HABITAT PROFILE

Non-Tidal Coastal Watersheds

Associated Species: Alewife (Alosa pseudoharengus), American Brook Lamprey (Lampetra appendix), American Shad (Alosa sapidissima), Atlantic Sturgeon (Acipenser oxyrhynchus), Banded Sunfish (Enneacanthus obesus), Blueback Herring (Alosa aestivalis), Bridle Shiner (Notropis bifrenatus), Burbot (Lota lota), Brook Trout (Salvelinus fontinalis), Rainbow Smelt (Osmerus mordax), Redfin Pickerel (Esox americanus americanus), Sea Lamprey (Petromyzon marinus), Shortnose Sturgeon (Acipenser brevirostrum), Slimy Sculpin (Cottus cognatus), Swamp Darter (Etheostoma fusiforme), Tessellated Darter (Etheostoma olmstedi)

Federal Listing: Not listed
State Listing: Not listed
Global Rank: Not ranked
State Rank: Not ranked
Author: New Hampshire Fish and Game and The Nature Conservancy

Element 1: Distribution and Habitat

1.1 Habitat Description

Non-tidal coastal watersheds contain river systems that are similar to low tidal watersheds except they are above the tidal extent and many are connected to the deep and large Merrimack River mainstem. Low non-tidal watersheds contain extensive, deep, and coarse sediment deposits, although this watershed group contains a large swath of moderately calcareous metasedimentary bedrock and less fine marine clay than low tidal watersheds. Despite having less fine marine clay, low non-tidal watersheds may still have more buffering capacity than other parts of the state due to the influence of the moderately calcareous metasedimentary bedrock.

Low non-tidal watersheds have a relatively high percentage of low to mid-elevation landforms with gentle sloping hills and abundant wet and flat landforms. The lower Merrimack River mainstem, south of the Winnipesaukee River confluence in Franklin, dominates much of this watershed group, which has more miles and a greater percentage of large river habitats than any system other than the Connecticut River watershed.

Low to moderate gradient streams dominate the tributaries of this system. They are generally composed of riffle-pool habitats with occasional dune-ripple habitats in areas of deep and extensive coarse sediment. There is no strictly tidal marsh community of plants and animals as in low tidal systems. Depending on fish stocking, habitat quality, and the ability of fish to move upstream past barriers in the Merrimack River, diadromous fish (such as American shad (*Alosa sapidissima*), alewife (*Alosa pseudoharengus*), American eel (*Anguilla rostrata*), Atlantic salmon (*Salmo salar*), or blueback herring (*Alosa aestivalis*)) may spawn or rear their young in these low non-tidal rivers. Some fish that are more characteristic of large and deep lakes may occur in these watersheds as the Merrimack River deepens and slows throughout sections of the mainstem.

Low non-tidal watersheds primarily include the larger watersheds directly adjacent to the Merrimack River mainstem, although the smaller brooks draining into the mainstem provide unique habitats. The mouths of small streams along large river mainstems may provide refuges and breeding habitats for both local and wide-ranging fish species. However, most of these smaller streams are dammed at our near their confluence with the Merrimack River, which prevents natural connectivity to upstream habitats.

Low Non-Tidal Fine Scale Systems: 11, 12
Fine scale systems 11 and 12 are fairly similar. Both

watershed types are nearly entirely low elevation, composed of more gentle landforms, have a high degree of coarse sediment, and are highly influenced by the large Merrimack River mainstem and lower slow-flowing sections of large tributaries. There are a few key differences between these systems, the primary being that the southern fine scale system 11 overlaps with a large swath of moderately calcareous bedrock (Berwick Formation), which may provide significant buffering capacity to those streams. This bedrock is characterized by multiple metasedimentary and metavolcanic geologic units with up to 15% calcareous rock, some of the "richest" in the state. Fine scale system 12 watersheds are more directly adjacent to the Merrimack River mainstem, whereas fine scale system 11 also includes watersheds of larger tributary rivers flowing south across the Massachusetts border.

1.2 Justification

The large mainstem of the Merrimack River and associated small and medium tributaries are critical habitats for diadromous and other wide-ranging migratory fish. There are few large river habitats in the state (or in the region) that support this suite of species and ecological processes, and so all large rivers are a high priority for conservation. Large river habitats require representation across wide geographies.

1.4 Habitat Distribution

Low non-tidal watersheds occur in nine watersheds in New Hampshire's south-central Merrimack Valley region, including small tributaries to the Merrimack River south of the town of Franklin. These watersheds extend north from the Massachusetts state line to the confluence with the Winnipesaukee River. The rivers in this system are not tidally influenced.

Low non-tidal watersheds sit entirely within the Merrimack-Saco-Charles River Ecological Drainage Unit (EDU) and the Southern New England Coastal Hills and Plains subsections of TNC's Lower New England-Northern Piedmont Ecoregion. The southernmost watersheds cross into Massachusetts, including small tributaries to the Merrimack River such as the Nashua River, Beaver Brook, Salmon Brook, Nesenkeag Brook, Chase Brook, and portions of the Squannacook River watershed in Massachusetts.

1.8 Extent and quality of data

While low non-tidal watersheds are distinct from other major watershed groups, the fine scale systems embedded within this group are less clear. The major landscape parameter defining the difference is the abundant calcareous bedrock in the southern watersheds. It is unclear whether this difference has a significant effect on the composition of aquatic species. This difference may have a stronger influence on current and long-term water chemistry and water quality, such as the ability to buffer the effects of acid deposition.

Both fine scale systems are important from a statewide perspective. The enriched bedrock of fine scale system 11 may provide unique and long-term buffering capacity, and fine scale system 12 has unique small stream connectivity with the Merrimack River mainstem. Additional research and data would help further determine the relative importance of these fine scale systems compared to other watersheds in the state. For example, the Connecticut River and low tidal watersheds also have enriched bedrock, and the Connecticut River systems also have small tributary connections with a large river mainstem. A regional analysis comparing these habitats with those in Massachusetts might help focus conservation actions depending on adequate fish passage for diadromous species and whether watersheds with enriched geologic features have a detectable influence on assemblages of aquatic species.

Element 2: Species/Habitat Condition

2.1 Scale

Due to the large land area covered by the major watershed groups (Figure 3), a fine scale classification (Figure 4) was used, when possible, to assess the relative condition of aquatic habitats across the state. The types and sources of information were extremely variable and covered many different scales, and so the following sections refer to both the major and fine scale systems. The actual scale at which the natural conditions and processes lead to differences in aquatic communities is unknown.

The low non-tidal watershed group can be divided into two smaller units, the upper Merrimack inner basin (fine scale system 12) and the lower Merrimack drainages (fine scale system 11) (Figure 4).

2.2 Relative Quality

The upper Merrimack inner basin (fine scale system 12) encompasses 899.9 km^2. It consists of 81% small headwater streams (watershed area <48.28 km^2), 8% small rivers (watershed area of 77.70-518.00 km^2) that drain into the large mainstem of the Merrimack River, and 11% large rivers (watershed area >2590 km^2). This system lacks the full range of river sizes typical of most other watershed groups. The lower Merrimack group (fine scale system 11) encompasses 1,422 km^2 and contains a greater variety of river sizes, with 8% small rivers, 4% medium-sized rivers (watershed area of 518.00-2590 km^2), and 4% large rivers.

There are 429 lakes and ponds with a surface area greater than 1 acre in the low non-tidal watershed group. Of these water bodies, 137 are greater than 4.05 ha (10 ac). The group has a relatively high density of lakes greater than 4.05 ha (5.4/100 km^2), behind the low-moderate and moderate south watershed groups (Figure 3).

Deep, coarse sediment left by retreating glaciers creates a number of unique communities, including pine barrens, floodplain forests, and inland sand dunes along the banks of the upper Merrimack River (fine scale system 12). The river corridor is used by bald eagles (*Haliaeetus leucocephalus*) during winter and as a migration route for songbirds in the spring and fall. The Merrimack River is important habitat for freshwater mussels, including the state endangered brook floater (*Alasmidonta varicosa*). The river also provides important spawning habitat for anadromous fish such as alewives, American shad, blueback herring, Atlantic salmon, and sea lamprey (*Petromyzon marinus*) (USFWS 2000).

In addition to the mainstem of the Merrimack River, fine scale system 11 contains a number of low gradient, meandering streams and small rivers that join the Merrimack River in Massachusetts. The vegetated shorelines of the lakes, rivers, and ponds in these watersheds provide important habitat for many uncommon or rare native fish such as the banded sunfish (*Enneacanthus obesus*), redfin pickerel (*Esox americanus americanus*), and bridle shiner (*Notropis bifrenatus*). These three fish species commonly use the abundant wetlands in this system, which often grade into pond or stream habitats. The connections between open water, wetland, and upland habitats is critical to the many species of fish, amphibians, waterfowl, and turtles that use multiple habitat types throughout their life cycles. Beyond the urban areas of Manchester and Nashua, much of the headwaters of the lower tributaries to the Merrimack River, such as the Squanacook and Nissitissit Rivers, remain forested.

2.3 Population Management Status

N/A

2.4 Relative Health

Land Use

The lower Merrimack River and its surrounding watersheds (fine scale system 11) are in the fastest growing part of New Hampshire (SPNHF 2005). The population grew by an average of 12,498 people per year between 1990 and 2000. Road density is the highest in the state at 2.77 km of road/km^2 of land area. The upper Merrimack River corridor (fine scale system 12) is close behind with the second highest road density (2.39 km/km^2). The population is increasing the fastest along Interstate 93, which parallels the mainstem of the Merrimack River (SPNHF 2005). A proposed expansion of this highway will put increasing development pressure on these systems. The well-drained, sandy soils of these watersheds are highly suitable for development. Developed land currently makes up 17.5% of fine scale system 11 and 15% of fine scale system 12. These proportions of developed land are twice that of the next closest system (the low tidal fine scale system 13 at 8%). Lake shorelines are a high priority for developers. Census blocks around 76 of the 470 lakes greater than 4.05 ha in low non-tidal watersheds are predicted to increase in density class by the year 2020 (TNC 2005).

The amount of agricultural land is also relatively high in fine scale systems 11 and 12 (5.9% and 6.6%, respectively). Chemicals, excess nutrients, and sediments that run off agricultural fields can degrade adjacent water bodies. Forested buffers around headwater streams can reduce the impacts of runoff from developed and agricultural land. The amount of forested land within 250 ft (76.2 m) of headwater streams in fine scale systems 11 and 12 is the lowest in the state at 63.06% and 63.64%, respectively. Further loss of forested buffers adjacent to headwaters will be detrimental to aquatic habitats throughout low non-tidal watersheds.

Water Quality

The Merrimack River was once listed as one of America's ten dirtiest rivers (NHDES 2000). The Clean Water Act has led to great improvements in water quality by regulating industrial sources of pollution. The upper Merrimack River has excellent water quality for a large river, although water quality monitoring does reveal some issues. While the river passes NHDES class B water quality standards during dry weather, the river exceeds standard levels of fecal coliform after heavy rains (Landry and Tremblay 2000). Volunteer sampling of invertebrates at sites along the river reveals a decline in the number of species from upstream to downstream (Landry and Tremblay 2000). The decrease in water quality after heavy rains and the decline in species richness downstream are signs of non-point source pollution. Although non-point source pollution is the major contributor of pollutants to the Merrimack River watershed, wastewater treatment facilities are also a significant source of phosphorous, nitrogen, and *E. coli* (USACE 2004). Although none of New Hampshire's waters meet water quality standards for mercury, the lower Merrimack and coastal watersheds of southeastern New Hampshire have been specifically identified as "mercury hotspots" (Evers 2005).

The mainstem of the lower Merrimack River has relatively poor water quality. Manchester and Nashua are the major sources of pollution through combined sewer outflows (CSOs), which occur when wastewater treatment facilities are bypassed during heavy rainfall. The cities are currently working with NHDES to reduce pollution from CSOs. There is less information about the watersheds of the tributaries that join the Merrimack River in Massachusetts. While the New Hampshire portions of these watersheds lack the point sources of the urban areas downstream, rapid development will likely have an increasing impact on water quality (Dunn 2002).

Hydrology

New Hampshire's aquatic ecosystems are fragmented by a history of small-scale industrialization, which resulted in a high density of small dams throughout the southern watersheds (NHDES 1999). There are 367 active dams in the lower Merrimack River watershed. The number of dams for every 10 km of river in fine scale systems 11 and 12 is 2.49 and 1.92, respectively. The proportion of free-flowing river reaches in fine scale systems 12 and 11 are the second and third lowest in the state, behind the lower Connecticut River. Only the Amoskeag Dam in Manchester has a fishway for upstream fish passage, which provides access to just 8 km (5 mi) of river upstream. The fishway is designed to allow anadromous fish to pass upstream during spring spawning runs. Design elements that regulate flow and a short operating season limit the effectiveness of the fishway for most freshwater fish species.

Culverts and stream crossings add to the aquatic habitat fragmentation caused by dams (Warren and Pardew 1999). With the highest road density in the state, these watersheds are extremely fragmented. The relatively high density of roads, parking lots, roofs, and driveways contribute to stormwater runoff from impervious surfaces. Not only does this runoff inject sediment and contaminants into water bodies, but it also alters local hydrological patterns (NHDES 1999), which can lead to significant alterations in stream geomorphology and aquatic habitats.

The Amoskeag Dam in Manchester, Garvin Falls Dam in Bow, and the Hooksett Dam in Hooksett are the 3 major hydroelectric dams on the Merrimack River. The operation of these facilities creates large impoundments, causes unnatural water level fluctuations above the dams, and alters flows below the dams. The three dams are currently undergoing relicensing, which presents an opportunity to improve fish passage at the Amoskeag fishway and install fish passage at the other two dams.

An estimated 1.2 billion L (320 million gallons) of water are withdrawn from the Merrimack River watershed per day for municipal drinking water, irrigation, and industrial uses (MRWC 2001). The NHDES has identified the lower Merrimack River as potentially impacted by water withdrawals. A local resident reported that the operation of the Methuen Falls hydropower project on the Spickett River repeatedly drained the river dry over the summer of 2002 and affected river flows well into New Hampshire (Low Flow Inventory 2004). North of Manchester, the upper Merrimack River watersheds (fine scale system 12) have a much lower rate of water withdrawals.

Invasive Species

There are 12 known invasive aquatic plant infestations in fine scale system 11 and 7 infestations in fine scale system 12. Not only do these systems have a relatively high number of infestations, but they also have the widest variety of invasive species, including variable milfoil (*Myriophyllum heterophyllum*), Carolina fanwort (*Cabomba caroliniana*), water chestnut (*Trapa natans*), and Brazilian elodea (*Egeria densa*).

Many non-native fish species, such as the common carp (*Cyprinus carpio*), smallmouth bass (*Micropterus dolomieu*), largemouth bass (*Micropterus salmoides)*, and black crappie (*Pomoxis nigromaculatus*), have become naturalized in water bodies throughout low non-tidal watersheds. The long-term effects of these species on native populations are poorly understood. Most non-native fish introductions result from illegal private stocking of sport fish (Estuarine and Freshwater Working Group 2005).

The state of New Hampshire is working on a comprehensive plan for the management of aquatic nuisance species (Estuarine and Freshwater Working Group 2005). The plan lists a number of species of exotic fish, including species from the snakehead family (Channidae), which have not yet established populations in New Hampshire. Exotic species are more often introduced when people release private aquarium fish into a lake or river. Urban areas tend to have higher incidences of exotic species introductions. The urban communities of Concord and Manchester on the mainstem of the Merrimack River, and Nashua on the Nashua River, present a great risk for the introduction of exotic species.

2.5 Habitat Patch Protection Status

The lower Merrimack River watersheds (fine scale system 11) and upper Merrimack River corridor (fine scale system 12) have the lowest percentages of unfragmented blocks of land (46.0% and 57.5%, respectively) compared to the other 13 systems. Of the total amount of unfragmented blocks of land, 13.6% are protected in fine scale system 11 and 18.6% in fine scale system 12. Public conservation land comprises 8.2 % of the total land area in fine scale system 11 (the lowest in the state) and 13.7% of fine scale system 12.

Both the upper sections of the Merrimack River (from the confluence of the Winnipesaukee and Pemigewasset Rivers in Franklin to Garvins Falls in Bow) and the lower sections (from the Bedford/Merrimack town line to the New Hampshire/Massachusetts state line) are designated river reaches in the Rivers Management and Protection Program (RSA 483).

2.6 Habitat Management Status

Management activities for aquatic habitats in low non-tidal watersheds include water quality monitoring, hydrological research and management, and anadromous fish restoration. The Merrimack River Watershed Council (MRWC) coordinates over 30 volunteer water quality monitoring groups through the Volunteer Environmental Water Quality Network (VEMN). The MRWC has also funded a number of studies, including an assessment of the Powwow River watershed and an analysis of water use throughout the Merrimack River watershed (Monnelly and Strauss 2001, MRCW 2001). Management plans have been developed for the upper and lower sections of the Merrimack River designated under the Rivers Management and Protection Act (RSA 483). While the mainstem of the Merrimack River receives considerable attention, there has been less focus on the smaller Merrimack River tributaries, such as the Spickett River and Beaver Brook, which join the main stem of the Merrimack River in Massachusetts.

There is an ongoing effort to restore anadromous fish populations in the Merrimack River watershed. Recent work has focused on improving downstream fish passage at hydroelectric dams (Jon Greenwood, NHFG Fisheries Biologist, personal communication). Returns of adult anadromous fish to the Merrimack River watershed in New Hampshire are limited by the effectiveness of upstream fish passages in Massachusetts. Relicensing of the Amoskeag, Hooksett, and Garvin Falls Dams, owned by Public Service of New Hampshire, provide opportunities to install or improve fishways. A fishway on the Hooksett Dam would provide access to excellent habitats in the Soucook and Suncook Rivers.

2.7 Sources of Information

Data from NHFG, volunteer water quality reports (VRAP reports coordinated through NHDES), watershed management plans (under the Rivers Management and Protection Program, RSA 483), and conversations with local watershed organizations were used to assess the status and relative quality of watershed groups.

2.8 Extent and Quality of Data

An evaluation of the Upper Merrimack Monitoring Program data validates the work of the volunteers who monitor water quality in the upper Merrimack River watershed (Landry and Tremblay 2002). Most monitoring has occurred along the mainstem of the Merrimack River. There is very little information about the smaller tributaries that feed into the Merrimack River.

2.9 Condition Assessment Research

While the New Hampshire Natural Heritage Bureau has identified rare and exemplary shoreline plant communities, there has been little work to identify rare or unique aquatic communities. Future surveys should attempt to identify aquatic communities indigenous to the low non-tidal watersheds, document the current ranges of invasive species, and assess the extent of habitat degradation in these watersheds.

Element 3: Species and Habitat Threat Assessment

Threats to aquatic habitats in low non-tidal watersheds are related to the rapidly increasing population density. Nonpoint source pollution will worsen with further increases in impervious surface area. The risk of invasive species introductions will increase with the number of people using and living near the water bodies in these drainages. Dams and poorly designed culverts are restricting the amount of habitat available to some species. Many other species are impacted by unnatural fluctuations in water level. Refer to the general threats section for: Transportation Infrastructure, Development (Fragmentation and indirect effects), Non-Point Source Pollution (Runoff and Sedimentation), Acid Deposition, Introduced Species, Altered Hydrology, Recreation, Unsustainable Harvest (Forestry Operations and Management), and Agriculture.

Element 4: Conservation Action

While land protection can help prevent further aquatic habitat degradation in low non-tidal watersheds, many heavily impacted areas will require restoration. A coordinated effort is needed to reduce fragmentation and impervious surface area in these watersheds. Setting limits on water withdrawals or water level fluctuations will have long-term benefits for fish and wildlife.

Refer to the general strategies section for: Transportation Infrastructure, Development (indirect effects), Fragmentation, Pollutants (Acid Deposition), Invasive Species, Altered Hydrology, Sedimentation, Recreation, Forestry, Pollutants (Stormwater runoff), and Agriculture.

Element 5: References

5.1. Literature

Dunn, J.W. Jr. 2002. Merrimack River five-year watershed action plan. Executive Office of Environmental Affairs – Massachusetts Watershed Initiative. Devens, MA.

Estuarine and Freshwater Working Group. 2005. State of New Hampshire Comprehensive Management Plan for the Prevention and Control of Aquatic Nuisance Species, Unpublished draft. Concord, New Hampshire, USA.

Evers, D. 2005. Mercury Connections: The extent and effects of mercury pollution in northeastern North America. Biodiversity Research Institute. Gorham, ME. 28 pgs.

Landry, S.C. and M.L. Tremblay. An Evaluation of the Statistical Power of Volunteer-Generated Data Compiled by the Upper Merrimack Monitoring Program. Upper Merrimack Monitoring Program

Landry, S.C. and M.L. Tremblay. 2000. State of the Upper Merrimack 1995-1997, a river quality report. Upper Merrimack Monitoring Program

Low Flow Inventory [Internet]. 2004. Merrimack River Basin. Massachusetts Executive Office of Environmental Affairs. Cambridge, MA. Available: http://www.mass.gov/dfwele/river/rivlow_flow_inventory/merrimack.html

New Hampshire Department of Environmental Services [NHDES]. 2000. State of New Hampshire 2000 section 305(b) water quality report. Concord, New Hampshire.

New Hampshire Department of Environmental Services [NHDES]. 1999. New Hampshire nonpoint source management plan. Concord, New Hampshire.

Northeast Aquatic Nuisance Species Panel [NEANS].

2003. Rapid Response to Aquatic Species in the Northeast: Developing an Early Detection and Eradication Protocol - Workshop Proceedings. May 20-21, 2003 Bar Harbor, Maine.

Merrimack River Watershed Council [MRCW]. 2001. Water demand analysis on the Merrimack River watershed: Data and literature on the water use of the Merrimack River watershed. Prepared for the Merrimack Watershed Team.

Monnelly, A., and J. Strauss. 2001. Powwow River watershed assessment final report. Merrimack River Watershed Council (MRCW). Lowell, MA.

Society for Protection of New Hampshire Forests [SPNHF]. 2005. Population growth and land use changes: what they mean for the granite state. Society for the Protection of NH Forests, Concord NH.

The Nature Conservancy (TNC). 2005. New Hampshire Lakes Classification. Unpublished draft submitted to the New Hampshire Fish and Game Department.

United States Army Corps of Engineers [USACE]. 2004. Merrimack River Watershed Assessment Study: Screening Level Model. Prepared for Merrimack River Basin Communiy Coalition.

United States Fish and Wildlife Service [USFWS]. 2000. Strategic Plan for the Restoration of Anadromous Fish to the Merrimack River. Central New England Fishery Resources Complex. Nashua, NH.

Warren, Jr., M.L. and M.G. Pardew. 1999. Road crossings as barriers to small-stream fish movement. Transactions of the American Fisheries Society 127: 637-644.


Watershed Groupings:
NON-TIDAL
COASTAL
N
0 15 30
Miles