HABITAT PROFILE

Connecticut River Mainstem Watersheds

Associated Species: Alewife (Alosa pseudoharengus), American Eel (Anguilla rostrata), American Shad (Alosa sapidissima), Atlantic Salmon (Salmo salar), Atlantic Sturgeon (Acipenser oxyrhynchus), Blueback Herring (Alosa aestivalis), Brook Trout (Salvelinus fontinalis), Rainbow Smelt (Osmerus mordax), Sea Lamprey (Petromyzon marinus), Slimy Sculpin (Cottus cognatus), Tessellated Darter (Etheostoma olmstedi)
Federal Listing: Not listed
State Listing: Not listed
Global Rank: Not ranked
State Rank: Not ranked
Authors: New Hampshire Fish and Game and The Nature Conservancy

Element 1: Distribution and Habitat

1.1 Habitat Description

The unifying feature of the Connecticut River watershed group is the Connecticut River mainstem and its smaller tributaries on both sides of the Vermont-New Hampshire border. Bedrock geology is more calcareous in this watershed group than in any other in New Hampshire. Bedrock geology changes dramatically on the Vermont side, becoming even more enriched. This enriched bedrock extends into New Hampshire towns immediately adjacent to the Connecticut River. Despite the potentially distinct geologic difference between New Hampshire and Vermont, the aquatic species moving throughout the Connecticut River and its immediate tributaries are likely to be similar. Large-scale threats and land-use patterns are similar throughout the Connecticut River corridor.

Watersheds in this group have moderate elevations and moderate or gentle hill and side slopes. Every watershed in this group borders or encompasses the mainstem of the Connecticut River, and so there are also low floodplain terraces and wet flat landforms.

The Connecticut River mainstem, tributaries, and small headwater streams provide a wide range of aquatic habitats for both warm and coldwater species. Small coldwater streams that only support brook trout can occur in close proximity to larger, warmer streams. Rivers in this watershed group can have diverse habitats with moderate and slow moving sections and a variety of substrates and vegetation.

Connecticut River fine scale systems: 1, 2
Elevation is the dominant characteristic that splits the Connecticut River watershed group into two distinct systems. Fine scale system 1 is a more northerly, upstream collection of watersheds. It is higher in elevation with slightly more side slope and hilltop landforms. The Connecticut River mainstem meanders through large adjacent floodplains in this region. Fine scale system 2 has slightly more calcareous bedrock, more than any other watershed type in the state, which is mixed with acidic bedrock. In this area, the Connecticut River mainstem is more confined, flowing through deep coarse sediment rather than the deep fine sediment of wetlands and floodplains in fine scale system 1.

1.2 Justification

Like the Merrimack River, the Connecticut River represents one of the few large river habitats in the state or in the region that has the potential to support the full suite of diadromous fish species, such as Atlantic salmon (*Salmo salar*), American eel (*Anguilla rostrata*), river herring (*Alosa pseudoharengus* and *Alosa aestivalis*), American shad (*Alosa sapidissima*), and sea lamprey (*Petromyzon marinus*). Large rivers provide critical and unique habitats for wide-ranging species, and they require representation across wide geographies.

The Connecticut River watershed is the focus of rare species restoration and monitoring. For example, it is one of the few rivers in the world that still supports healthy and reproducing populations of the dwarf wedgemussel (*Alasmidonta heterodon*), a federally endangered species, and the cobblestone tiger beetle (*Cicindela marginipennis*), a state endangered species. The Ashuelot River, a tributary of the Connecticut River, also supports the dwarf wedgemmussel. The Connecticut River has been the subject of rare diadromous fish restoration, focusing on Atlantic salmon.

1.4 Habitat Distribution

Except the Lower Ashuelot River, watersheds in this group include substantial portions of the Connecticut River mainstem. The Ashuelot River watershed extends up through Keene, sharing landform, geology and elevation characteristics. The northernmost extent of this watershed group (approximately in Northumberland) occurs where the Connecticut River becomes less like the mainstem of a large river and more like the headwater tributary to a large river.

1.8 Extent and quality of data

The strongest parameter defining this watershed group is the enriched calcareous geology along the Connecticut River mainstem. The moderate elevation and the combination of landforms were similar to other moderate elevation watershed groups. The watersheds in the southwestern corner of New Hampshire were particularly difficult to assign to a specific watershed group, given their similarity with watersheds in other parts of New Hampshire. Despite these uncertainties, the Connecticut River mainstem unifies this collection of watersheds. The connected geography, the need to consider the Connecticut River mainstem as one system, and the similar human uses and threats all support the definition of this watershed group.

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 uncertain.

The large river ecosystem of this watershed group is divided into two fine scale systems (Figure 4). Fine scale system 1 includes 5 watersheds of the Connecticut River in central western New Hampshire (from Northumberland to Lebanon). Fine scale system 2 includes 6 watersheds of the Connecticut River in southwestern New Hampshire (from Lebanon to the New Hampshire/Massachusetts border). All watersheds in the Connecticut River watersheds group have similar connectivity and large river ecosystem characteristics.

2.4 Relative Quality of Habitat Patches

Fine scale system 1 encompasses 1078 km^2 (266,308 acres) in New Hampshire. Headwater streams (watershed area <48.28 km^2) are the most dominant stream/river type in this system, comprising 75% of the total stream area. Large rivers (watershed area >2589.99 km^2) comprise 24% and small rivers (watershed area of 77.70-518.00 km^2) comprise 1%. The most dominant elevations are moderate (243.84-518.16 m) and low (6.10-243.84 m) elevations, at 68.2% and 23.2%, respectively.

The Connecticut River Rapids Macrosite is recognized for high concentrations of ecologically significant habitats and rare, threatened, and endangered species at both federal and global levels (Francis and Mulligan 1997). It extends from the confluence of the Connecticut and Ompompanoosuc Rivers (across from Hanover) to Claremont. A section of the macrosite falls within fine scale system 1. The greatest percentages of rare, threatened, and endangered species occur in the Hanover-Lebanon area. Dwarf wedgemussels occur within the macrosite. The area is used by migratory shorebirds, provides summer habitat for bald eagles, and supports Jesup's milk vetch (*Astragalus robbinsii* var. *jesupii)* in its floodplains (Francis and Mulligan 1997).

Fine scale system 2 encompasses 1097 km^2 (271,020 acres). Headwater streams are the most

dominant stream/river type in this system, comprising 86% of the total stream area. Large rivers, medium rivers (watershed area of 518.00-2,589.99 km^2), and small rivers comprise 7%, 4%, and 2%, respectively. Moderate and low elevations dominate the area, at 51.6% and 46.8% of the watershed.

Within fine scale system 2, the Connecticut River offers a mosaic of habitat types for aquatic species. Numerous rapids and riffles provide suitable coldwater fish habitat. The Connecticut River Rapids Macrosite continues from fine scale system 1 downstream to Claremont. Deeper and slower water further downstream provides habitat to warmwater fish species. Confluences of feeder tributaries and the Connecticut River mainstem are important aquatic habitats that provide thermal refuges (Francis and Mulligan 1997).

Areas around the Vernon Dam impoundment and Ashuelot River confluence in Hinsdale provide necessary nesting and wintering habitat for waterfowl, ospreys, and eagles (Francis and Mulligan 1997, Zankel 2004). The Ashuelot River watershed provides suitable habitat for great blue heron (*Ardea herodias*) colonies and rookeries, containing 7.5% of the statewide population. Common loons (*Gavia immer*), blue-gray gnatcatchers (*Polioptila caerulea*), and common nighthawks (*Chordeiles minor*) have been observed nesting and feeding along the Ashuelot River (NHDES 1993).

Throughout the lower and middle sections of the Connecticut River watershed group, lakes and ponds with surface areas less than 4.05 hectares (10 acres) are the most abundant (96% of the total number of lakes and ponds). There are relatively few larger lakes and ponds. For lakes and ponds greater than 4.05 hectares, there is an average density of 1.25 lakes/ponds per 100 km^2 of land. Moore Reservoir (3,490 acres) is the only lake greater than 405 hectares (1,000 acres). Fifty-three percent of lakes and ponds are at elevations of 6.10-243.84 m (20-800 ft) and 46% are at elevations of 243.84-518.16 m (800-1,700 ft).

2.2 Relative Health of Populations

Land Use

Bank erosion from water level fluctuations, boat wakes, and upstream bank stabilization projects have been identified as significant problems, especially in Haverhill. Bank erosion is projected to increase from rising trends in recreation and development (Francis and Mulligan 1997). A survey of 1,300 landowners along the Connecticut River indicates bank erosion as the primary landowner concern (NHDES 1999).

In fine scale system 1, most land within 0.40 km (0.25 mi) of the Connecticut River consists of sparsely settled farms and forests, with 8.4% of total land area classified as agricultural (Francis and Mulligan 1997). There is less fragmentation compared to downstream areas of the Connecticut River. Total land area consists of 79% unfragmented land and 2.9% developed land. The highest densities of development (residential, commercial, and industrial) occur in the Lebanon and Hanover areas (Francis and Mulligan 1997). The estimated population for 2005 is 25,869 people (15 people/km^2). The density of roads (expressed as km of road/ km^2 of total land area) maintained by the New Hampshire Department of Transportation (NHDOT) is 0.66 km/km^2 and the density of private/gravel roads is 0.42 km/km^2.

The northern areas of the Connecticut River in fine scale system 2 are predominately rural and undeveloped. Fine scale system 2 has the highest density of agricultural land in New Hampshire at 8.5% of total land area. Total land area consists of 74% unfragmented land and 4.3% developed land. The estimated population for 2005 is 37,696 people (20 people/km^2). The density of roads maintained by NHDOT is 0.79km/km^2 and the density of private/gravel roads is 0.66km/km^2.

Housing increases for census blocks adjacent to lakes and ponds in the Connecticut River watershed group were estimated using 1990 values and projected 2020 values (see Lake Type Classification for methods). Changes between rural (<0.063 housing units/ha), exurban (0.063 to 0.25 units/ha), and suburban (0.25 to 2.5 units/ha) housing densities could indicate increases in shoreline development, impervious surfaces, and non-point source pollution. Census blocks are expected to change from exurban to suburban around 38 lakes and from rural to exurban around 120 lakes.

Water Quality

Water quality in the Connecticut River watershed has gradually improved over the past few decades. Algal blooms, sedimentation, erosion, and bacterial, point,

and non-point source pollution still occur (Francis and Mulligan 1997). In 1986 and 1987, chromium and PCBs were found in fish tissue in the Connecticut River.

The Connecticut River Management Plan expressed the need for more long-term water quality monitoring data. A 1995 NHDES survey of Moore Reservoir indicates an improvement in water quality. The reservoir was classified as eutrophic by NHDES in 1979 and reclassified as oligotrophic in 1995 (NHDES 1995).

In 2004, levels of dissolved oxygen, pH, specific conductance, temperature, and bacteria were adequate to support aquatic habitats at 24 of 29 sampling stations in the middle and lower Connecticut River. In five sampling stations, there were low pH levels, invasive species (Eurasian milfoil (*Myriophyllum spicatum*)), or high concentrations of metals (aluminum and copper), which render these areas not fully supportive as aquatic habitat (Connecticut River Joint Commission 2004).

A wastewater treatment facility in Lebanon has a combined sewer outflow (CSO) that can be overwhelmed during heavy storms. Two treatment facilities in Vermont (St. Johnsbury and Springfield) have CSOs that may deposit untreated waste into tributaries of the Connecticut River mainstem during storms (Francis and Mulligan 1997).

Surface water quality monitoring of the Ashuelot River was conducted in 2003 as part of the NHDES Volunteer Rivers Assessment Program (VRAP). Dissolved oxygen and turbidity levels met state requirements for class B waters at all sample sites. Increased turbidity levels were observed near urban areas. The range of pH values (pH 5.47-7.36) was below state water quality standards for class B waters (pH 6.50-8.0). Natural environmental conditions (e.g., soils, geology, and wetland drainage) and acid deposition can lower pH values. In some locations, total phosphorus exceeded the NHDES total phosphorus level of concern (>0.05 mg/L). Phosphorus values increased near urban locations (NHDES 2003).

The number of National Pollution Discharge Elimination System (NPDES) permits regulated by NHDES per river kilometer is 0.029 permits/river km for fine scale system 1 and 0.014 permits/river km for fine scale system 2. The number of NPDES permits in fine scale system 1 is relatively high when compared to other systems in New Hampshire.

Invasive Species

There is a high potential for the spread of introduced invasive species in the Connecticut River watershed. The high recreation rate, suitable water chemistry, and close proximity to infected waterbodies (e.g., zebra mussels (*Dreissena polymorpha*) in Lake Champlain) could lead to exotic species infestations (Francis and Mulligan 1997). There are no documented occurrences of exotic aquatic plants in fine scale system 1 (Smagula 2004). In fine scale system 2, there have been 3 infestations of exotic aquatic plants. Eurasian milfoil was detected in the Connecticut River (Charlestown) in 1995. Variable milfoil (*Myriophyllum heterophyllum*) was found in Forest Lake (Winchester) in 1998 and the Ashuelot River (Winchester) in 2000 (Smagula 2004).

Several non-native fish populations have become naturalized in the Connecticut River. Increased water temperatures and enhanced habitat from large impoundments facilitate proliferation of these species. Several of these fish provide sport-fishing opportunities. Largemouth bass (*Micropterus salmoides*), smallmouth bass (*Micropterus dolomieu*), walleye (*Stizostedion vitreum vitreum*), black crappie (*Pomoxis nigromaculatus*), northern pike (*Esox lucius*), rock bass (*Ambloplites rupestris*), and rainbow trout (*Oncorhynchus mykiss*) are examples of species that have naturalized populations (Francis and Mulligan 1997, Estuarine and Freshwater Working Group 2005).

To assess the likelihood of recreation or stocking contributing to invasive fish and aquatic plant introductions, the degree of remoteness of lakes and ponds was analyzed using GIS. The results indicate that 92% of lakes and ponds are within 500 m of a trail or road, 5% are enclosed by a protective buffer of 500-805 m without a mapped road or trail, and 3% are enclosed by a protective buffer of 805-1609 m without a mapped road or trail. No lakes or ponds have a buffer greater than 1609 m (1 mile).

Hydrology

There are approximately 111 active dams/impoundments in fine scale system 1 and 214 in fine scale system 2, which vary from large river impoundments for hydroelectricity production to small earthen dams that create wildlife ponds.

There are 0.034 impoundments/river km in fine

scale system 1 and 0.044 impoundments/river km in fine scale system 2. Fifty-three percent of the Connecticut River mainstem in New Hampshire and Vermont is impounded by 14 dams (Francis and Mulligan 1997). Targeted research on the ecological implications of flood control and hydroelectric dams along the Connecticut River mainstem and tributaries showed that altered flow rates affect the characteristics of river bottoms and adjacent floodplains. Impoundments resulted in habitat fragmentation and affected natural aquatic communities (NHDES 1999).

Moore Reservoir in Littleton is New Hampshire's largest undeveloped lake and New England's largest hydroelectric facility. New England Power Company owns the 49.6 km shoreline of this 1,412.35 ha reservoir (NHDES 1995, Francis and Mulligan 1997). Seasonal water level drawdowns of Moore Reservoir and Comerford Reservoir in Monroe vary from 9.14-12.19 m (30-40 ft) (Francis and Mulligan 1997). In both 1979 and 1995, NHDES noted the absence of rooted plants in Moore Reservoir due to water levels fluctuations (NHDES 1995).

2.3 Population Management Status

N/A

2.5 Habitat Patch Protection Status

Conserved land in fine scale system 1 comprises 17.8% of the total land area. Twenty-one percent of unfragmented land is protected through conservation. In fine scale system 2, 13% of the total land area and 16% percent of the unfragmented land is protected through conservation.

The Ashuelot and Connecticut Rivers are designated in the New Hampshire River Management and Protection Program (RMPP)(NHDES 2004). The RMPP regulates dam construction, instream water flow levels, channel modification, water quality, solid waste and hazardous waste storage/treatment facilities, and motorized boating traffic.

2.6 Habitat Management Status

It is difficult to assess the efforts to restore and manage habitats at such a broad level. A database of conservation groups may enhance cooperative efforts and eliminate repetitive or redundant projects.

There are conservation and management plans for the Ammonoosuc, Ashuelot, and Connecticut River watersheds. These plans identify ecologically significant areas and guide human use and management of these areas (Francis and Mulligan 1997, Ammonoosuc Conservation Trust 2004, Zankel 2004). Public outreach and education are identified as useful tools for conserving and restoring these watersheds. These plans provide highly detailed information at localized levels and should be used to help identify sensitive areas, local impacts, and management actions. The Connecticut River Management Plan (1997) is currently under revision.

Several agencies are actively involved in habitat restoration projects and identifying potential areas of habitat enhancement or improvement. Ongoing or recently completed projects include riparian buffer stabilization, stream bank erosion inventories, creating a task force for dam removal, landowner education, NHDES fish biomonitoring, and annual river clean ups. Ongoing habitat restoration focuses on Atlantic salmon, American shad, and blueback herring.

2.7 Sources of Information

A watershed classification based on geological, topographical, climactic, and connectivity attributes, developed by TNC, was used to define scale. Watershed management plans, GIS analyses, and anadromous fish restoration plans were used to identify significant habitats, relative condition, quality, and ongoing management and restoration efforts.

2.8 Extent and Quality of Data

Information on current habitat quality and restoration was highly concentrated on larger rivers. Smaller rivers in this watershed group were not well represented. Information from GIS analyses may not accurately represent all physical features.

2.9 Condition Assessment Research

Increased sampling of aquatic communities and water quality will provide more conclusive, long-term trend data. Additional monitoring would help identify the impacts of water flow alterations (e.g. erosion, changes in dissolved oxygen, and impoundments) on plants, fish, and other aquatic wildlife. Increased sampling of fish tissue throughout these watersheds may recognize

areas affected by contaminants. Habitat assessments, water quality monitoring, and aquatic community data are needed for the headwater streams and small tributaries of this watershed group. The pilot projects initiated by TNC in the Ashuelot River watershed should be expanded to other watersheds in this group to identify and protect additional areas of significant habitat.

Element 3: Species and Habitat Threat Assessment

Existing river management plans and GIS analyses indicate that non-point source pollution (especially sedimentation and stormwater runoff), altered hydrology, and invasive species are the primary threats to habitats in this watershed group.

Refer to the general threats section for Transportation Infrastructure, Development (Fragmentation, General), 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 Actions

The Connecticut River Management Plan, The Ashuelot River Management Plan, and the Ammonoosuc Watershed Region Conservation Plan contain strategies for conservation in this area.

Refer to the general threats section for Transportation Infrastructure, Development (Fragmentation, General), Non-Point Source Pollution (Runoff and Sedimentation), Acid Deposition, Introduced Species, Altered Hydrology, Recreation, Unsustainable Harvest (Forestry Operations and Management), and Agriculture.

Element 5: References

5.1 Literature

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Watershed Groupings:
CONNECTICUT
RIVER
MAINSTEM
N
0 15 30
Miles