood turtle populations. At priority sites where nesting areas not known, mature females should be tracked via radiotelemetry.

Political Location:
Statewide

Watershed Location:
Statewide

Maintain & enhance nesting habitat

Primary Threat Addressed: Habitat conversion due to development of nesting habitat

Specific Threat (IUCN Threat Levels): Residential & commercial development

Objective:
Create, enhance, and maintain multiple nesting areas at each priority wood turtle site.

General Strategy:
Nesting guidelines need to be developed for wood turtles. A complete overview of nest enhancement guidelines can be found in Guidelines for Nest Site Management and Creation within High Priority Blanding's Turtle Sites in the Northeastern United States available at blandingsturtle.org. Existing nesting areas should be identified, protected, and enhanced as necessary. Large disturbed areas, including active and abandoned excavation areas, are often important nesting areas for turtles when they occur in proximity to suitable wetlands. Loaming and planting excavated areas often reduces their suitability for nesting turtles and many other wildlife species (e.g., black racers, eastern hognose snake, New England cottontail, bank swallow, kingfisher, shrubland and grassland birds). Managers should use extreme caution when augmenting or restoring known nesting habitat for wood turtles and management should occur outside of the nesting and incubation period. In areas where nesting opportunities appear to be few, far from wetlands, or when turtles must cross roads to reach, new

nesting areas may be created. Landowners and land managers are encouraged to work with NH Fish & Game to identify nest enhancement projects, especially in priority Blanding's turtle sites. Nesting area creation or management should be monitored using visual surveys or camera surveys to assess use and document threats to nesting turtles, eggs, or young (predation, disturbance, etc.). Nesting areas should be systematically surveyed every five years to ensure that tree species are not shading the area.

Political Location:
Statewide

Watershed Location:
Statewide

Minimize disturbance to wood turtles from recreational activities.

Primary Threat Addressed: Mortality and disturbance from increased recreation (hiking, mountain biking, OHRV)

Specific Threat (IUCN Threat Levels): Human intrusions & disturbance

Objective:
Minimize impacts of recreation on wood turtle populations by using recreation guidelines and incorporating species' needs into property management plans

General Strategy:
The potential negative influence of recreational trails on wood turtle populations may be reduced through a combination of management techniques. Recreation guidelines have not been developed for NH but similar concerns and management techniques are outlined in Guidelines for Recreational Areas within High Priority Blanding's Turtle Sites in the Northeastern United States available at blandingsturtle.org. Objectives and Guidelines for Recreational Trails in High Priority Blanding's Turtle Sites: Prevent direct adult mortality caused by ATVs, OHRVs, trucks, bikes, etc. 2. Minimize disturbance of adults, particularly nesting females. 3. Minimize mortality of nests, hatchlings, and juvenile turtles. 4. Maintain the integrity of confirmed and potential nesting habitat. Specific actions could include: 1.) Seasonal closures of ATV/OHRV trails bisecting sensitive wetland areas and turtle movement corridors; 2.) seasonal (24 May to 4 July) or afternoon/evening (>16:00 h) closures to protect nesting females where trails bisect nesting habitat or nesting corridors; 3) Permanent closures of ATV/OHRV trails in known and potential nesting areas.4) Increased, targeted law enforcement presence during sensitive time periods when turtle movements are frequent and relatively
predictable (e.g., June); 5) Trail relocation to avoid bisecting sensitive wetland complexes and to avoid separating suitable wetland habitats from suitable nesting habitats. 6) Avoid placing hiking trails or sports fields in or adjacent to nesting areas.

Political Location:
Statewide

Watershed Location:
Statewide

Develop and promote the use of forestry guidelines in areas where wood turtles occur

Primary Threat Addressed: Mortality of individuals from forestry equipment

Specific Threat (IUCN Threat Levels): Biological resource use

Objective:
Develop and encourage use of wood turtle forestry guidelines to minimize impacts to wood turtle populations.

General Strategy:
Forestry protocols have not been developed for wood turtles at this time so that would be needed first. Guidelines for Forestry Activities within High Priority Blanding's Turtle Sites in the Northeastern United States have been developed by the Northeast Blanding's turtle working group and are available at blandingsturtle.org.

Political Location:
Statewide

Watershed Location:
Statewide

Enforce wildlife regulations

Primary Threat Addressed: Mortality from the commercial collection of individuals from the wild

Specific Threat (IUCN Threat Levels): Biological resource use

Objective:
Enforce wildlife regulations pertaining to the illegal collection, possession, or sale of wood turtles in New Hampshire.

General Strategy:
In NH, it is illegal to kill, harm, possess, collect, or sell a wood turtle without a permit from the NHFG. Because the removal of individual wood turtles from the wild can impact local populations, enforcement of rules and laws pertaining to this species are particularly important. NHFG biologists will work with NHFG law enforcement staff to identify violations and enforcement actions. NHFG staff will also work with neighboring states to identify origin of animals during confiscations.

Political Location:
Statewide

Watershed Location:
Statewide

Outreach to landowners

Primary Threat Addressed: Mortality from casual collection of individuals from the wild or moving animals to a different location

Specific Threat (IUCN Threat Levels): Biological resource use

Objective:
Provide information on the status and risks of species via various media outlets to educate public on importance of not collecting or moving turtles.

General Strategy:
NHFG will increase landowner knowledge of the species' status and threats by developing materials and messages on various media including Facebook, NHFG webpage, and press releases to other

media outlets (newspaper, radio, television).

Political Location:
Statewide

Watershed Location:
Statewide

Minimize road mortality to wood turtles

Primary Threat Addressed: Mortality of individuals from vehicles on roadways

Specific Threat (IUCN Threat Levels): Transportation & service corridors

Objective:
Minimize mortality of wood turtles on roadways.

General Strategy:
NHFG will work with NHDOT, NHDES, towns, and other partners to minimize road mortality of wood turtles on roadways. Specific targeted actions will include: avoid placement of new roads in priority wood turtle landscapes, avoid upgrading unpaved roads to paved surfaces in priority wood turtle landscapes, designing roadways to minimize mortality such as avoiding use of steep curbing, upgrading culverts/underpasses to increase opportunities for safe passage of turtles, place turtle crossing signs to educate motorists in priority wood turtle areas, and manage vehicle speed by reducing speed limits or installing speed bumps. Priority landscapes for implementation will need to be assessed using a combination of habitat modelling, turtle road crossing data, and local knowledge.

Political Location:
Statewide

Watershed Location:
Statewide

Regional coordination

Objective:
Coordinate with other regional, national, or international initiatives to conserve wood turtles.

General Strategy:
A northeast wood turtle working group was formed during the development of a regional wood turtle status assessment (Jones et al. 2014). This working group has continued as part of a competitive state wildlife focused on conservation planning and priority action implementation for wood turtles in the northeast. NHFG will continue to participate in these regional, national, or international discussions and meetings to further the conservation purposes of wood turtles.

Political Location:

Watershed Location:

Evaluate impacts and develop environmental review guidelines

Primary Threat Addressed: Habitat impacts from development of surrounding uplands

Specific Threat (IUCN Threat Levels): Residential & commercial development

Objective:
Evaluate all projects that have potential to cause harm to wood turtle populations and provide guidance to minimize impacts to those populations.

General Strategy:
NHFG will review proposed activities (residential and commercial development, recreation, bridge replacement, dam licensing, habitat management, etc) that has the potential to harm wood turtles. NHFG will work with applicants and permitting staff from other state and federal agencies, primarily Department of Environmental Services (Wetlands Bureau) and U.S. Army Corps of Engineers, to identify avoidance and minimization conditions for permit applicants. NHFG will develop guidelines for consistent and effective review of projects potentially impacting wood turtles. Guidelines will consider scenarios where impacts should be avoided and scenarios where impact minimization of mitigation may be appropriate. Pre- and post- construction monitoring of wood turtles and associated habitat (e.g., floodplains, nesting areas) should be considered as a component of project review. Protection should be prioritized according to condition of habitat and wood turtle population.

Political Location:
Statewide

Watershed Location:
Statewide

References, Data Sources and Authors

Data Sources
Habitat information came from the Northeast Wood Turtle Working Group (2011), peer-reviewed literature, and a wood turtle species viability report conducted by the White Mountain National Forest (unpublished document, originally prepared by K. Marchowsky 2001; revised by M. Marchand 2002). The Reptile and Amphibian Reporting Program (RAARP), Wildlife Sightings, and NHNHB databases were used to assess distribution. Neighboring state websites were consulted for recent distribution information. Habitat maps were produced by NHFG using available GIS data layers from various sources (metadata available upon request).
The Northeast Wood Turtle Working Group (2011) as part of the Regional Conservation Needs (RCN) report, Status and Conservation of the Wood Turtle (Jones et al. 2014), used a "corroborated occurrence" method to amalgamate multiple occurrences, sightings, specimens, and observations (within 2 km of each other and ≤ 30 years apart) along the same section of stream habitat. This effort was implemented to minimize pseudoreplication with individual turtles that may have been displaced by floods, migrated long distances, or released from captivity. Data for this analysis was provided by NHFG and the New Hampshire Natural Heritage Bureau, Forest and Lands Program, Department of Resources and Economic Development (DRED). Other datasets were received from B. Wicklow, Jones and Sievert, Jones and Willey, and several museums. There were 88 corroborated occurrences in New Hampshire. Further condition information was obtained from the NHNHB Element Occurrence database.Threat assessments were conducted by a group of NHFG biologists (Michael Marchand, Brendan Clifford, Loren Valliere, Josh Megysey).

Data Quality
Observations from RAARP and Wildlife Sightings were reviewed for quality before inclusion. However,

distribution information is not complete, and new town records are likely. Information has been collected on a few populations by researchers (i.e., Michael T. Jones) conducting mark-recapture studies, and Tuttle and Carroll (1997, 2003) conducted an intensive population study for NHFG in the early 1990s.
Wood turtle may occupy many of the available watersheds in the state, but only portions of watersheds have been documented (93 known of 319 potential), and only a few populations have been studied in detail through mark-recapture and radio telemetry.

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Eastern Hog-nosed Snake

Heterodon platirhinos

Federal Listing	N/A
State Listing	E
Global Rank	G5
State Rank	S1
Regional Status	Very High

Photo by New Boston Air Force Station

Justification (Reason for Concern in NH)

The eastern hognose snake was listed as Threatened by the Committee on the Status of Endangered Wildlife in Canada (COSEWIC) as of January 1, 2001 and is considered a species of regional concern in the northeastern United States (Therres 1999). Eastern hognose snakes were listed as a species of 'Severe' and 'Very High' concern in the northeast United States (NEPARC 2011, Northeast RSGCN list 2014). In New England, the eastern hognose snake is listed as S2 in Rhode Island, S2S3 in Connecticut, and S4 in Massachusetts; it doesn't occur in Maine. The species was previously unknown from Vermont but a single individual was confirmed in southeastern part of the state within the last 10 years. New Hampshire's peripheral population of hognose snakes is state endangered (RSA 212-A, FIS 1000). Hognose snakes in New Hampshire have large home ranges (LaGory et al. 2009, Goulet 2010, Goulet and Mills 2011, Goulet et al. 2015) and are restricted to the Merrimack River corridor south of Concord, an area where development and human population increases are intense and remaining blocks of suitable habitat are becoming smaller and isolated (SPNHF 2005). In addition, the sandy, well-drained soils preferred by hognose snakes are easily converted to residential and commercial developments and are targeted for commercial sand extraction operations.

Distribution

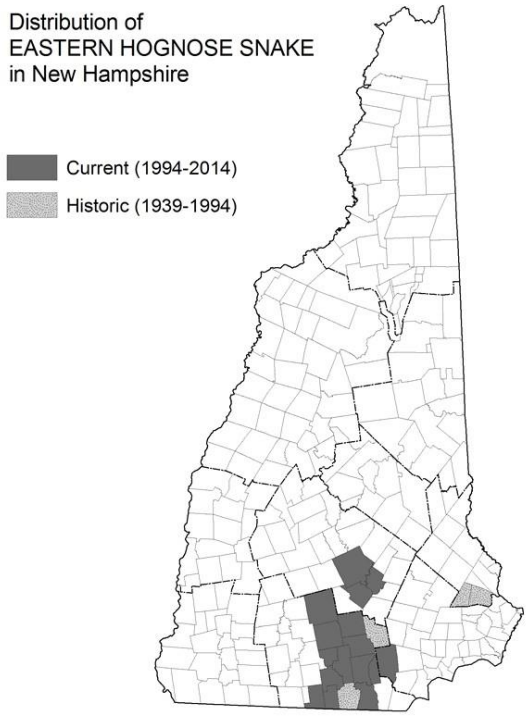
The eastern hognose snake is found from southern New England and Ontario south along Atlantic coast to Florida and west to Texas, Kansas, Nebraska, and South Dakota (Ernst and Ernst 2003). New Hampshire represents the northern limit of the species range on the east coast, where they are restricted to the sandy plain of the Merrimack River, extending from Concord on the north to the Massachusetts state line, as far east as Londonderry, and as far west as New Boston. In fact, the majority of recently confirmed reports (2008-2013) have been near the western boundary of the species' known range in NH (i.e., Mason, Brookline, Milford, Mont Vernon, New Boston) suggesting the need to target surveys in these areas. In addition, 3 biologists have reported finding eastern hognose snakes historically in the Durham/Lee area of southeastern New Hampshire (Phillip Sawyer, formerly Professor of Zoology, University of New Hampshire; David Allen, formerly a biologist with the USDA Soil Conservation Service, now known as the Natural Resource Conservation Service; John Litvaitis, Professor of Wildlife Ecology, University of New Hampshire. Sandy soils generated by glacial outwash, the critical habitat feature for hognose snakes, are common in the Durham/Lee area. Also, a recent documented occurrence in southeastern Vermont might indicate a potential for an undocumented population along the Connecticut River in southwestern New Hampshire (e.g., Hinsdale).

Habitat

Eastern hognose snakes are found in open woodland, grasslands, and fields with sandy soil derived from glacial outwash (Michener and Lazell 1989). Natural vegetation commonly occurring in these New Hampshire sandy soils include white pine (*Pinus strobus*), pitch pine (*Pinus rigida*), scrub oak (*Quercus ilicifolia*), and a mixture of hardwoods (Michener and Lazell 1989). Hognose snakes feed largely on amphibians, especially toads; however, other prey may be taken (Edgren 1955, Platt 1969). Therefore, wetlands that are suitable for amphibian breeding may be an important habitat component, but prey preference could potentially vary regionally or locally depending on prey availability. Eggs are laid in sandy soils, usually during June-July, and young snakes emerge from nests in August-September (Ernst and Ernst 2003). Hibernation often occurs individually in mammal burrows, loose soil, or down logs (Plummer 2002, Ernst and Ernst 2003). Selection of habitat may occur at multiple spatial scales (Goulet 2010, Goulet et al. 2015). At one site in NH, microhabitat features associated with snake activity sites (compared to random sites) included higher ground- surface temperatures, proximity to wetlands, limited canopy closure, as well as an abundance of shrubs, debris, and rock cover (Goulet 2010, Goulet et al. 2015). Some sites in NH are associated with active or abandoned sand & gravel operations because of the preferred sandy deposits and the mix of sandy openings and patches of shrubs surrounded by forest.

NH Wildlife Action Plan Habitats

- Appalachian Oak Pine Forest
- Pine Barrens
- Developed Habitats
- Hemlock Hardwood Pine Forest
- Marsh and Shrub Wetlands
- Shrublands
- Vernal Pools



Distribution Map

Current Species and Habitat Condition in New Hampshire

There are 45 known occurrence records of hognose snakes in New Hampshire, 13 of which (29%) are considered historic (over 20 years old). Many of these historic sites may still be occupied and have gone undetected more recently due to the cryptic behavior of the species. However, for the purposes of this section only the 32 current (within 20 years) occurrence records are summarized. Total land area within 500 meters of known current records is 7,099 ha, 77% of which (5,448 ha) was in natural cover (forest, grass, wetland, floodplain forest). 26,165 ha of habitat was identified when forest blocks overlapping the 500 meter buffer were included. The mean size of habitat polygons was 61 ha +/- 253 ha SD. Ninety-six habitat polygons are over 10 Ha, with the largest being 3,568 ha.

Information on the condition of hognose snakes in New Hampshire is not suitable to determine the viability of local populations. Several hognose snakes are reported to the NHFG annually; however, these observations largely consist of individual snakes, with very few locations having repeated observations.

The most studied population in NH occurs at the New Boston Air Force Station. Several years of radiotelemetry studies have been completed along with continued mark-recapture of the population (LaGory et al. 2009, Goulet 2010, Goulet et al. 2015). Incidental encounters within this population continue and natural resources staff at the NBAFS provide education and technical assistance to other staff at the NBAFS. The NBAFS also has an Integrated Natural Resources Management Plan for the property which includes recommendations for eastern hognose snakes. Progress on this plan is reviewed by NHFG and USFWS staff on an annual basis. The NBAFS is near the edge of the NH's western range and habitat is somewhat different from the typical citations (NBAFS includes more mesic hemlock forests with variable soils, Goulet et al. 2015). The NBAFS ownership has relatively low levels of development and paved roads, has restricted use by the public, and habitat is managed with wildlife as a focus. As such, the NBAFS provides a potentially suitable landscape for hognose snakes to persist.

The second most studied population in NH is in Pembroke at the Army National Guard property. Hibernation locations and successful reproduction have been confirmed at this site and some critical habitat areas have been identified (Goulet and Mills 2011). However, further evaluation is needed to assess the condition of this population.

All other sites in NH are represented by incidental encounters and reports to the NHFG. During April-September 2015, NHFG conducted targeted searches for hognose snakes within 13 focal areas in the towns of Litchfield and Londonderry. No hognose snakes were observed despite a substantial effort and relatively recent incidental encounters by the public. During the summer of 2002, the University of New Hampshire surveyed 6 sites for hognose snake presence but none were encountered (Oberkrieser and Litvaitis 2002). These efforts indicate the difficulty in observing this cryptic species, especially when densities are likely low.

The majority of recently confirmed reports (2008-2013) have been near the western boundary of the species' known range in NH (Mason, Brookline, Milford, Amherst, Mont Vernon, New Boston) suggesting the need to target surveys in these areas. All records for towns of Bedford and Manchester are historic (1973-1985). Recent reports within the towns of Hollis, Nashua, Merrimack, Pembroke, and Bow, as well as towns between, need further evaluation. Litchfield and Londonderry have a combination of historic and recent reports but a targeted survey during 2015 did not reveal any new occurrences.

Population Management Status

There is very little population management and or research occurring for hognose snakes in New Hampshire. The New Boston Air Force Station and Pembroke Army National Guard have both conducted several years of radiotelemetry to document habitat use and movement patterns within their ownership (LaGory et al. 2009, Goulet 2010, Goulet and Mills 2011). This information is used during planning for various land management activities.

Regulatory Protection (for explanations, see Appendix I)

- NHFG Rule FIS 803.02. Importation.
- NHFG Rule FIS 804.02. Possession.
- NHFG Rule FIS 811.01 Sale of Reptiles.
- Endangered Species Conservation Act (RSA 212-A)
- NHFG FIS 1400 Nongame special rules
- Fill and Dredge in Wetlands - NHDES
- Comprehensive Shoreland Protection Act - NHDES
- Alteration of Terrain Permitting - NHDES

Quality of Habitat

Sandy glacial outwash is plentiful along the Merrimack River in Hillsborough and Merrimack counties, as well as the Lee/Durham area of New Hampshire. The abundance of the prey base (principally toads and frogs) has not been quantified, but several species, including American toads (*Anaxyrus americanus*), spring peepers (*Pseudacris crucifer*), gray treefrogs (*Hyla versicolor*), and pickerel frogs (*Rana palustris*), appear to be common in this area of the state. Development is intense and human population densities are rapidly expanding in southern New Hampshire. Many remaining fragmented blocks of habitat may be too small to support viable local populations of hognose snakes. The scarcity of hognose snake encounters may be a reflection of low habitat quality along with low detection probability.

Habitat Protection Status

Twenty-eight percent (1,525 ha) of area within 500 meters of recent (within 20 years) hognose records are in conservation. When the 500 meter buffer around occurrences is extended to include overlapping forest blocks, 20% (5,207 ha) of land area is in conservation. The average (mean) size of conservation parcels was 63 Ha +/- 180 Ha SD. Thirty-seven conserved habitat polygons are over 10 Ha with largest conserved habitat polygon = 1,480 ha. However, the actual amount of land in permanent protection is likely considerely less because the NH conservation lands layer includes some areas that are not permanently protected (e.g., New Boston Air Force Station). Also, it is not known whether management of conservation parcels (e.g., habitat management, recreation) is compatible for hognose snakes.

Habitat Management Status

No habitat management has occurred specifically for hognose snakes in New Hampshire to date. Restoration of Pine Barrens (i.e., prescribed fires, forestry, and mowing) in south-central New Hampshire (e.g., Concord) may improve habitat suitability for hognose snakes but this needs further evaluation. Management of shrubland habitats for other species such as New England Cottontail (e.g., Londonderry and Litchfield) may benefit hognose snakes (LaGory et al. 2009) but a detailed hognose snake assessment is needed to determine where snakes are present and how they are affected (positively or negatively) by management. Potential impacts to hognose snake habitats are assessed during the Nongame & Endangered Species Program review of newly proposed developments projects.

Threats to this Species or Habitat in NH

Threat rankings were calculated by groups of taxonomic or habitat experts using a multistep process (details in Chapter 4). Each threat was ranked for these factors: Spatial Extent, Severity, Immediacy, Certainty, and Reversibility (ability to address the threat). These combined scores produced one overall threat score. Only threats that received a "medium" or "high" score have accompanying text in this profile. Threats that have a low spatial extent, are unlikely to occur in the next ten years, or there is uncertainty in the data will be ranked lower due to these factors.

Habitat conversion due to development of uplands (Threat Rank: High)

The corridor along the Merrimack River in Hillsborough and Merrimack counties is heavily urbanized and continuing to grow in human population and development. Continuing habitat conversion may degrade preferred habitat, fragment it into areas too small to support the home range of an individual, increase encounters with humans and other generalist predators, and reduce the prey base of anurans that this species depends on.

Urbanization often converts hognose snake habitat to pavement and mowed lawns. Eastern hognose snakes are also noted for having relatively large home ranges (LaGory et al. 2009, Goulet 2010, Goulet and Mills 2011) and at times moving as much as 600 m at a time (Plummer and Mills 2000)]; conversion of habitat to standard New Hampshire 0.8 ha (2 acre) building lots or commercial uses dominated by impervious surfaces thus has great potential to negatively affect this species.

Amphibian populations, likely the primary prey for hognose snakes, are adversely impacted by wetland filling (especially vernal pools) and development of surrounding uplands, resulting from residential and commercial development.

Habitat conversion and mortality from mining (sand & gravel) (Threat Rank: Medium)

The abundance of sandy deposits along the Merrimack River is important to the distribution of hognose snakes in NH and has been an attractive resource for mining operations. As a result, sand mining operations are often found in or around known populations of hognose snakes in NH. Substantial removal of sandy deposits may reduce habitat quality for hognose snakes by reducing nesting and foraging areas. Mining operation machinery may also directly kill snakes by running over them or excavating them while snakes or eggs are underground. Following extraction of sand, these areas are often targeted for commercial development which severely and permanently reduces habitat availability and suitability. Abandoned sand operations can be valuable habitat for hognose snakes and other wildlife species.

Numerous NH wildlife species including hognose snakes are known to occur in or around sandy mining operations, especially those that have been abandoned. It is known that some of these previous mining operations have been converted to commercial developments in areas where hognose snakes were known or suspected to occur (i.e., Bow, Concord, Londonderry). No hognose snakes have been tracked via radiotelemetry at these locations.

Mortality of individuals from vehicles on roadways (Threat Rank: Medium)

Given the probable large home range requirements of this species (LaGory et al. 2009, Goulet 2010, Goulet and Mills 2011) and high road densities along the Merrimack River corridor, the opportunity for deadly encounters with automobiles is probably high.

The number of snakes found dead on roads has been enumerated at other locations (Ashley and Robinson 1996, Enge and Wood 2002), but the degree to which road mortality threatens population viability in New Hampshire is largely unknown but expected for slow-moving species or those with

large home ranges. However, it is also possible that hognose snakes avoid crossing some paved roads which might reduce road mortality but could have adverse genetic implications to local populations (Robson 2011).

Mortality from human persecution (Threat Rank: Medium)

Many people have an irrational fear or hatred for snakes. The eastern hognose snake has an extensive threat display (Lazell and Michener 1976) and is a heavy bodied snake that is commonly misidentified as a dangerous species (e.g., cobra, rattlesnake). Removal of individuals from an already small population can reduce population size. Small populations are subject to many problems that threaten viability including demographic and environmental stochasticity, genetic drift, and inbreeding depression (Meffe and Carroll 1997).

At least several individual hognose snakes have been killed and reported to the NHFG in previous 10 years (e.g., Bow, Litchfield) and it is likely to occur more often than reported since hognose snakes are state protected (low reporting), may occur near human dwellings (higher likelihood of encounter), and are commonly misidentified as a dangerous snake. There is no information on the frequency with which this species is killed or collected by humans and impacts to local populations.

Mortality and species impacts (decreased fitness) of individuals from various diseases (snake fungal disease) (Threat Rank: Medium)

Since the mid-1990's an increasing number of snakes in the eastern United States have been observed with fungal skin infections. As the number of reported cases has grown the infections have now been termed snake fungal disease (SFD). A novel fungus (Ophidiomyces ophiodiicola) has been identified in many individuals with suspected SFD and is thought to be the cause of mortality although some questions remain as to whether this species is the primary or secondary pathogen.

O. ophiodiicola has now been documented in more than 10 different snake species from 11 different states ranging from New Hampshire to Florida and as far west as Arkansas and Minnesota. Eastern hognose snakes have not been reported with signs of SFD to date (NEPARC 2013) and therefore, there is no evidence to determine prevalence and effect on populations. However, based on the large number of other snake species affected and the difficulty in observing hognose snakes, it is possible that this species is also affected.

List of Lower Ranking Threats:

Mortality from subsidized or introduced predators

Habitat conversion and succession from grass and shrubs to forested areas

Mortality to individuals from military training activities

Mortality and degradation from legal and illegal OHRV activity

Species impacts from declines in prey abundance

Mortality from welded plastic erosion control blankets

Actions to benefit this Species or Habitat in NH

Conserve priority hognose snake habitat

Primary Threat Addressed: Habitat conversion due to development of uplands

Specific Threat (IUCN Threat Levels): Residential & commercial development

Objective:
Conserve priority hognose snake habitat

General Strategy:
Hognose snake parcels need to be prioritized for protection. These sites will be updated over time as new information becomes available. Priority sites will be incorporated into NH Wildlife Action Plan revision maps and incorporated into state land conservation funding consideration (e.g., Aquatic Resource Mitigation Fund, LCHIP). NHFG staff will provide technical assistance to land trusts and towns in identifying and conserving priority parcels. NHFG staff will also provide technical assistance in developing management objectives compatible with hognose snake conservation.

Political Location:
Hillsborough County, Merrimack County, Rockingham County

Watershed Location:
Merrimack Watershed, Coastal Watershed

Promote wildlife friendly erosion control matting

Primary Threat Addressed: Mortality from welded plastic erosion control blankets

Specific Threat (IUCN Threat Levels): Residential & commercial development

Objective:
Promote wildlife friendly erosion control matting to reduce mortality of snakes.

General Strategy:
Some erosion control matting has a welded plastic netting that captures and kills snakes and birds. Wildlife friendly options are available and will be favored and promoted during environmental reviews, technical assistance with landowners, and technical assistance to other land managers.

Political Location:
Statewide

Watershed Location:
Statewide

Enforce wildlife regulations

Primary Threat Addressed: Mortality from human persecution

Specific Threat (IUCN Threat Levels): Biological resource use

Objective:
Enforce wildlife regulations pertaining to the illegal harm, killing, collection, possession, or sale of eastern hognose snakes in New Hampshire.

General Strategy:
In NH, it is illegal to kill, harm, possess, collect, or sell an eastern hognose snake without a permit from the NHFG. Because the species is endangered and populations are few and appear to have low densities, enforcement of rules and laws pertaining to this species are particularly important. NHFG biologists will work with NHFG law enforcement staff to identify violations and enforcement actions.

Watershed Location:

Political Location:
Hillsborough County, Merrimack County, Rockingham County

Watershed Location:
Merrimack Watershed, Coastal Watershed

Monitor hognose snake populations

Objective:
Assess the distribution and condition of hognose snake populations.

General Strategy:
Eastern hognose snakes are often difficult to detect during surveys. Effective monitoring will likely require monitoring individual animals with radiotelmetry to determine habitat use and movement.

Political Location:

Hillsborough County, Merrimack County, Rockingham County

Watershed Location:

Merrimack Watershed, Coastal Watershed

Disseminate information about species status

Primary Threat Addressed: Mortality from human persecution

Specific Threat (IUCN Threat Levels): Biological resource use

Objective:
Provide outreach and technical assistance to landowners within the range of the eastern hognose snake to reduce animals being killed.

General Strategy:
NHFG will increase landowner knowledge of the species' status and threats by developing materials and messages on various media including Facebook, NHFG webpage, press releases to other media outlets (newspaper, radio, television), and targeted landowner communications

Political Location:
Hillsborough County, Merrimack County, Rockingham County

Watershed Location:
Merrimack Watershed, Coastal Watershed

Review any proposed activities that has the potential to harm eastern hognose snakes.

Primary Threat Addressed: Habitat conversion due to development of uplands

Specific Threat (IUCN Threat Levels): Residential & commercial development

Specific Action: Review development proposals in eastern hognose habitat through NHFG environmental review program

Objective:
Review all proposed activities in hognose snake habitat in order to avoid, minimize, and mitigate the effects of the proposal on a state endangered wildlife species protected under RSA 212-A.

General Strategy:
Eastern hognose snakes are listed as endangered in New Hampshire. As such, NHFG will review any proposed activities (residential and commercial development, recreation, habitat management, etc.)

that has the potential to harm hognose snakes. NHFG will work with applicants and permitting staff from other state and federal agencies, primarily Department of Environmental Services (Wetlands Bureau) and U.S. Army Corps of Engineers, to identify avoidance and minimization conditions for permit applicants. NHFG will develop guidelines for consistent and effective review of projects potentially impacting hognose snakes. Guidelines will consider scenarios where impacts should be avoided and scenarios where impact minimization of mitigation may be appropriate. Pre- and post-construction monitoring of hognose snakes and associated habitat should be considered as a component of project review. Although all hognose snake populations have some protection by state law (RSA 212-A), NHFG should prioritize protection at higher quality sites.

Political Location:
Hillsborough County, Merrimack County, Rockingham County

Watershed Location:
Merrimack Watershed, Coastal Watershed

References, Data Sources and Authors

Data Sources

The major source of distribution information for New Hampshire was from the Reptile and Amphibian Reporting Program (RAARP) and NH Wildlife Sightings website coordinated by the Nongame and Endangered Wildlife Program at NHFG, the rare species database maintained by the NHNHB, and literature reviews and unpublished reports and professional knowledge of the authors. State and global heritage ranks were taken from NatureServe 2015. Habitat maps were completed by UNH, Complex Systems Research Center during the development of the 2005 NH WAP.
Condition of hognose snake locations was assessed based on data from the RAARP, NH Wildlife Sightings and rare species database maintained by the NHNHB. Threat assessments were conducted by a group of NHFG biologists (Michael Marchand, Brendan Clifford, Loren Valliere, Josh Megysey).

Data Quality

The extent of the eastern hognose snakes' current range in the state, given the clustering of records near the Merrimack River south of Concord, is fairly well known. However, it is possible that there is an unidentified population in southwestern NH along the Connecticut River.
The condition of hognose snakes in New Hampshire is extremely poorly understood.

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Smooth Greensnake

Liochlorophis vernalis

Federal Listing	N/A
State Listing	SC
Global Rank	
State Rank	S3
Regional Status	High

Photo by Michael Marchand

Justification (Reason for Concern in NH)

Smooth green snakes were listed as a species of 'High' conservation concern in the northeast United States (NEPARC 2011, Northeast RSGCN list 2014). Anecdotal accounts appear to indicate a decline in smooth green snake abundance since the mid-1900s in southern New England (Klemens 1993) and in other areas (Brodman et al. 2002). Since that time, many early successional habitats that smooth green snakes prefer have become reforested or have been converted to residential and commercial developments (Klemens 1993, SPNHF 2005). The maintenance of lawns and hayfields by mowing can lead to direct mortality of individual smooth green snakes. Frequent mowing may reduce habitat suitability by altering the diversity of vegetation and soil moisture, potentially limiting the abundance of prey such as gastropods (Kjoss and Litvaitis 2001a). Insecticides reduce prey bases and direct mortality to smooth green snakes (George and Stickel 1949).

Distribution

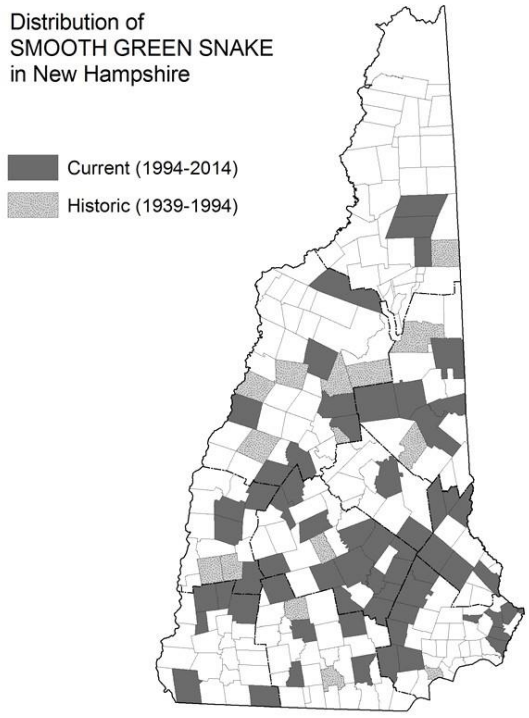
The smooth green snake likely occurs throughout most of New Hampshire including documented records on Star Island, Isles of Shoals (Taylor 1993, D. Hayward, personal communication). Milan (2004) Berlin (2003), and Gorham (2011) represent the most northerly recent records for species in Coos County NH and has been reported for Shelburne historically (Oliver and Bailey 1939). In a historic unpublished report, Donald Carle, a professor of science at Keene Teachers College, wrote "They have been reported at the tree line on Mount Monadnock in Jaffrey, on top of Mount Stinson in the White Mountains and at the tree line next to the cog railroad going up Mt. Washington."

Habitat

Smooth green snakes may be found in a variety of open or lightly forested habitats such as pastures, old fields, wet meadows, marsh borders, coastal grasslands, Pine Barrens, blueberry barrens, and grassy hilltops (Klemens 1993, New Hampshire Reptile and Amphibians Reporting Program 2015). Smooth green snakes feed primarily on invertebrates including arthropods, caterpillars, grasshoppers, slugs and earthworms. Females may lay two or more clutches of well-developed eggs a season, usually in July- August, in piles of rotting vegetation or sawdust, rotting logs and stumps or mammal burrows (Ernst and Ernst 2003). Ant mounds, rock crevices and mammal burrows may be used during hibernation (Carpenter 1953, Ernst and Ernst 2003).

NH Wildlife Action Plan Habitats

- Shrublands
- Grasslands
- Marsh and Shrub Wetlands
- Peatlands
- Rocky Ridge
- Cliff
- and Talus



Distribution Map

Current Species and Habitat Condition in New Hampshire

Not assessed because of insufficient information.

Population Management Status

Not assessed because of insufficient information.

Regulatory Protection (for explanations, see Appendix I)

- NHFG Rule FIS 803.02. Importation.
- NHFG Rule FIS 804.02. Possession.
- NHFG Rule FIS 811.01 Sale of Reptiles.
- NHFG FIS 1400 Nongame special rules
- Fill and Dredge in Wetlands - NHDES

Quality of Habitat

Not assessed because of insufficient information.

Habitat Protection Status

Not assessed because of insufficient information.

Habitat Management Status

Not assessed because of insufficient information.

Threats to this Species or Habitat in NH

Threat rankings were calculated by groups of taxonomic or habitat experts using a multistep process (details in Chapter 4). Each threat was ranked for these factors: Spatial Extent, Severity, Immediacy, Certainty, and Reversibility (ability to address the threat). These combined scores produced one overall threat score. Only threats that received a "medium" or "high" score have accompanying text in this profile. Threats that have a low spatial extent, are unlikely to occur in the next ten years, or there is uncertainty in the data will be ranked lower due to these factors.

There are no threats ranked high or moderate for this species.

List of Lower Ranking Threats:

Species impacts from agricultural pesticide use causing prey declines

Mortality and species impacts (decreased fitness) of individuals from various diseases (snake fungal disease)

Habitat conversion due to succession from grass and shrubs to forested areas

Mortality of individuals from vehicles on roadways

Habitat conversion of hayfields to row crops

Mortality from mowing and agricultural machinery and vehicles

Habitat conversion due to development of upland habitat

Actions to benefit this Species or Habitat in NH

Evaluate health of smooth green snakes

Primary Threat Addressed: Mortality and species impacts (decreased fitness) of individuals from various diseases (snake fungal disease)

Specific Threat (IUCN Threat Levels): Invasive & other problematic species, genes & diseases

Objective:
Evaluate health of smooth green snakes

General Strategy:
Smooth green snakes observed with signs of disease will be evaluated and considered for testing.

Political Location:
Statewide

Watershed Location:
Statewide

Collect distribution information

Objective:
Collect, compile, and evaluate distribution information for smooth green snakes in NH.

General Strategy:
NHFG will encourage volunteers of the reptile and amphibian reporting program to report observations of the species. Researchers conducting work in smooth greensnake habitat will be encouraged to submit observations of species.

Political Location:
Statewide

Watershed Location:
Statewide

Use species as indicator for health of habitat

Objective:
Evaluate whether species is suitable for inclusion in grassland condition assessments and evaluation of pesticides.

General Strategy:
Smooth green snakes are associated with grasslands, wetland edges, and openings with grasses. They have been reported as vulnerable to agricultural management (e.g., haying) and pesticide applications. As such, researchers evaluating these habitats or their condition should consider whether smooth green snakes would serve as useful indicators.

Political Location:
Statewide

Watershed Location:
Statewide

References, Data Sources and Authors

Data Sources
Status and ranking information was taken from NatureServe (2014). New Hampshire Reptile and Amphibian Reporting Program (RAARP) and NH Wildlife Sightings records and Taylor (1993) were the primary source of locality records. Online museum collection databases (Museum of Comparative Zoology, Harvard and Yale Peabody Museum) were searched for historical records.
No data available to assess condition of smooth green snake populations. Threat assessments were conducted by a group of NHFG biologists (Michael Marchand, Brendan Clifford, Loren Valliere, Josh Megysey).

Data Quality
The distribution, habitat use, and condition of smooth green snake populations in New Hampshire are not well understood. This assessment was limited to high quality records that were included in museum collections, were found in scientific reports, or were reported to the New Hampshire Reptile and Amphibian Reporting Program and NH Wildlife Sightings by a trained expert or reports that included a specimen or clear photograph. We suspect that smooth green snakes in towns with historic observations probably have not been extirpated but rather these areas have not received recent survey effort targeting this species.

No data available to assess condition of smooth green snake populations.

2015 Authors:
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2005 Authors:
Kim A. Tuttle and M. N. Marchand, New Hampshire Fish and Game

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Eastern Box Turtle

Terrapene carolina carolina

Federal Listing	N/A
State Listing	SC
Global Rank	
State Rank	S1
Regional Status	Very High

Photo by Michael Marchand

Justification (Reason for Concern in NH)

The eastern box turtle is a species of concern in the northeast (NEPARC 2010, Therres 1999). States reporting declines of box turtles have included Connecticut, Delaware, Florida, Illinois, Indiana, Iowa, Maryland, Massachusetts, Missouri, New Jersey, New York, Ohio, Oklahoma, Tennessee, Virginia, West Virginia, and Wisconsin (Nazdrowicz et al. 2008, Stickel 1978, Williams and Parker 1987, Lieberman 1994). Massachusetts and Connecticut consider the eastern box turtle a species of special concern, and in Maine eastern box turtles are listed as endangered (Hunter et al. 1999). Box turtles are a long-lived species with delayed ages of sexual maturity, relatively low fecundity, and dependence on high adult survival. Therefore, they may be extremely vulnerable to increased mortality associated with rapid development in New England. The current and historic status of box turtles in New Hampshire is not known and needs further evaluation.

Distribution

In New England the box turtle's range includes southeastern Maine, southeastern New Hampshire, eastern Massachusetts including Cape Cod and the islands, the Connecticut River region, and much of Rhode Island and Connecticut (Klemens 1993, DeGraaf and Yamasaki 2001). Box turtles do not occur in Vermont (Hunter et al. 1999). In Maine, box turtles have been reported in at least 13 towns (Hunter et al. 1999). However, reports distant from south-coastal Maine were likely released pets. Records in Maine consist largely of single individuals and do not attest to a population (P. deMaynadier, Maine Department of Inland Fisheries and Wildlife, personal communication). In Massachusetts, there are box turtle records in at least 4 towns that border New Hampshire but each of these towns only has one occurrence record (Erb 2011).

In New Hampshire, the distribution and abundance of box turtles is not well known. A specimen was collected in Pelham, Rockingham County historically (Huse 1901) and submitted to the Manchester Institute of Arts and Sciences, but has apparently since been lost (Natural Heritage Rare Species Database 2004). Specimens from Lee were also reported (Huse 1901), suggesting that box turtles occurred in southern New Hampshire historically. Remains of a box turtle were found at a pre-colonial excavation site from Lake Massabesic, New Hampshire (Largy 2003). This report may suggest that a native population of box turtles existed in New Hampshire historically.

Use and trade of box turtles by Native Americans has complicated our understanding of the historic distribution of the species (Adler 1968). Box turtles were occasionally consumed (Dodd 2001), were commonly used as ceremonial objects (Klemens 1993, Dodd 2001), and were transported, often north of the species' current range (Bleakney 1958, Adler 1968). Therefore, it is possible that box turtles were traded to New Hampshire from other locations where box turtles are currently more abundant (e.g., southern New England). Box turtle shells recovered in Ontario, north of the current range, have

been considered not native (Bleakney 1958). However, Adler (1970) reported that Native Americans (primarily Iroquois) may have been responsible for the elimination of box turtles in western New York and possibly in southern Ontario.

The NHFG Nongame and Endangered Species Program received reports of box turtles from 12 towns between 1992 and 2004. Reports of box turtles from central and northern New Hampshire (Wentworth Location, Eaton, Moultonborough) were most likely the result of released pets. Box turtles were extremely popular in the pet industry (Ernst et al. 1994, Lieberman 1994), and in New Hampshire, it was not illegal to possess Eastern box turtles until 1996.

In 1985, a recently deceased box turtle was reported from Hudson. Habitat surrounding the turtle was described as a dry oak forest with a power line right-of-way and a graminoid marsh (Korpi 1985). Taylor (1993) illustrates 2 additional locations in southeastern New Hampshire on the edge of Rockingham and Strafford Counties, and Dodd (2001) depicts 2 locations on the southern border of Maine and New Hampshire.

From 2006-2014 (Wildlife Action Plan timeframe), the NHFG Nongame and Endangered Species Program received an additional 7 reports with photographs from 7 different towns (Hudson, New Ipswich, Newfields, Pembroke, Westmoreland, Wilton, Windham). Several additional unconfirmed reports were received. The report from Newfields was of two adjacent box turtles. All other reports were of individual box turtles. NHFG was able to acquire and track 3 of these 7 turtles with radiotelemetry. The New Ipswich animal was tracked periodically from June 2012 till October 2014; turtle used a variety of habitats available including forests, fields, and wetlands. Its home range over the two-year monitoring period was relatively large (MCP 38 ha, 94 acres) but travel was not linear during that period (turtle moved back and forth between various habitat areas perhaps indicating some experience at the site). The MCP of this turtle's two-year home range exceeds the averages of other states. In Massachusetts, single-season home ranges averaged 22.6 acres but maximum home ranges were 223-340 acres among 3 different sites (Erb 2011).

The Wilton turtle was found ~7 km from the New Ipswich animal. This animal was tracked for only a short period (June-August 2013) due to transmitter failure. The same animal was incidentally encountered and reported to NHFG crossing a major road 0.6 km from the release location. The Hudson animal was reported to NHFG with photograph during June 2014 and was a gravid female digging a nest chamber in a utility right of way, the first documented evidence of reproduction. NHFG was able to locate the turtle and verify the presence of 5 unlaid eggs. The turtle was induced and eggs were incubated but none of them successfully developed.

DNA samples were taken from the 3 tracked turtles and sent to Dr. John Placyk (University of Texas, Tyler) for extraction and analysis (methods as in Martin et al. 2013). Initial analyses indicate that the New Ipswich animal may have originated from outside of New England and that the Wilton and Hudson animals were consistent with genetics from box turtle populations in New England.

Individual box turtles have been confirmed from 14 scattered towns (two of which are historic, before 1994), mostly south of the Lakes Region. Despite these widely scattered reports, southern NH in the vicinity of Hudson, Derry, and Windham has the highest number of current and historic reports and is a target area for locating a box turtle population, despite the highly developed nature of the area.

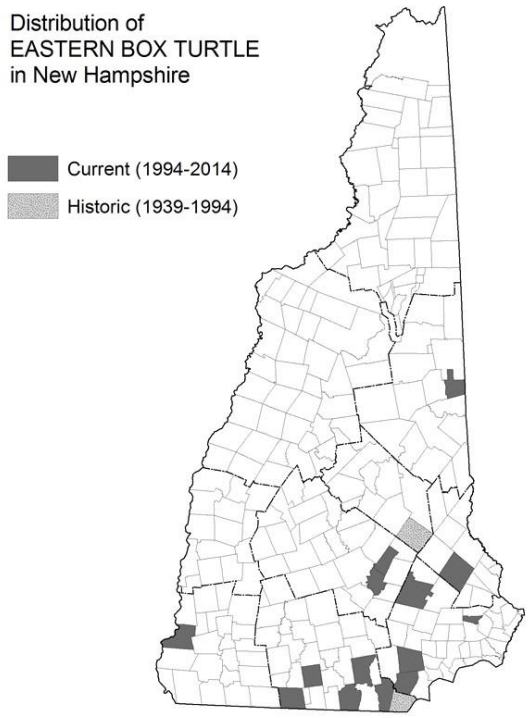
Habitat

Eastern box turtles are terrestrial generalists that use a variety of habitats including mesic forests xeric uplands, open woodlands, pastures, old fields, thickets, and powerline clearings (Klemens 1993, Ernst et al. 1994, DeGraaf and Yamasaki 2001, Mitchell 2003). Although considered a terrestrial turtle, box turtles may make extensive use of a variety of wetlands, shallow streams, or muddy seepages (Klemens 1993, Quinlan et al. 2004, Marchand et al. 2004) as relief from high temperatures, concealment from predators (Dodd 2001), and for additional foraging opportunities (Marchand et al. 2004). A diversity of habitats in close proximity is apparently favored (Madden 1975, Klemens 1993), and box turtles may adjust habitat preference depending on season and temperature (Madden 1975, Dodd 2001, Marchand 2004).

During periods of inactivity, box turtles may bury in litter or rest in brush piles or briar patches (Stickel 1950). Openings in the forest canopy are important for basking individuals (Stickel 1950), and well-drained open canopy areas are required for nesting (Ernst et al. 1994). As temperatures drop in the fall, box turtles dig progressively deeper into soil where they spend the winter. Portions of the carapace are sometimes visible even in northern climates (Dodd 2001).

NH Wildlife Action Plan Habitats

- Appalachian Oak Pine Forest
- Hemlock Hardwood Pine Forest
- Grasslands
- Marsh and Shrub Wetlands
- Shrublands
- Temperate Swamps



Distribution Map

Current Species and Habitat Condition in New Hampshire

Not assessed because of insufficient information.

Population Management Status

See 'Distribution' section for discussion of monitoring and genetic assessments.

Regulatory Protection (for explanations, see Appendix I)

- CITES - Convention on International Trade of Endangered Species of Wild Fauna and Flora
- NHFG Rule FIS 803.02. Importation.
- NHFG Rule FIS 804.02. Possession.
- NHFG Rule FIS 811.01 Sale of Reptiles.
- NHFG FIS 1400 Nongame special rules
- Fill and Dredge in Wetlands - NHDES
- Alteration of Terrain Permitting - NHDES

Quality of Habitat

Not assessed because of insufficient information.

Habitat Protection Status

Not assessed because of insufficient information.

Habitat Management Status

No ongoing targeted habitat management.

Threats to this Species or Habitat in NH

Threat rankings were calculated by groups of taxonomic or habitat experts using a multistep process (details in Chapter 4). Each threat was ranked for these factors: Spatial Extent, Severity, Immediacy, Certainty, and Reversibility (ability to address the threat). These combined scores produced one overall threat score. Only threats that received a "medium" or "high" score have accompanying text in this profile. Threats that have a low spatial extent, are unlikely to occur in the next ten years, or there is uncertainty in the data will be ranked lower due to these factors.

Habitat conversion due to development of upland habitat (Threat Rank: Medium)

Box turtles are long-lived and have a late age of maturity similar to several other turtles. As such, additional mortality to adults could adversely affect local populations. Much of southern New Hampshire has relatively high road densities and remaining undeveloped land is often fragmented.

There are no known populations of box turtles in New Hampshire. However, locations where box turtles have been reported in southern New Hampshire typically have major roads nearby. It is unknown to what extent roads and development are impacting box turtles in New Hampshire.

Mortality of individuals from vehicles on roadways (Threat Rank: Medium)

Box turtles are long-lived and have a late age of maturity similar to several other turtles. As such, additional mortality to adults could adversely affect local populations. Much of southern New Hampshire has relatively high road densities.

There are no known populations of box turtles in New Hampshire. However, locations where box turtles have been reported in southern New Hampshire typically have major roads nearby. It is unknown to what extent roads are impacting box turtles in New Hampshire.

List of Lower Ranking Threats:

Mortality and species impacts (decreased fitness) from various diseases (ranavirus)

Mortality from subsidized or introduced predators (egg and hatchling mortality)

Mortality from introduced or subsidized predators

Mortality and degradation from legal and illegal OHRV activity

Mortality of individuals from forestry equipment

Mortality from casual collection of individuals from the wild or moving animals to a different location

Mortality from mowing and agricultural machinery and vehicles

Actions to benefit this Species or Habitat in NH

Conserve priority parcels at documented box turtle populations

Primary Threat Addressed: Habitat conversion due to development of upland habitat

Specific Threat (IUCN Threat Levels): Residential & commercial development

Specific Action: Land and Water Rights Acquisition and Protection

Objective:
Conserve priority parcels at documented box turtle populations

General Strategy:
Following documentation of box turtle populations, NHFG will work with conservation partners (such as land trusts, towns, etc.) to conserve land in priority areas.

Political Location:
Statewide

Watershed Location:
Statewide

Location Description:
Location of populations unknown at this time.

Box turtle monitoring

Objective:
NHFG will survey sites where box turtles have been reported and track individual turtles to evaluate potential of populations.

General Strategy:
Multiple box turtle reports have been confirmed in NH but there are no known populations. Recent reports in southern NH indicate a possible population. NHFG will encourage reporting of any box turtle observations and will target communities and landowners in the vicinity of previous documented reports. NHFG will attempt to capture any box turtles reported in southern New Hampshire and potentially track those individuals via radiotelemetry. Radiotelmetry will indicate habitat use, movement patterns, and potentially lead to additional box turtles. DNA analysis of specimens may reveal potential for individual to represent native population. Multiple turtles from a location will indicate a population and further conservation actions will be developed at that time.

Political Location:
Cheshire County, Hillsborough County, Merrimack County, Rockingham County

Watershed Location:
Lower CT Watershed, Merrimack Watershed, Coastal Watershed

References, Data Sources and Authors

Data Sources

Sources of information include unpublished data from the NHFG Department, the Reptile and Amphibian Reporting Program database, NH Natural Heritage Bureau Rare Species database, NH Wildlife Sightings website database, Massachusetts Natural Heritage Element Occurrence Information, and Maine Reptile and Amphibian Atlas (Hunter et al. 1999).
Threat assessments were conducted by a group of NHFG biologists (Michael Marchand, Brendan Clifford, Loren Valliere, Josh Megysey).

Data Quality

The historic and current distribution of box turtles in New Hampshire is not well known. Data has improved during the last 10 years as the result of tracking 3 individual turtles and the associated genetics assessments for these animals.

2015 Authors:
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2005 Authors:
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Eastern Ribbonsnake

Thamnophis sauritus

Federal Listing	N/A
State Listing	
Global Rank	
State Rank	S5
Regional Status	Very High

Photo by Michael Marchand

Justification (Reason for Concern in NH)

The eastern ribbon snake was listed as a species of conservation concern in the northeastern United States due to a lack of data and a suspected decline (Therres 1999). Ribbon snakes were listed as a species of 'Very High' concern in the northeast United States (NEPARC 2011, Northeast RSGCN list 2014). The species is near the northern limit of its range in New England and is listed as a species of special concern in Maine, Vermont, Connecticut and Rhode Island because of uncommon and localized populations that appear to have declined (Klemens 1993). Ribbon snakes could be used as indicator species (e.g., for contaminants) because of their dependence on amphibians as prey and use of both aquatic and upland habitats (Smith 2002). Also, ribbon snake occupation may indicate high quality wetland habitat that could support other species of conservation concern such as spotted turtle (*Clemmys guttata*), leopard frog (*Rana pipiens*), and blue-spotted (*Ambystoma laterale*) and four-toed salamanders (*Hemidactylium scutatum*) (Klemens 1993). In a study from Nova Scotia, the authors concluded that the Eastern Ribbon Snake is relatively sedentary and therefore may be vulnerable to local extinction (Bell et al. 2007).

Distribution

Ribbon snakes occur east of the Mississippi River from southern Ontario and southern Maine to southeastern Louisiana and the Florida Keys, with isolated records from Nova Scotia (Ernst and Ernst 2003). Two subspecies, the eastern ribbon snake (*T. sauritus sauritus*) and the northern ribbon snake (*T. sauritus septentrionalis*) may occur in New England (Conant and Collins 1998). The range of the northern ribbon snake includes Nova Scotia and extends from southern Maine westward through New Hampshire, Vermont, and New York. The northern limit of the eastern ribbon snake includes the southern parts of Vermont, New Hampshire, and Maine (Conant and Collins 1998). Most Maine records are from York County, and no distinction was made between the two ribbon snake subspecies (Hunter et al. 1999). Most Vermont records are from the western part of the state (Champlain valley).

The NH Fish & Game Department has not made any distinction between the two sub-species of ribbon snake in NH. In New Hampshire, county records of ribbon snakes include Belknap, Carroll, Cheshire, Grafton, Hillsborough, Merrimack, Rockingham, Strafford, and Sullivan (Oliver and Bailey 1939, RAARP 2015). There are no confirmed records of the ribbon snake in Coos County. A 1920 record from Sanbornton (Museum of Comparative Zoology Herpetology Collection at Harvard) is the only documented record for Belknap County. Sullivan County also only has one town record which is historic (Newport). Carroll (1 current town, 2 historic towns) and Cheshire (2 current towns, 1 historic town) counties have limited town records. The largest number of recent observations has been

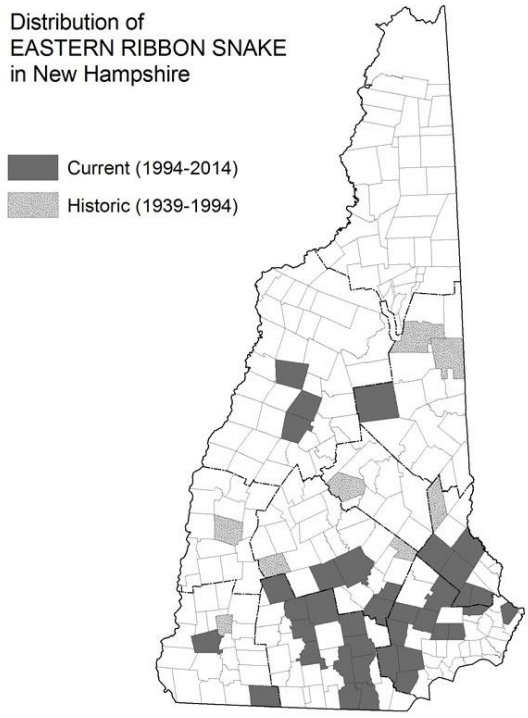
recorded in Hillsborough, Rockingham, Merrimack, and Strafford Counties. No systematic surveys have been conducted for ribbon snakes in New Hampshire. However, from 2005-2015, ribbon snakes were periodically observed during field surveys targeting other reptiles and amphibians (Blanding's turtles, black racer) in southeastern New Hampshire and because ribbon snakes were listed as SGCN in the NHWAP , observations were prioritized for reporting.

Habitat

The eastern ribbon snake is a slender, semi-aquatic snake often observed near the edges of emergent marshes, wet meadows, scrub-shrub wetlands, beaver impoundments, bogs, river and stream floodplains, and vegetated shorelines of ponds and lakes (Ernst and Ernst 2003, M. Marchand personal observation). Ribbon snakes generally avoid deep water but will swim readily along the surface. Juveniles and gravid females may use uplands (Smith 2002), but the extent of use is not well established. In Nova Scotia where the species is threatened, ribbon snakes were always found within 5 m of water during May to September. From September to mid-October, snakes moved up to 173 m away from the shoreline (Bell et al. 2007). Most ribbon snakes documented in New England have been found below 305 m (1,000 ft) elevation (Oliver and Bailey 1939, Klemens 1993). Possible hibernacula include muskrat (*Ondatra zibethica*) bank burrows and lodges (Ernst and Ernst 2003), ant mounds, mammal tunnels, and rock crevices (Carpenter 1953, Hansknecht et al. 1999). Though ribbon snakes eat primarily amphibians (Carpenter 1952), they will also consume lesser amounts of mice, spiders, small fish, and insects.

NH Wildlife Action Plan Habitats

- Marsh and Shrub Wetlands
- Peatlands
- Floodplain Habitats
- Vernal Pools



Distribution Map

Current Species and Habitat Condition in New Hampshire

Not assessed because of insufficient information.

Population Management Status

Not assessed because of insufficient information.

Regulatory Protection (for explanations, see Appendix I)

- NHFG Rule FIS 803.02. Importation.
- NHFG Rule FIS 804.02. Possession.
- NHFG Rule FIS 811.01 Sale of Reptiles.
- NHFG FIS 1400 Nongame special rules

Quality of Habitat

Not assessed because of insufficient information.

Habitat Protection Status

Not assessed because of insufficient information.

Habitat Management Status

Not assessed because of insufficient information.

Threats to this Species or Habitat in NH

Threat rankings were calculated by groups of taxonomic or habitat experts using a multistep process (details in Chapter 4). Each threat was ranked for these factors: Spatial Extent, Severity, Immediacy, Certainty, and Reversibility (ability to address the threat). These combined scores produced one overall threat score. Only threats that received a "medium" or "high" score have accompanying text in this profile. Threats that have a low spatial extent, are unlikely to occur in the next ten years, or there is uncertainty in the data will be ranked lower due to these factors.

Mortality of individuals from vehicles on roadways (Threat Rank: Medium)

Ribbon snakes are associated with wetland habitats. Ribbon snakes are vulnerable to mortality on roadways near wetland habitats.

Ribbon snakes are periodically reported as roadkill but information to evaluate threat is minimal.

Mortality and species impacts (decreased fitness) of individuals from various diseases (snake fungal disease) (Threat Rank: Medium)

Snake fungal disease has been detected on a number of snake species in the northeast. Research is underway to determine prevalence and severity of disease on different snake populations.

There is minimal information on snake fungal disease and its impacts on ribbon snakes.

List of Lower Ranking Threats:

Habitat conversion due to development (in and near wetlands)

Actions to benefit this Species or Habitat in NH

Evaluate health of ribbon snakes

Primary Threat Addressed: Mortality and species impacts (decreased fitness) of individuals from various diseases (snake fungal disease)

Specific Threat (IUCN Threat Levels): Invasive & other problematic species, genes & diseases

Objective:
Evaluate health of ribbon snakes

General Strategy:
Ribbon snakes observed with signs of disease will be evaluated and considered for testing.

Political Location:
Statewide

Watershed Location:
Statewide

Collect, compile and evaluate distribution information

Objective:
Collect, compile, and evaluate distribution information on ribbon snakes in NH.

General Strategy:
NHFG will encourage volunteers of the reptile and amphibian reporting program to report observations of the species. Researchers conducting work in ribbon snake habitat will be encouraged to submit observations of species.

Political Location:
Statewide

Watershed Location:
Statewide

Use as indicator species

Objective:
Evaluate species suitability for inclusion in wetland condition assessments.

General Strategy:
Ribbon snakes are associated with freshwater wetlands and could be an appropriate indicator to include within wetland assessments.

Political Location:
Statewide

Watershed Location:
Statewide

References, Data Sources and Authors

Data Sources

Status and ranking information was taken from NatureServe (2015). New Hampshire RAARP and NH Wildlife Sightings records and Taylor (1993) were the primary source of locality records. Online museum collection databases (Museum of Comparative Zoology, Harvard and Yale Peabody Museum) were searched for historical records. Habitat and life history information was taken from published literature.

No data available to assess condition of ribbon snake populations. Threat assessments were conducted by a group of NHFG biologists (Michael Marchand, Brendan Clifford, Loren Valliere, Josh Megysey).

Data Quality

The distribution, habitat use, and condition of ribbon snake populations in New Hampshire are not well understood. This assessment was limited to those records that were included in museum collections, were found in scientific reports, were reported to NHFG by a trained expert, or that included a specimen or clear photograph. Trained observers will likely result in many new town records.

No data available to assess condition of ribbon snake populations.

2015 Authors:

Michael Marchand, NHFG

2005 Authors:

Kim A. Tuttle and M. N. Marchand, New Hampshire Fish and Game

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