Chapter 3

USFWS

Federally endangered Jesup's milk-vetch

Affected Environment

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Introduction

This chapter describes the existing physical, ecological, socioeconomic, and historical environment of the refuge and larger Connecticut River watershed. This description serves as the baseline condition for determining the potential environmental impacts of the four management alternatives we analyze in this draft CCP/EIS. See chapter 4 for full description of these four alternatives and chapter 5 for the analysis of the alternatives' environmental impacts.

This chapter is divided into three parts to describe the environment at different scales. Part I describes the entire watershed's environment. Part II provides more general refuge information, while part III provides more specific and information on the refuge's existing divisions and units.

Several appendixes include supporting documentation and descriptions used to compile this chapter. For example, appendix M describes resource plans we used as references. Consulting these individual plans would provide the reader more detailed information on a wide variety of resources of interest. Of particular note, we recommend readers consult the respective State Wildlife Action Plans for Connecticut, Massachusetts, Vermont, and New Hampshire. These plans provide a comprehensive description of each State's fish and wildlife, historic and current habitat trends, and species and habitats of elevated conservation concern (New Hampshire Game and Fish Department 2005, Connecticut Department of Environmental Protection Bureau of Natural Resources 2005, Vermont Fish and Wildlife Department 2005, Massachusetts Department of Fish and Game 2006).

As we noted in chapter 2, the amount of information about the watershed is impressive, and new plans and information are being produced at a rapid pace. We highlight below the information we think is most important to relate about the watershed and refuge resources; it is based on information that was available during preparation of this draft document. Some of this information may become dated before completing the final document, but we will provide updates before the final CCP is issued.

Part I: The Connecticut River Watershed Environment

Land Use: Historic and Current

As noted in chapter 1, our project analysis area is the entire 7.2 million-acre Connecticut River watershed, located in the Northeastern United States ("Map 1.1. Location of the Connecticut River Watershed and the Service's Northeast Region (Region 5)"). It covers portions of four states: New Hampshire, Vermont, Connecticut, and Massachusetts (a very small portion also occurs in Maine and Canada). Of the watershed's 7.2 million acres, 13 percent lies in Connecticut, 24 percent in Massachusetts, 28 percent in New Hampshire, and 35 percent in Vermont. The watershed also includes more than 20,000 miles of tributaries and streams (TNC 2013a).

Both historic and current land uses in the watershed have been, and continue to be, largely influenced by its diverse geography and the changing needs of society. The next two sections describe the land use history of the Connecticut River from its earliest settlement by humans to the current day. We also direct readers to some interesting facts about the watershed on the CRWC Web site (CRWC 2013; *http://www.ctriver.org/river-resources/about-our-rivers/watershed-facts/;* accessed December 2014)

Cultural and Historic Resources Overview for Connecticut River Watershed
Starting with the earliest human occupation of the Connecticut River watershed more than 11,000 years ago, the river has provided focus for settlement, cultural exchange, and travel. People have been influenced by the environment and the

types of natural resources that were available. In turn, they affected the ecology of the watershed through their activities and land use (Waller and Cherau 2011, T. Binzen, personal communication 2013).

According to archaeological evidence, the first inhabitants were Paleoindian explorers who entered a sparsely vegetated landscape dominated by lakes of glacial meltwater. These people were highly mobile. They exchanged stone materials over great distances, and preferred to live on sandy plains of glacial outwash (Waller and Cherau 2011, T. Binzen, personal communication 2013). These people

Over the ensuing millennia, the climate changed within the watershed and the types of vegetation and animal species evolved as well. The Native American inhabitants formed societies that occupied different topographic zones within the watershed, adjusting to shifts in climate and ecology. After 7,000 years ago, tools for fishing become more common in the archaeological record. Native settlement tended to focus in upland areas. After 3,000 years ago, the vegetation regime in the watershed became similar to what is seen today. Along the coast, sea levels stabilized and systems of estuaries took the form that can be recognized today. Native Americans reoriented their settlement systems to the valley floors and coastal areas. Vast seasonal runs of diadromous fish drew people to gather at waterfalls and rapids along the Connecticut River and its tributaries. In addition to hunting and fishing, horticulture played an increasing role in Native American subsistence, and settlements became larger and more permanent (Waller and Cherau 2011, T. Binzen, personal communication 2013).

The native peoples of the watershed belonged to the Algonquian culture, sharing a common language and social structure and following an annual subsistence cycle. Landscapes they inhabited were highly variable, from the mountainous headwaters in the north, to the broad verdant plains of the central valley, down to the southern tidal area. Through time, the river formed a common chain and a route for travel, exchange, and communication (Waller and Cherau 2011, T. Binzen, personal communication 2013).

When the first European explorers arrived on the lower Connecticut River in the early 17th century, they encountered large Native populations, including members of the following tribes: Western Abenaki in the upper Connecticut River valley; Squakheag in New Hampshire; Norwottuck, Agawam, Woronoco, and Pocumtuck in the middle valley; and Wangunk in Connecticut. Dutch and English traders competed for influence with tribes, incrementally working their way further up the river to centers of trade in present-day Hartford and Springfield. Competition between tribes increased as the fur trade made control of headwater areas more important (Waller and Cherau 2011, T. Binzen, personal communication 2013).

Between 1620 and 1700, colonial settlement was rapid in the lower watershed. Within the Connecticut River watershed in the Connecticut and Massachusetts Bay colonies, the establishment of townships followed a common pattern. Proprietors were granted tracts of land which they were expected to "improve" by felling trees, building farmsteads, and cultivating cropland. The soils of the lower valley were highly favorable for this enterprise. Simple industries such as sawmills, grist mills, and tanneries were ubiquitous on the streams and smaller tributaries. As late as 1700, however, the northern frontier of colonial settlement was not far above Springfield. The watershed from that point north to the French colonies of Canada was unfamiliar to the colonial settlers. In the aftermath of regional conflicts in the early and middle 1700s (including Queen Anne's War and the French and Indian War), the Native American inhabitants of the lands north

of the frontier were decimated by disease and conflict, and colonial settlement expanded progressively northward (Waller and Cherau 2011, T. Binzen, personal communication 2013).

During the Industrial Revolution in the 1800s, forms of land use transformed the ecology of the Connecticut River watershed. Agriculture, population growth, and a profusion of new industries characterized the southern portion of the watershed. The establishment of the planned industrial city of Holyoke, Massachusetts, was emblematic of transformations in the central and northern watershed. By the 20th century, the availability of electrical power meant that industrial enterprises could be established away from the watercourses on which they had previously depended (Waller and Cherau 2011, T. Binzen, personal communication 2013).

Forests and Farmland

The landscape of eastern North America was completely transformed by logging, land clearance, and agriculture during the 18th and 19th centuries (Torrey and Allen 1906; Fisher 1933; Raup 1966; Cronon 1983; Whitney 1994). In central New England, 50 to 80 percent of the forested uplands were converted to pasture, hay fields, and tilled land by the mid-1800s and supported thriving agricultural activity based upon livestock and crop production (Bidwell and Falconer 1941; Black and Brisner 1952). In the late 1800s and early 1900s, urban manufacturing jobs and homesteading opportunities in the fertile Midwestern United States lured the population from eastern farms and triggered broad-scale reforestation. By the 1940s, 60 to 85 percent of the land in New England supported forests (Baldwin 1942).

Historical and ecological data from north-central Massachusetts suggest that widespread and intensive human disturbance, namely in the form of land clearing by European settlers, led to a shift in forest composition. Prior to European settlement, there was regional variation in forest composition, where oak, chestnut, and hickory communities were common at low elevations and hemlock, beech, sugar maple, and yellow birch communities were common at higher elevations. After European settlement, forest composition changed markedly in response to human land practices, leading to a more homogenous and broad-scale forest composition, and the rates of vegetation change remained high, reflecting continuing disturbance on the landscape (Fuller et al. 1998). One author suggests that the dynamic equilibrium in the ecology of upland oaks, notably white oak, which existed for thousands of years, had been destroyed in the few centuries following European settlement due to land clearing, extensive clear-cutting, catastrophic fires, chestnut blight, fire suppression, and intensive deer browsing (Abrams 2003).

Agriculture and forestry are the two main land use industries in the upper portion of the watershed, often characterized by dairy farms along the main stem and a few of the tributaries and expansive pastures for livestock. A majority of the land along the river is zoned for limited residential use, but there are commercial and industrial sites. New England Power Company owns 117 miles of river frontage and manages it for timber, wildlife, and recreation (NHDES 1991).

Forests are no longer owned principally by large corporations. Between 1980 and 2005, ownership of almost 24 million acres changed hands in New England's Northern Forest Region, a distinct region of 26 million acres. Ownership shifted from industrial forest ownership to various new financial and non-profit investors (e.g., timber investment management organizations, real estate investment trusts, and conservation organizations). By 2005, financial investors owned about one-third of the large forest tracts and industry owned only 15.5 percent

(1.8 million acres, mostly in a single ownership). Despite the rapid turnover of timberland in the last decade, most forest blocks have remained intact, although there is a trend toward more forest owners with associated smaller parcel sizes (Hagan et al. 2005).

It is useful to understand broad patterns in land use for the watershed and how those patterns affect natural environments. Of all America's forests under pressure from development, New England's are shrinking the fastest. Connecticut and Massachusetts will lose the highest percentages of forest among all states by mid-century (Carpenter 2007). Although the region's forests made a remarkable comeback, since the early 20th century, these forests are being displaced and fragmented by ever-encroaching home development with larger homes and lot sizes. In a study released by Harvard Forest researchers titled *Wildlands and Woodlands,* following almost 200 years of natural reforestation, forest cover is declining in all six New England states (Foster et al. 2010). The authors of this report recommend conserving 70 percent of New England as "working and wild forestland," a target they say is critical to protecting vital natural benefits that would be costly, and in some cases impossible, to replace.

One example of land use trends in the watershed, described in the recent report *Losing Ground: Beyond the Footprint*, is that between 1971 and 1999 the land considered developed increased from 17 to 24 percent in Massachusetts, while "wildlife habitat," which is defined as forest, wetlands, and open water, declined from 70 to 64 percent. Massachusetts Audubon estimates that Massachusetts is losing 40 acres a day to development (DeNormandi 2009). Similarly, by 2050, 61 percent of Connecticut will be urbanized, according to a report in the Journal of Forestry (Nowak and Walton 2005) compiled by Forest Service researchers.

Potential future shifts in fuel and power production will also have an effect on the watershed's forests and rivers. The 4 states in the watershed are part of a 10-state agreement to limit greenhouse gas emissions (Carter, Ledyard, and Milburn LLP 2007). The 10 states have capped CO_2 emissions from the power generation sector, and agreed to a 10 percent reduction in these emissions by 2018. In order to meet that goal, the states are considering all viable alternative energy options such as wood biomass production mills, solar and wind-driven electrical generation, and hydropower. These alternative energy sources will influence the watershed forests and rivers due to the removal of trees and other vegetation to support biomass plants or to construct solar- and wind-farms and the use of water to cool biomass plant operations and to run hydropower generators.

Agricultural land uses continue to be a mainstay in the watershed. "Traditional" agriculture, such as dairy, apple orchards, and maple sugar production, is still prominent, although there has been some adaptation to fewer, larger dairies and organic dairies. "Niche" agriculture has become popular in the region over the last 10 years. For example, there has been an increase in farm stands, pick-your-own produce farms, community supported agriculture (CSA), community involved in sustaining agriculture (CISA), organic crop and grain production, farm cooperatives with local food markets and restaurants, organic meat production, farmers' markets, selling compost in bulk, and collecting and selling wild mushrooms (Taylor 2009). Tilled agricultural land is largely restricted to the valleys and lower slopes where prime soils occur. Dairy farms tend to be concentrated in the upper watershed, particularly in northern Vermont (Clay et al. 2006).

Agriculture is an ever-changing and dynamic industry. Farmland throughout the watershed is under pressure from the high value of land for development; between 1982 and 1997 the watershed lost 19 percent of its farmland and,

between 1997 and 2002, lost another 7.5 percent. Additionally, only 11 percent of prime farmland and 16 percent of non-prime farmland are protected (Clay et al. 2006). The profitability of farm businesses is a high-risk endeavor, making farmland conservation an immense challenge. Prominent challenges include: an aging farm community, reduction in the number of farm owners, land values rising faster than the income it can generate, loss of farmland, and the economic inability to permanently protect farmland (Clay et al. 2006).

Conserved Lands Network in the Watershed

The Connecticut River watershed has an extensive network of conserved lands equaling 1.5 million acres or 22 percent of the watershed ("Map 1.2. Conserved Lands in the Connecticut River Watershed"). Conserved lands in the watershed are permanently protected from development through deed or easement restrictions, but in some cases may allow or require land uses such as farming and forestry. Our source of data for existing conserved lands was obtained by TNC (2011).

Within the watershed, many agencies, organizations, and private individuals own and maintain conserved lands for a variety of different purposes. Those include: water supply, flood protection, timber production, agricultural use, recreational use, and fish and wildlife habitat. Some owners place a restriction on development simply for aesthetic reasons.

Table 3.1 and map 1.2 show estimated acres in the watershed held by various agencies and organizations. It is important to note that there are likely small parcels held by municipalities, small land trusts, or private landowners that are not in the database yet, and more are being added all the time.

Table 3.1. Conserved Lands in the Connecticut River Watershed by State as of October 2013.

	Connecticut	Massachusetts	Vermont	New Hampshire	Totals
Federal	428	11,149	215,699	238,173	465,450
State	78,407	345,013	172,236	150,742	746,399
Local[1]	42,820[1]	78,478	26,398	48,898	196,595
Private	39,199	48,860	179,467	214,182	481,710
Unknown[2]	2,502	6,468	0	**0**	8,970
Totals	**163,357**	**489,970**	**593,802**	**651,996**	**1,899,126**

Sources: Connecticut Department of Energy and Environmental Protection (CT DEEP; formerly CT DEP) Natural Resources Center GIS; Midstate Regional Planning Agency (CT); University of New Haven (CT); The Nature Conservancy (CT); MassGIS; NH GRANIT; Vermont VCGI; South Windsor Regional Planning Commission (VT); Northeastern Vermont Development Association; and the U.S. Fish and Wildlife Service.

[1] *This includes approximately 22,159 acres held to protect water supplies.*

[2] *This could not be determined from the data available.*

In the Connecticut portion of the watershed, about 163,357 acres (approximately 9 percent of total watershed conserved lands) are conserved (table 3.1). The State owns 48 percent of these acres, most of it secured as either State forest, park, or wildlife management areas. Local and municipal governments own

the next highest amount of conservation land at 26 percent, followed by private conservation lands at 24 percent

In the Massachusetts portion of the watershed, about 489,970 acres (approximately 26 percent of total watershed conserved lands) is in some kind of conservation status. The State owns 70 percent of these acres, and similar to Connecticut, most of it is secured as State forest, park, or wildlife management area, or water supply (e.g. Quabbin reservoir). Local and municipal governments own the next highest amount of conservation land at 16 percent, followed by private conservation lands at 10 percent (table 3.1).

In the Vermont portion of the watershed, about 593,802 acres (approximately 31 percent of the total watershed conserved lands) is in some kind of conservation status. Approximately 36 percent of these lands are Federal, including the U.S. Forest Service's Green Mountain National Forest and the Conte Refuge's Nulhegan Basin Division. Private lands make up another 30 percent of the total, followed by State lands which comprise approximately 29 percent (table 3.1).

In the New Hampshire portion of the watershed, about 651,996 acres (approximately 34 percent of the total watershed conserved lands) is in some kind of conservation status. Approximately 36 percent of these lands are Federal, including the U.S. Forest Service's White Mountains National Forest and the Conte Refuge's Pondicherry Division. Private lands make up another 33 percent of the total, followed by State lands at 23 percent, the bulk of which is Nash Stream State Forest.

Physical Environment

The watershed is part of several different regions based on topography and character: the Great North Woods of New Hampshire (*http://www.visitnh.gov/welcome-to-nh/about-the-regions/great-north-woods.aspx*; accessed December 2014), the Northeast Kingdom of Vermont (*http://www.nekchamber.com/;* accessed December 2014), the Upper Valley of Vermont and New Hampshire (*http://www.uppervalleychamber.com/uvtowns.html;* accessed December 2014), the Pioneer Valley of Massachusetts (*http://www.valleyvisitor.com/;* accessed December 2014), and the Tidelands of southern Connecticut (*http://www.ctrivergateway.org/*; accessed December 2014).

Traversing these regions the river changes course in response to elevation, gradient, and other physical features. The area of the watershed in the Northeast Kingdom includes mountains with elevations exceeding 3,000 feet. Here the river is a narrow, swift, cold-water stream that falls some 900 feet in 30 miles, the sharpest drop within the river's profile. There are three artificial impoundments within this northernmost section of the river: Second Connecticut Lake, First Connecticut Lake, and Lake Francis. Spruce-fir forests dominate this rural area.

As the river leaves the Northeast Kingdom, it travels from Pittsburg, New Hampshire, to Moore Reservoir near Littleton, New Hampshire. This stretch is characterized by elevations of 2,000 feet or less. Here the river is wider, slower, more meandering, while making its second greatest fall, dropping some 400 feet between Gilman, Vermont, and East Ryegate, Vermont. The width and slower flow here can be attributed in part to the presence of five dams.

Moving into the Pioneer Valley region, from approximately Moore Reservoir to Turners Falls, Massachusetts, the river flows through hilly and rolling country, with elevations of up to 2,000 feet and gradually drops 365 feet. This section of the river contains six dams. Farmland and dairies characterize this rolling landscape.

Continuing through the Pioneer Valley and into the Tobacco Valley of Connecticut—from Turners Falls, Massachusetts, to Middletown, Connecticut—the river is characterized by a wide elongated valley floor less than 500 feet above sea level, with adjacent uplands to the east and west that rise sharply in elevation. The river has an extensive floodplain and a gradual fall. There are two dams in this stretch of the river: one at Holyoke, Massachusetts, and one in Enfield, Connecticut. The Enfield Dam, built in 1827, has been in disrepair for many years and has naturally breached (Frisman 2002). These rich valley lands encompass some of the most valuable farmlands in the watershed and attracted settlement early in America's history.

South of Middletown, Connecticut, the area can be characterized as a plateau with a few hilly or mountainous elevations rising to 660 feet. Lands along the river are fairly steep and little valley floor exists. The river here is free-flowing and tidal, flowing through the most urbanized section of the watershed.

Moving into the Tidelands area, from Chester, Connecticut, south to Long Island Sound, the river continues its decrease in elevation, transitioning from uplands to tidal coves, extensive tidal marshes, meadowlands, and large estuarine islands. The mouth of the river is defined by sandy beaches and sheltered bays, as well as a number of offshore rocks, shoals, and shifting sandbars. Although this river delta and coastal plain landscape is highly urbanized, the Connecticut River is one of the few large rivers in the U.S. that does not have a major city at its mouth.

Geomorphology—History of Geological and Climatic Processes
The Connecticut River valley's current diversity it topography and natural communities is a product of millions of years of geologic, glacial, climatic, and erosive dynamics (Stinton et al. 2007, Freeman 2007) as confirmed by dated bedrock in the Berkshire Mountains (*http://www.bio.umass.edu/biology/conn.river/crvgeology.html*; accessed December 2014). Uplift and glaciation were the predominant geologic and climatic events that shaped the current landscape. The Connecticut River began in a rift valley formed as the supercontinent Pangaea broke apart 180 million years ago along the deep ocean mid-Atlantic Ridge, which also formed the Atlantic Ocean. This was followed by valley layers tilting during earthquakes to form the basalt "traprock" ridges—the Holyoke Range and Mount Tom in Massachusetts, and Connecticut's Metacomet Ridge that were more resistant to the subsequent glacial scouring that wore down adjacent sedimentary rock. Over millennia, sedimentary sandstones and conglomerates filled the valley, and eons of flooding events have deposited deep, accumulated layers of terraced silt loams through which the river flows today (Stinton et al. 2007).

The Laurentide glacier reached its maximum southern extent about 18,000 to 21,000 years ago, depositing enormous amounts of glacial till and outwash gravels to form a massive terminal moraine (Rittenour 2013). When the glacier melted back to the Hartford, Connecticut area, deposits blocked the whole valley, forming an earthen dam. Dammed meltwater formed glacial Lake Hitchcock, which stretched from Rocky Hill, Connecticut, to St. Johnsbury, Vermont, and existed for more than 4,000 years. As rivers drained into Lake Hitchcock, the heavy sand particles were deposited in deltas that formed sandplains in Windsor, Connecticut, Westfield, Massachusetts, Montague, Massachusetts, as well as a few other scattered locations. The finer clay particles that settled in the lake's bottom today support many wetland areas, and the rich sediments from the lake also provide for the productive agricultural lands in the Pioneer and Tobacco Valley regions (Rittenour 2013).

Bald eagle

Steve Maslowski/USFWS.

When the dam forming Hitchcock Lake finally breached, the Connecticut River receded to approximately its current location and started to erode the Hitchcock sediments. Over time, the river has changed its course in places and left some abandoned channels (oxbow lakes) creating ecologically important floodplain areas. Some of the scenic, narrow valley segments we see today became established where the sediments were more difficult to erode, leading to the creation of waterfalls and rapids (Rittenour 2013).

Hydrology and Water Quality

The movement of water through the watershed, its quantity and quality, and the impacts from human activities all play important roles in the management of the river system and the fish and wildlife populations that depend upon it. Many aquatic plants and animals are sensitive to stream flow and water pollution. The health of a river system and its watershed is reflected in the species it is able to support. Groundwater typically originates in upland recharge areas and moves to lower discharge points. Because groundwater percolates down through the soil, our land uses affect its quality and quantity (CRWC 2008).

The main stem of the Connecticut River is 410 miles long, draining well over 7 million acres of diverse rural and urban lands. It is the largest riverine ecosystem in New England. The Connecticut River and its watershed are largely defined by the occurrence, distribution, movement and properties of water, and its relationship with the environment through the hydrologic or water cycle. Like its land, the water is in high demand and is critical for many uses in households, businesses and industries; irrigation of farms; conservation of parklands, fish and wildlife habitat; and for production of electric power (USGS 2013, USFWS 1994).

Under the National Watershed Boundary System, the watershed is classified as a subregional hydrologic unit (i.e., hydrologic unit code (HUC) 0108) within the Northeastern Region, one of 21 national hydrologic regions (Mulligan 2009). Within this subregion, there are 10 watersheds officially recognized by the USGS and NRCS. The main stem of the Connecticut River receives water from 36 major tributaries, 26 of which drain 100 square miles or more (table 3.2; map 3.1).

Map 3.1. The Connecticut River and Its Major Tributaries.

Table 3.2. The Connecticut River's Major Tributaries.

River - State	River Miles (upstream of Long Island Sound)	Length (in miles)	Drainage Area (in square miles)	Fall (in feet)
Lieutenant - CT	3	5	12	33
Eightmile - CT	9	11	62	300
Salmon - CT	18	20	152	520
Hockanum - CT	50	22	82	510
Farmington - CT	57	47	602	350
Scantic - CT	59	35	113	900
Westfield - MA	75	57	517	1,780
Chicopee - MA	80	17	721	260
Manhan - MA	92	18	106	900
Sawmill - MA	114	12	30	660
Deerfield - MA/VT	119	73	664	2,900
Falls - MA	122	12	36	400
Millers - MA	126	45	392	900
Ashuelot - NH	140	64	421	1,475
West - VT	149	53	423	1,780
Cold - NH	172	15	110	1,000
Saxtons - VT	173	20	78	1,565
Williams - VT	176	24	118	1,330
Black - VT	183	40	204	1,055
Sugar - NH	195	27	275	800
Ottauquechee - VT	210	38	222	1,485
Mascoma - NH	214	34	194	1,015
White - VT	215	58	712	2,170
Ompompanoosuc - VT	225	20	136	800
Ammonoosuc - NH	226	56	402	4,560
Waits - VT	247	24	146	1,950
Wells - VT	266	16	100	680
Stevens - VT	277	7	49	435
Passumpsic - VT	280	23	507	245
John's - NH	303	9	76	200
Israel's - NH	312	21	135	1,445
Upper Ammonoosuc - NH	325	40	254	1,345
Paul Stream - VT	340	14	58	940
Nulhegan - VT	345	16	151	285
Mohawk - NH	359	11	92	850
Headwater Areas - VT/NH	372	29	304	875

The average annual runoff for the watershed as a whole is about 23 inches or about one half of the average annual precipitation (Federal Power Commission 1976). Daily flow at the mouth of the Connecticut averages nearly 16,000 cubic feet per second (cfs), similar to Hudson and Delaware Rivers. However, the flow has ranged as high as 282,000 cfs and as low as 971cfs. In the spring, daily flows average over 24,000 cfs, but drop to less than 5,000 cfs in late summer. Mean monthly river discharges are highest during April and May and lowest during August and September (USFWS 1994).

Water temperatures in many of the streams within the watershed closely follow seasonal air temperatures. Summer water temperatures in the mid-Connecticut River main stem average between 70° Fahrenheit to 80°F with temperature peaks sometimes reaching 90°F in July and August (USFWS 2010). Minimum water temperatures occur from December through March with ice often forming on water surfaces and temperatures ranging from the low to mid-30°F (USFWS 1995a).

The Upper Connecticut River watershed is mountainous, steep, and rugged. Streams, brooks, and rivers are fresh, and often descend quickly through this northern terrain, being fed through rainfall, snowmelt, and groundwater. Streamflow at the headwaters in New Hampshire can be just a trickle, often barely 1cfs. Streamflow increases southward as the area of land being drained increases and is about 10,000 cfs at the northern Massachusetts border. As a drowned river valley, the lower river is strongly influenced by waters of Long Island Sound. The Connecticut River discharges nearly 70 percent of the freshwater input into the Sound, thus exerting a major influence on this northeast estuary. The lower 60 miles of the Connecticut River from Long Island Sound to the Scantic River, 8 miles above Hartford, Connecticut, mix with sea water and are tidally influenced. The range of tide height during periods of low flow is from one foot at Hartford to 3.5 feet at the rivers mouth. The heavier saltwater moves under the overlying freshwater in a wedge and its "intrusion" upriver is dependent upon the amount of surface freshwater runoff, wind direction, and tide conditions (USFWS 1994).

The amount of salinity greatly affects the distribution of plants, animals, and habitat types in the lower river. For plants, the most significant salinity conditions for submerged and emergent plants are those that exist during the warm growing season. At the beginning of the growing season in early May, when river flows are at their peak, there is no detectable salt in the surface waters of the river estuary, regardless of the stage of the tide. However, as the summer season progresses, and the river flow decreases, the penetration of salt water and tidal influence increases, as does water temperature (USFWS 1994).

Fish and wildlife are adapted to natural, seasonal hydrologic events. Natural hydrology is greatly disrupted by artificial capture, holding, and release of river water for water supply, irrigation, snowmaking, flood risk reduction, electric power generation, and recreation. There are more than 2,700 dams of various sizes in the watershed and 18 main stem dams that impound over half the river's length ("Map 2.2. Locations of Dams Throughout the Connecticut River Watershed"). Less conspicuous than dams are the 44,000 road culverts that can fragment aquatic ecosystems and impede the natural movement of water, fish, and other aquatic organisms (TNC 2010).

There are 38 flood risk reduction projects operated by the USACE and almost 1,000 small dams on the tributaries that were built to power mills in the 1700s and 1800s. Flows, especially during low-flow periods, are highly regulated and restricted by dams in the watershed (Kapala and Brown 2009). Maintaining

a natural flow regime in such a highly controlled river system presents a tremendous challenge. The State of Connecticut adopted new stream flow regulations in 2011 (State of CT 2012), and efforts are underway by TNC and the USACE to develop a hydrologic model to better understand flow dynamics and use demands, thereby helping to more effectively manage human use of the river (UMass-Amherst 2012).

Water diversions out of the watershed are an important ecological consideration because flow and volume requirements for aquatic resources in the Connecticut River can be significantly impacted. The Quabbin Reservoir located on the Swift River in the Chicopee River drainage, stores runoff from an 86-square-mile watershed for the greater Boston area. Flows in excess of 85 million gallons per day in the upper Ware River are diverted to either the Quabbin or Wachusett Reservoirs. Out of watershed water diversions, including water from the main stem Connecticut River and Millers River, have been considered as a source of potable water for Boston. Fortunately, however, aggressive water conservation steps taken in Boston by the Massachusetts Water Resources Authority prevented diversions from the Connecticut River (Postel 2013).

The Connecticut River has undergone a dramatic transformation in the last three decades. During this time, a number of public agencies and private organizations have worked diligently to implement policies and measures aimed at improving the river's quality. Ample data collected over the years indicate that the actual water quality conditions of the Connecticut River, as measured by empirical parameters, have improved. The water quality of rivers and streams in the Connecticut River watershed has likewise improved considerably, with all waters now designated at least Class B. State water quality agencies actively work with industries, municipalities and agricultural groups to meet water quality standards within the watershed. However, point and nonpoint pollution is still a concern within the watershed.

Friends of Conte Refuge

Salmon River, Connecticut

Some municipalities in the watershed still have combined sewer systems. These systems are designed to treat both sewage and stormwater (as found in Hartford, Connecticut, and Holyoke and Springfield, Massachusetts) and often are inadequate to handle large storms, causing pulse overflows of raw sewage and stormwater into the Connecticut River and its tributaries.

"Nonpoint source pollution" also occurs in the watershed from land runoff, precipitation, atmospheric deposition, drainage, or seepage. Unlike "point source" pollution, nonpoint source pollution can not be traced back to specific site (e.g., a specific industrial or sewage treatment plant). Another form of nonpoint source pollution is hydrologic modification. Although soil erosion and sediment transport are natural processes, they can be aggravated by a particular use or recreation activity and alter hydrological processes (e.g., removal of vegetation, shoreline

erosion from excessive boat wakes) (USEPA 2012a). Common nonpoint pollutants include excess fertilizer, herbicides, and pesticides from agricultural, and residential lands; oils and toxic chemicals from urban and industrial areas; excess nutrients and bacteria from agricultural lands and livestock; and acids and other pollutants from abandoned mines and industrial areas.

The primary pollutants in the Connecticut River watershed are sediments, nutrients (e.g., nitrates and phosphorus), animal wastes, pesticides, salt, and various toxic chemicals (e.g., antifreeze, motor oil) (SCCD 2013). Most erosion within the watershed results from agricultural practices, construction, and fluctuating water levels within tributaries and the main stem river. Nutrient and sediment laden agricultural and urban runoff and landfill leachate contribute to pollution. Nutrient loads increase with increasing intensity of land use and with increasing population densities. Major sources of nutrients include atmospheric deposition, groundwater discharge, agricultural fertilizer and manure spread, urban nonpoint runoff from roads and impervious surfaces, and municipal wastewater discharge (USGS 1999).

Water quality in the watershed is affected by thermal pollution in certain locations. Thermal loading (i.e., increased water temperatures) resulting from impounding water behind dams and eliminating vegetative shading by clearing floodplain forests adversely affects indigenous wildlife, fish, and vegetation (Pace University 2000). The Vermont Yankee nuclear facility in Vernon, Vermont, uses water from the Connecticut River to cool the reactor, returning heated water to the river. The former Connecticut Yankee facility in Haddam, Connecticut, and the Rowe Yankee Nuclear Power Station in Rowe, Massachusetts, have been retired. Three fossil-fuel generating plants also use Connecticut River water for system cooling. Two of these are located in Massachusetts and one is in Connecticut.

The USGS sampled streambed sediments, fish tissues, surface water, and groundwater from a variety of sites in the Connecticut River watershed as part of its National Water Quality Assessment Program (USGS1998). The most common contaminants in sediments were chromium, copper, lead, mercury, nickel, zinc, chlordane, DDT (dichloro-diphenyl-trichloroethane), PCBs (polychlorinated biphenyls), and PAHs (polycyclic aromatic hydrocarbons). The most commonly detected compounds in fish were chlordane, DDT, DDE (dichloro-diphenyl-dichloroethylene) and PCBs. The highest concentrations are in the southern urban basins in Massachusetts and Connecticut.

The concentrations of PCBs and organochlorine pesticides in the Connecticut River were among the highest found in the country, and exceeded aquatic life criteria at several sites. Although most of these compounds are presently banned, they are very stable and still persist in the environment from applications that occurred prior to the ban. In general, the more chlorine present in a PCB, as there are many forms, the longer it will take to degrade and the more potential harm it may cause organisms.

Not only do PCBs persist in the environment for a long time, they also tend to bio-accumulate and bio-magnify. Pollutants that bioaccumulate are taken up and stored by organisms over time. Bio-magnification occurs when the concentration of these pollutants increase as they are transferred through the food web (i.e., predators have greater concentrations of a particular pollutant than their prey) (EPA 2012). Because of this, there are broad restrictions on eating many fish species, especially bottom-dwelling catfish and carp, from the Connecticut River in Massachusetts and Connecticut due to high PCB levels (MDPH 2011; CDPH 2013). A USGS (1998) investigation also detected a wide variety of pesticides, but concentrations in streams and groundwater were relatively low. Nitrate concentrations in shallow groundwater wells under agricultural areas

were usually greater than the national average, with 15 percent of these wells exceeding the drinking water standards (USGS 1998).

All four states recommend restricting the consumption of resident freshwater fish caught in the watershed due to elevated mercury levels from atmospheric contamination, notably for pregnant and nursing women and small children. Coal contains mercury, and airborne mercury is released in emissions from coal-fired power plants. Rates of mercury deposition are estimated to be higher in the northeastern U.S. relative to other parts of the country. This is widely attributed to the presence of coal-fired power plants in the region, and the airborne transport of mercury on the prevailing winds from power plants outside the region.

Soils

Soil type and distribution in the Connecticut River watershed has an important influence on the distribution of plant communities and wildlife. Soil elements such as calcium, nitrogen, phosphorus, and potassium are the principle nutrients needed by plants. The valley is recognized for its highly diverse soils, including the rich agricultural soils in the lower valley regions of Massachusetts and Connecticut. The watershed contains 221,000 acres of "prime farmland" soils (Clay et al. 2006). As defined by the USDA, prime farmland is farmland that has the best combination of physical and chemical characteristics for producing food, feed, forage, fiber, and oilseed products, and is also available for those uses (USDHHS 2011).

Due to the variety of bedrock in the watershed and the influence of glaciers, plant growth, climate variation, elevation, wind, and water-born erosion over millennia, hundreds of soil types exist within four major orders of soils: entisols, histosols, inceptisols, and spodosols. Upland soils are generally well drained and often formed from glacial till. Many soils formed from alluvium on floodplains, and sandy and gravely outwash exist on stream and river terraces. Organic soils are frequent in lowlands and wetlands (Villars 2009).

The variety of soils in the watershed is too extensive to present in this chapter, but examples range from the well-drained, Turnbridge glacial till that supports forests and agriculture in the Green Mountains, to the Cabot glacial till that supports wetlands and agriculture in the Vermont Piedmont, and the Windsor sandy glacial outwash series that supports intensive agricultural development and sand and gravel extraction (Villars 2009, USDA 2013).

State and county soil surveys are published by the National Cooperative Soil Survey, a joint effort of the USDA, other Federal agencies, State agencies and their agricultural experiment stations, and local agencies. NRCS has leadership for the Federal part of the National Cooperative Soil Survey. These surveys are comprehensive and provide useful information on soils and wildlife habitat (e.g., Connecticut Soil Survey 2009; *http://websoilsurvey.sc.egov.usda.gov/App/HomePage.htm*; accessed December 2014). NRCS provides detailed soil surveys for soil conservation districts that are aligned with county boundaries. The NRCS "Web Soil Survey" provides access to the largest natural resource information system in the world, and the agency has soil maps and data available online for nearly all of the nation's counties.

Climate

Present Climate

The climate and seasonality of the Connecticut River Valley play a large role in the terrestrial and aquatic habitats and species that inhabit the valley landscape. Climate indicates a region's general, seasonal patterns of temperature,

precipitation, humidity, wind, and air pressure. The current climate of the Connecticut River watershed is extremely varied and diverse for a variety of reasons. The watershed is influenced by the dynamic confluence of solar radiation, east-northeast moving continental air masses, the Hudson Bay's polar vortex, jet stream, and moisture from the Atlantic and Gulf of Mexico colliding over the unique geomorphology of the valley.

Hardiness zones are one indicator of long-term climate trends. The USDA determines hardiness zones based on the average annual minimum temperature during a 30-year period. The valley covers seven USDA plant winter hardiness zones, ranging in total from 0°F near Long Island Sound to -35°F in northern New Hampshire. Although hardiness zones are useful guides about the types of plants and animals that may occur in a given area, plants and animals are also adapted to other environmental factors related to climate, such as precipitation, humidity, and wind. Their nesting, spawning, germination, leaf-fall, migrations, and hibernations are all driven by seasonal climate and available light (Maleski 2009, Koch 2009).

The climate varies considerably depending on elevation and distance from the coast. The watershed is subject to frequent, but generally short periods of heavy precipitation because it lies in the path of prevailing westerly winds and cyclonic storms or "nor'easters." Serious blizzards occur, as witnessed in 1717, 1888, 1969, 1978, and the 1993 "Blizzard of the Century" that blanketed eastern North America. Ice storms occur with regularity. The valley is accustomed to major flood events, as occurred in 1913, 1927, and 1936. The central and lower portions of the valley are exposed to occasional coastal storms, some of tropical origin, that travel up the Atlantic seaboard. The greatest weather disaster ever to hit Long Island and New England was a category 3 hurricane referred to as the 163 mile per hour *Long Island Express* that roared up the Connecticut River valley in 1938 causing extensive damage. Watershed temperature extremes range from a recorded summer high of 105 °F in 1975 to a winter low of -50 °F in 1933. Average annual rainfall is over 40 inches. Average annual snowfall ranges from 40 inches in the lower valley to over 100 inches in the northern watershed (Maleski 2009, Koch 2009).

Climate Change

Climates are dynamic, although time frames for detectable changes typically are very long. Change is influenced by a number of major factors including the shape of the Earth's orbit, orientation of the Earth's tilt or axis, its wobble (precession) around its axis, variation in solar intensity, emissions from volcanic eruptions, and even continental plate tectonics. These climate change "drivers" often trigger additional changes or "feedbacks" within the climate system that can amplify or dampen the climates initial response (whether the response is warming or cooling). These drivers include glacial (cold) and interglacial (warm) periods, increases and decreases in the Earth's solar reflectivity, and changes in global ocean currents. When changes in the Earths orbit become more elliptical, it triggers a cold glacial period, and conversely, when the orbit is more circular it promotes a warm (or interglacial) period. Increasing concentrations of carbon dioxide may amplify the warming by enhancing the greenhouse effect. When temperatures become cooler, CO_2 enters the ocean thus minimizing the greenhouse effect and contributes to additional cooling. During at least the last 650,000 years, CO_2 levels have tended to track the glacial cycles (IPCC 2007, Mithen 2003, and USEPA 2013).

There have been irregularities in the transition from the Last Glacial Maximum of 20,000 BC to the present with an abrupt warming around 13,000 BC and then an abrupt cooling around 10,000 BC. Even within the last 2,000 years,

there have been irregularities including the warming period from about 900 to 1300 AD and the "Little Ice Age" from 1500 to 1850 AD. These changes can be explained by the interactions of the influences mentioned above. However, there is now sufficient evidence to unequivocally support the scientific consensus that manmade pollutants are warming the climate. Recent, historically unprecedented levels of greenhouse gases are being released into the atmosphere, largely from the combustion of fossil fuels, exacerbating the influences noted above, anthropogenically raising average global temperatures and causing changes in the global climate due to a stronger greenhouse effect. Predicted changes for the northeast, like less snow cover, more frequent large rain events, and more frequent fall droughts, could negatively affect native plants and wildlife (IPCC 2007, Mithen 2003, and USEPA 2013).

In the northeast, annual temperatures have increased an average of 0.14 °F per decade since 1900. However, this increase has sped up in recent decades. Since 1970, the average annual temperature has increased 0.5°F per decade (Union of Concerned Scientists 2006). Winters have been warming even faster—by 1.3°F per decade since 1970. If we remain reliant on current sources of energy, annual temperatures are projected to increase a total of 6.5 to 12.5 °F by 2100. This projection is reduced by roughly half, if present energy sources are replaced with more renewable sources that minimize the carbon footprint. On the present trajectory, summers in upstate New York may resemble those currently experienced in South Carolina or Georgia by 2100 (Union of Concerned Scientists 2006).

Climatic changes are expected to alter current precipitation patterns (Union of Concerned Scientists 2006). Winter precipitation is projected to increase and to fall more as ran than snow. Rainfall intensity is expected to increase, with more frequent periods of heavy rainfall. More storms are expected to travel further up the eastern seaboard. Rising temperatures are expected to increase evaporation rates and reduce soil moisture, leading to more frequent short-term droughts in the summer and fall (Union of Concerned Scientists 2006). Data available from the northeast from 1900 to 2001 show an average growing season of 190 days in the early to mid-1990s, but this has since increased to a 200-day growing season (Koch 2009). Earlier emergence of plants in spring has the potential to disrupt phenological relationships of plants and animals (e.g., insect emergence synchronized to flower blooming may occur before spring migrating birds arrive, thereby diminishing a critical food source).

Red eft

USFWS

The Northeast Climate Impacts Assessment (NECIA) is an effort between the Union of Concerned Scientists (UCS) and a team of more than 50 independent experts to develop and disseminate a new assessment of climate change, impacts

on climate-sensitive sectors, and solutions in the northeastern United States. According to the NECIA, "continued warming, and more extensive climate-related changes to come could dramatically alter the region's economy, landscape, character, and quality of life" (Frumhoff et al. 2007). Some predict that in the next century, ranges of New England's northern hardwood and boreal spruce-fir forests could retreat north, and be replaced with forests that are common today in southern New England and/or the Mid-Atlantic states with losses of Bicknell's thrush, snowshoe hare, and Canada lynx. Northern hardwoods (American beech, yellow birch, and sugar maple) may persist, but the optimal climate zone may shift northward 350 to 500 miles. The impacts on wildlife and fish communities, as we know them today, could be profound (Frumhoff et al. 2007). Since wildlife species are closely adapted to their environment, their survival is at risk if they are unable to adapt to a changing climate and its effects on habitat. This is compounded by existing stressors such as invasive species and air and water pollution. There is an urgent need to manage preemptively to better enable species and habitats to adapt (Frumhoff et al. 2007).

Analysis of breeding bird survey data over a 26-year period shows a northward range expansion (9 of 27 species studied), with an average shift of about 1.46 miles per year (2.35 kilometers per year). No significant shift to the south was observed (Burns 2008). Trout habitat may shrink 50 to 100 percent by next century; hemlock woolly adelgid will steadily move north thereby removing hemlocks and reducing shade that moderates stream temperatures, among other impacts; and Lyme and hemorrhagic diseases will expand as insect vectors move north. Only a third of current national wildlife refuges in the Northeast Region will be in same biome by 2100 (Inkley 2008, Union of Concerned Scientists 2006, Frumhoff et al. 2007). Changes in fall temperatures could affect the timing and vibrancy of the fall leaf colors, an important tourism feature of the region. "Southern" invasive species such as kudzu vine may expand its range northward.

Greater winter rainfall and earlier snow melt may lead to higher flow levels and flooding during spring run-off (Inkley et al. 2004, Union of Concerned Scientists 2006). In contrast, summer low-flow periods may extend impacting riparian habitats and in-stream fish, wildlife and invertebrate populations (Koch 2009). Aquatic and riparian species will need to adapt to these changes rapidly, or they may experience population declines. Replacement of some species by more southerly species is predicted. Warmer waters in Long Island Sound may exacerbate shellfish diseases, harmful algae blooms, and the duration and frequency of hypoxia and anoxia, as well as interfere with temperature-regulated fish migrations.

If global temperatures rise as predicted, glaciers and sea ice will melt, raising sea levels by 4 to 33 inches (Union of Concerned Scientists 2006). Sea levels could rise as much as 20 feet over the next few centuries, if the major Greenland and West Antarctic ice sheets melt. The extensive marshes in the lower Connecticut River are probably at risk, first from salt regime changes as the precipitation patterns change, and second, as they are submerged by rising sea levels. Many of these marshes are surrounded by suburban infrastructure or steep banks, and cannot therefore "emigrate" as might have occurred historically during periods of climatic fluctuations (Ron Rozsa pers. comm, CT DEEP).

Air Quality

Local air quality affects our daily lives, and like the weather changes from day to day. Polluted air can impact wildlife and vegetation; cause acidification of water; degrade habitats; accelerate weathering of buildings and other facilities; and impair visibility (USEPA 2012b, USFWS 2013). Ground-level ozone and airborne particles are two air pollutants that pose a threat to human health. Emissions

from industrial facilities and electric utilities, motor vehicle exhaust, gasoline vapors, and chemical solvents are some of the major sources of nitrogen oxides (NO_x) and volatile organic compounds, components of smog. The southern portion of the watershed supports a large urban environment that often contributes to poor air quality. Similarly, there is a constant concern for the effects of toxic air emissions on the health of wildlife and their habitats.

The CAA of 1970, as amended, requires the EPA to set and regulate National Ambient Air Quality Standards (NAAQS) for six common air pollutants (42 USC Chapter 85). These six air pollutants are found all throughout the U.S., and include ozone, particulate matter, carbon monoxide (CO), NOx, sulfur dioxide, and lead, as well as other hazardous air pollutants, such as mercury. Pursuant to the CAA, the Service has an affirmative responsibility to protect air quality related values on national wildlife refuges, with special emphasis on Class I Wilderness Areas (i.e., more than 5,000 acres formally designated as Wilderness prior to August, 1977). As noted earlier, there is no designated wilderness administered by the refuge; however, there are wilderness areas in the nearby White Mountain National Forest and the Green Mountain National Forest (note: the majority of these wilderness areas lie outside of the Connecticut River watershed). All other clean air regions are designated Class II areas with moderate pollution increases allowed (unless an area is redesignated by a state or Tribe).

Under the CAA, any area that violates national ambient air quality standards for any of the six criteria pollutants is designated as a "non-attainment area." Activities that emit significant levels of criteria pollutants in a non-attainment or maintenance area are subject to control, and the Service and any other Federal agency must demonstrate that their actions (e.g., prescribed burning) will not impede the state implementation plans to attain or maintain the ambient air quality standard.

EPA previously set a NAAQS for ground-level ozone at 0.08 parts per million (ppm)[1], averaged over 8 hours. In New England, the states operate a network of 60 ozone monitoring stations during the ozone season (i.e., April 1 through September 30). Figure 3.1 below shows those shaded areas in New England that have been designated as nonattainment, or not meeting, the 0.08ppm/8-hour ozone standard (USEPA 2012c). New Hampshire and Vermont have attained the ozone standard; however, counties in Massachusetts and Connecticut have reached "moderate" nonattainment.

Based on nonattainment designations, states were required to develop implementation plans and ozone attainment demonstrations outlining what actions they will take to meet the 0.08ppm ozone standard (e.g., enhanced vehicle inspection programs). Information from "Scorecard: The Pollution Information Source" (Good Guide 2011), indicates that 66 percent of the days in Hartford County, Connecticut, achieved good air quality, whereas the other two Connecticut counties in the watershed were markedly higher: Middlesex (85 percent) and New London (83 percent). Hamden County, Massachusetts (Springfield area) had good air quality for 68 percent of days; whereas the more rural Hampshire County to the north had 96 percent (information was not available for Franklin County, MA). Watershed counties in New Hampshire and Vermont maintained consistently good air quality.

[1] Based upon a required review of air quality standards every 5 years, EPA issued revisions to the ozone standard in 2008 to 0.075 ppm; however, EPA has not designated areas for this standard as nonattainment. In 2009, EPA announced reconsideration of 0.075 standard and is now considering ozone standards (*http://www.epa.gov/glo/actions.html*; accessed December 2014).

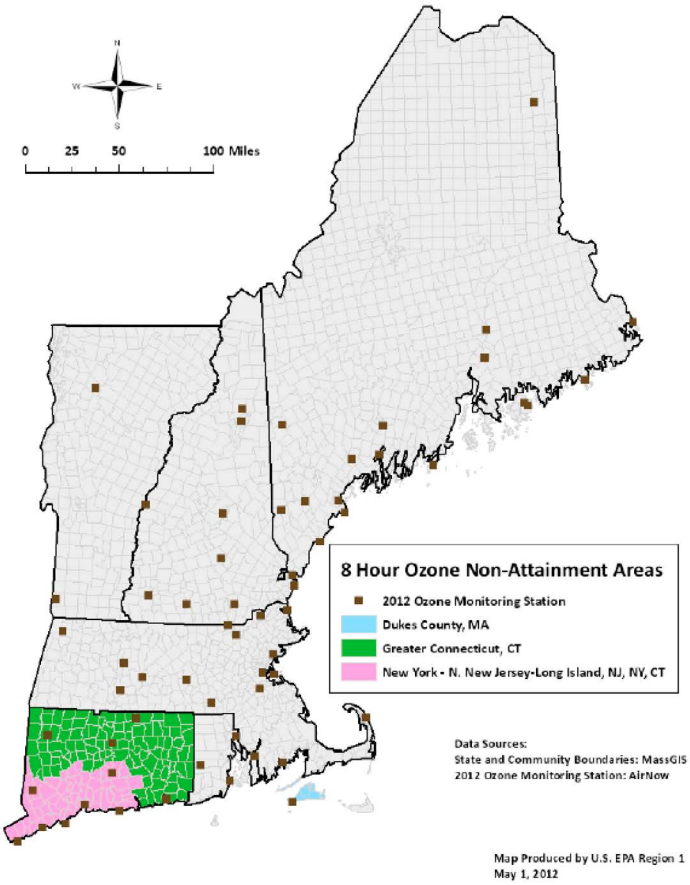


Figure 3.1. 8 Hour Ozone Non-attainment Areas, 2012.

Biological Environment

The Service is legislatively authorized and entrusted to protect and manage a number of natural resources; the most prominent of these "Federal trust" resources are migratory birds, migratory or "interjurisdictional" fish, wetlands, and threatened and endangered species. These are resources protected by Federal law. National wildlife refuges are legislatively created and also constitute a Federal trust resource. These Federal trust resources are, in effect, the Service's legally explicit, manifest priorities. Of particular interest on Conte Refuge are those resources that were legislatively mandated in the Conte Refuge Act to be part of the refuge purposes (see chapter 1). Those resources specifically mentioned in the legislation are: Atlantic salmon, American shad, river herring, shortnose sturgeon, bald eagle, peregrine falcon, osprey, and American black ducks; native species of plants, fish, and wildlife and their ecosystems; endangered, threatened, and candidate species; and wetlands and other waters.

Through policy mandates, the Service is also responsible for assisting the conservation of priority State fish and wildlife resources, especially as they occur on national wildlife refuges and management is consistent with respective refuge purposes. Species of greatest conservation need (GCN) have been identified in each of the Wildlife Action Plans (WAP) for Connecticut (Connecticut Department of Environmental Protection Bureau of Natural Resources 2005), Massachusetts (Massachusetts Department of Fish and Game 2006), Vermont (Vermont Fish and Wildlife Department 2005), and New Hampshire (New Hampshire Game and Fish Department 2005). Almost without exception, the GCN species include those already identified by the Service and are recognized

by regional conservations partnerships (e.g., Joint Ventures) as a priority resources of concern. These species are also included in the *NatureServe* rankings supported by natural heritage programs. The WAPs are comprehensive and readers are directed to those individual plans for further details.

Recognizing the size of this 7.2 million-acre watershed, the biological environment of the Connecticut River Valley is extremely diverse and expansive. The wide range of habitats that occur in the watershed support approximately 140 species of fish, 60 mammals, 250 birds, 20 reptiles, 20 amphibians, 1,500 invertebrates, and more than 3,000 plants (USFWS 1995). Given these numbers, we are not able to provide an exhaustive review of the flora and fauna in the watershed. There are many sources for a more thorough discussion regarding the habitat needs and geographic distribution of mammals, birds, reptiles and amphibians, and fish and freshwater mussel species in New England.

For more information on birds, refer to the *Atlas of Breeding Birds in Connecticut* (Bevier 1994), the *Atlas of Breeding Birds of Vermont* (Laughlin and Kibbe editors1985), *Atlas of Breeding Birds in New Hampshire* (1994), *Birds of Massachusetts* (Veit and Petersen 1993), *Online Breeding Bird Atlas of Massachusetts* (*http://www.massaudubon.org/our-conservation-work/wildlife-research-conservation/statewide-bird-monitoring/breeding-bird-atlases/bba2*; accessed December 2014). Other sources include DeGraaf et al. (2005), Bevier (1994), Veit and Peterson (1993).

There are numerous sources for New England taxa, including mussels (Nedeau 2008), amphibians, reptiles, mammals, and birds (Hammerson 2004, DeGraaf and Yamasaki 2001, DeGraaf and Rudis 1986), reptiles, and amphibians (Klemens 1993, Taylor 1993). There are also plant checklists developed by the various states' natural heritage programs (e.g., Dow Cullina et al. 2011 for Massachusetts).

The remainder of this section provides a summary of the general habitat types in the watershed, and highlights the fish, wildlife, and plant species that are a priority for conservation.

General Habitat Types

Below we describe the general habitat types that occur within the watershed. These habitats types follow the Northeast Terrestrial Habitat Classification System (NETHC) developed by TNC (Gawler 2008). This classification system is also used by the NALCC. NETHC data suggests approximately 80 percent of the watershed is forested; 7 percent is in grassland, pasture, or croplands; 9 percent is developed; 4 percent is wetland (emergent, shrub-scrub or forested); 2 percent is shrub-scrub; and 2 percent is water.

The remainder of our discussion on habitat types in this section is organized under subheadings that correspond to the general habitat types addressed in our proposed management direction under each alternative in chapter 4 and in appendix A.

Forested Uplands and Wetlands

Spruce-fir/Conifer Swamp

Spruce-fir habitats are associated with cool, moist sites. These habitats are found at both low elevations and montane sites where conditions are suitable. Both occur primarily in Vermont and New Hampshire (Sperduto and Nichols 2004, Thompson and Sorenson 2000). Dominant trees include red spruce, black spruce, and balsam fir. Sites range from well or moderately well drained upland forests to poorly or very poorly drained swamps. These forests are important for several

priority species including the Bicknell's thrush (montane), bay-breasted warbler (montane and lowland), and Canada lynx.

Recognition of the importance of these habitats has led multiple agencies to protect and manage this forest type. The Green Mountain National Forest in Vermont and the White Mountain National Forest in New Hampshire both contain substantial acreages of high-elevation spruce-fir habitat. Lowland spruce-fir forests are managed within the Nulhegan Basin, Blueberry Swamp, and Pondicherry Divisions of the Conte Refuge.

Hardwood Forest

Hardwood forest communities represent a large matrix community throughout the watershed. They include deciduous-dominated forests, such as northeast interior dry-mesic oak, Central Appalachian dry oak-pine, North Atlantic coastal plain dry hardwood forest, and Laurentian-Acadian northern hardwood forests, as well as mixed wood communities, such as Laurentian-Acadian pine-hemlock-hardwood, Appalachian hemlock-northern hardwood, and northeast coastal interior pine-oak forests.

Deciduous-dominated communities are often associated with moist, loamy, fertile soils and are most common below 2,500 feet elevation on gentle to steep slopes. Soil permeability, aspect, geographic area, as well as other micro and macro conditions influences the growth, abundance, and diversity of deciduous species present, thus leading to a number of sub-community types. Tree species common to this habitat are sugar and red maple, American beech, yellow and white birch, quaking aspen, and to a lesser extent basswood, white ash, and black cherry. As this community transitions into the northern extent of the central hardwood community, oak (red, white, black) and hickory (shagbark, bitternut, and pignut) become more abundant, especially on well drained soils.

Mixed-wood forests are often along transitional zones between deciduous and coniferous dominated habitats, and thus are characterized by plant species and soil properties that stem from both. Most often these are found on either gently sloping benches or plateaus or at higher elevations (2,000 to 2,500 feet), where soils are typically shallow above a restricting pan layer. Localized site conditions and past disturbance creates a considerable amount of variability in species composition. Composition in the northern portion of the Connecticut River watershed typically consists of sugar and red maple, yellow birch, red spruce, balsam fir, and aspen. Further south in the watershed red oak, red maple, eastern hemlock, and white pine become more abundant.

Black-throated blue warbler

Bill Dyer

These forests are important for several priority species including wood thrush, American woodcock, and black-throated blue warbler. As with most large upland communities within the watershed, hardwood forests are not a resource of concern, although a variety of wildlife associated with this habitat are recognized as being in need of conservation efforts. Our understanding of the forest structure within the watershed comes exclusively from a reading of forest history in New England_a legacy of intensive past-use that altered the vegetation structure and composition, landscape patterns, and ongoing ecological dynamics (Cronon 1983; Whitney 1996; Foster *et al.* 1997; Bellemare et al. 2002; Hall *et al.* 2002). The CCP assumes the forests of the watershed are more homogeneous than those of three centuries earlier, and they include more sprouting and shade-intolerant species and fewer long-lived mature forest

Steve Maslowski/USFWS.

American black bear

tree species (Foster et al. 1998; Goodburn and Lorimer 1998; Foster 2000; Cogbill 2002; Bellemare et al. 2002; Abrams 2003). Areas of the watershed also support forests with a simplified age structure where canopy layers, dead and dying trees, and down coarse woody material may be lacking. The list of threats to the health of forests is long, but the occurrence and spread of invasive species and over browsing by ungulates are common themes among the State WAPs.

Woodlands (Natural)

This habitat type includes Central Appalachian pine-oak rocky woodland, and alpine glade and woodlands–two habitats uncommon to the watershed. Larger representations of this habitat type are confined to the warmer southern regions of the eastern U.S. Pin-oak rocky woodlands encompass open or sparsely wooded hilltops and outcrops or rock slopes, mostly at lower elevations, but occasionally up to 4,000 feet in West Virginia. Patch vegetation characterized by *Pinus* spp. with mixed *Quercus* species is common.

Hardwood Swamps

Forested swamps occur in large and small patches within and around the larger upland formations throughout the watershed. They occur on terrain with little to no slope, in topographic depressions and sumps, and often in watershed headwater basins. Drainage is typically poor to very poor with seasonal fluctuations varying greatly in areas that stem from stream or lake flooding, and less so where ground water or surface runoff is the primary source. Soils vary from shallow to deep and can be predominately mineral, organic, or muck with occasionally a peat component (Gawler 2008). Hardwood forested swamps vary in their hydrological regimes—from wetlands having standing water for only a small part of the year, to wetlands which are quite wet and have seasonally flooded and/or saturated surfaces for a substantial part of the year.

Forested swamps provide important wildlife habitat; for example, forested wetlands tend to have more total birds as well as more bird species nesting in a given area than upland forested sites (Newton 1988).

Red maple swamps are the most common type of forested wetland in the watershed, reaching their greatest abundance in the southern part of the watershed. Red maple swamps occur in a wide range of settings and provide habitat for a large variety of wetland–dependent species including wood ducks, marbled salamanders, and beaver. Studies have demonstrated that red maple swamps constitute significant habitat for amphibians (Golet et al. 1993).

Hardwood swamps are larger and more common in the southern and central portion of the watershed. Hardwood swamps in the south are often dominated by red maple with a lesser component of swamp white oak, black and green ash, and black gum. Further north, red maple will typically continue to be the dominant species in hardwood swamps, but species such as black ash will become more abundant and warmer climate species such as black gum and green ash less abundant to non-existent in the far northern reaches. In the northern part of the

watershed, in the conifer forest region, the wetter areas support spruce–fir and northern white cedar swamps.

Pine Barrens and Maritime Forest

Pine barrens occur on sandplains such as outwash plains and stabilized sand dunes. Pitch pine is the usual dominant, and cover may range from closed-canopy forest to (more typically) open woodlands. Red oak, white pine, and gray birch are common associates. A tall-shrub layer of scrub oak and/or dwarf chinkapin oak is commonly present, although portions of some barrens (or occasionally the entire barrens) lack the scrub oak component. A well-developed low-shrub layer is typical, with lowbush blueberry, black huckleberry, and sweet fern characteristic (Gawler 2008).

The Montague sandplains in Massachusetts are recognized as an IBA by Mass Audubon, and consists of a 1,500-acre state wildlife management area managed by the Massachusetts Department of Fisheries and Wildlife. The Plains are an excellent example of an uncommon pine barren that supports habitat for many rare plants and animals. The Montague Plains, located on a large sand delta, formed more than 10,000 years ago when melt water streams from the retreating glaciers emptied into Lake Hitchcock. Four species of grassland birds breed there including grasshopper sparrows.

The structure and species composition within maritime forests are influenced by proximity to marine environments, and include both upland and wetlands. They are subject to salt spray, high winds, dune deposition, sand shifting and blasting, and occasional over-wash during extreme disturbance events. Species range from deciduous hardwoods to pitch pine and Virginia pine (Gawler 2008).

These habitats are uncommon in the watershed, and are being impacted by invasive species and recreational activities. Species such as the golden-winged warbler and Northern harrier use these habitats.

Shrub Swamps and Floodplain Forests

Shrub Swamps: Shrub swamps are wetlands dominated by woody shrubs. They occur throughout the watershed and are highly variable depending on climate, past disturbance, hydrology, and mineral enrichment. These habitats are typically subject to seasonal flooding and saturated soils. They are often found in transitional zones between marshes and forested wetlands, along pond and lake margins, and along rivers and streams (Gawler 2008, Thompson and Sorenson 2000). They provide habitat for a number of state and Federal resources of concern. Concern over degradation of the ecosystems is widely acknowledged. Changes in hydrology from development and the introduction of invasive species are two of the most significant threats.

Floodplain Forests: Annual spring high water flows in the Connecticut River valley have created a substantial number of floodplains. In the past, "bulldozing" by ice and large trees floating down river during floods produced naturally disturbed scour areas adjacent to the river channel. However, in areas without constant scouring, floodplains host rich forest habitats. Connecticut River floodplain forests are usually dominated by silver maple, Eastern cottonwood, and black willow, with an understory of ostrich fern, wood nettle, and/or false nettle. Historically, American elm was an important constituent before eradication from Dutch elm disease. These riverside forests provide critical nursery habitats (e.g., shade, cover) for some fish and important migratory stopover habitat for many migrating songbirds (Smith College 2006).

Although active flooding has limited development, many of these floodplain forests have been converted to agriculture, and others have been altered by a lack of seasonal flooding. Dams in the upper watershed have changed

the flooding regime, reducing the frequency and intensity of large scouring events. Historic floodplains have been cut off by elevated railroad grades that follow the river course and/or by the dikes/levees built around urban areas (e.g., Northampton, West Springfield). Roads are commonly located adjacent to rivers/streams. In both situations, altered site hydrology is thought to negatively affect floodplain vegetation. Invasive plants pose serious threats to floodplain habitats because they often are well adapted to disturbed areas.

TNC collected data and used a number of models to look at floodplain remnants, identify the best quality remaining floodplains for conservation, and identify suitable restoration areas (Anderson et al. 2008). Additional research is underway to better understand the ecology and status of watershed floodplain forests (Marks et al. 2011).

Non-Forested Uplands and Wetlands

Rocky Outcrop

This habitat type includes the Northern Appalachian-Acadian rocky heath outcrop and Laurentian-Acadian calcareous rocky outcrop systems. These systems occur on ridges or summits of bedrock. Vegetation is often patchy; a mosaic of woodlands and open glades predominant. Species may include oaks and conifers, such as white pine and red spruce, and low heath shrubs. Exposure to the elements, bedrock type, and occasional fire are major factors in species composition and open areas (Gawler 2008).

Cliff and Talus

Cliff and talus systems occur below treeline at low to mid elevations. The vegetation is patchy and often sparse, punctuated with patches of small trees that may form woodlands in places (Gawler 2008). The type of rock, microclimate, and soil availability from higher elevation sources directly and indirectly influence vegetation within these systems (Thompson et al. 2000). Rock types may include limestone, dolomite, granite, schist, slate or shale which breakdown differently in the environment providing varying levels of nutrients, moisture, ground stabilization, and soil availability. Sun exposure, aspect, elevation, and moisture provide different microclimate conditions affecting vegetation type and growth. These systems provide unique niches for rare and uncommon plants, and habitat for snakes, including the rare eastern timber rattlesnake, black rat snake and eastern garter snake. Exposed cliffs provide nesting habitat for turkey vultures, ravens, porcupines, and peregrine falcons: a refuge and state species of resource concern.

USFWS

Peregrine falcon

Freshwater Marshes

Freshwater marshes are open wetlands found throughout the watershed. They are dominated by herbaceous vegetation such as sedges, grasses, and cattails with little or no woody vegetation present. Soils are typically a mixture of muck, mineral, and peat and can be seasonally flooded to permanently saturated. Freshwater marshes generally have water at or above the surface throughout the year and are further categorized through a number of factors such as surface water depth and vegetation (Gawler 2008, Thompson and Sorenson 2000).

Freshwater marshes are rich and very productive biological communities. They are identified as having high ecological and functional importance within the state wildlife action plans. Also within these plans, a common concern exists for the health and proliferation of these habitats. Development, invasive species, dredging, and sedimentation are a few of the threats that are damaging these ecosystems.

In the Connecticut River Valley, old oxbows form many of these marshes. Marshes may be shallow or deep, with water levels ranging from a few inches to several feet. Marshes support a variety of emergent plants such as cattails, grasses, and sedges. Some extremely rare plants grow in these freshwater marshes, including the federally endangered northeastern bulrush.

Peatland

The most commonly recognized peatlands are bogs and fens. These communities occur throughout the watershed in kettle holes, along pond margins, in isolated valley bottoms, and stream headwaters. They are permanently saturated wetlands that can be open or wooded. The characteristic that distinguishes these from other wetlands is the presence of peat soils. Peat is the accumulation of partially decomposed organic material, which accumulates due to water levels being at or near the surface creating anaerobic conditions that slow or halt decomposition of plant material. Bogs typically have deeper peat buildup than fens and are highly acidic and nutrient poor. Fens often receive additional water from ground discharge or inlets, which introduces varied amounts of mineral nutrients (Gawler 2008, Thompson and Sorenson 2000).

Peatlands are ecologically sensitive communities that provide habitat for several rare plant and wildlife species. These communities are recognized by most state and Federal agencies, and non-governmental conservation organizations as areas that are critically important for conservation efforts.

Bogs: Bogs are poorly drained acidic wetlands, unconnected to the water table, which form a floating mat of vegetation. Bogs vary from small floating mats along the edges of ponds to peat filled watersheds that may be as deep as 100 feet. Bogs contain unique plant communities specifically adapted to survive on few nutrients. The dominant vegetation is sphagnum moss. Other characteristic plants in bogs include tamarack, black spruce, sweet gale, orchids, and leatherleaf (TNC 1985). Due to their uniqueness and their extreme sensitivity to disturbances, bogs are given the highest priority for protection under New Hampshire State law RSA 483–A.

Fens: Fens (calcareous wetlands) are mineral rich with a hydrologic connection to the ground water table. These wetlands support a lush and diverse flora and a number of rare plants (Dowhan and Craig 1976). These calcium rich, low acidic wetlands host various orchids and sedges, particularly calcium loving species such as chestnut colored sedge. Besides protecting these wetlands, it is important to protect the surrounding aquifers as well, so that alkaline rich springs continue to flow through the calcareous wetlands.

Pasture/Hay/Grassland

In the Connecticut River watershed, pasture, hay, and grasslands are primarily the result of agricultural production activities. Although, historically there was natural grasslands in the region, most likely in major river valley and along the coast, very little natural grassland reminas today (Dettmers and Rosenberg 2000). Today, little historic natural grassland remains. Although agricultural lands are not native wildlife habitat; they can serve the needs of many species. Forage lands or pasture, hay fields, open vegetable patches, and sod fields can be valuable to many species of birds, mammals, reptiles and amphibians. Some examples of species include Eastern American toad, Northern leopard frogs, spotted turtles, Eastern hognose snake, turkey vultures, Canada geese, horned lark, American or water pipit, Northern harrier, red-tailed hawk, American kestrel, American woodcock, mourning dove, Northern shrike, Northern rough-winged swallow, field sparrow, and Eastern meadowlark, least shrew, Eastern cottontail, Eastern pipistrelle bat, woodchuck, meadow vole, red fox, and striped skunk (DeGraf and Yamasaki 2001).

Currently, agricultural lands occupy roughly 8.5 to 12 percent of the watershed's land base, of which one-half to one-third, approximately 229,000 acres, is prime agricultural land. Most of the quality agricultural lands are in the broad Connecticut River Valley of Connecticut and Massachusetts although there is a large, agriculturally based grassland complex in northern New Hampshire. Current estimates suggest that of the overall cropped lands (approximately 229,000 acres), 69 percent is managed for forage, 6 percent in vegetable crops, and 3 percent in Christmas tree farms. The remaining includes corn, tobacco, potatoes, orchards, nurseries, sod, and "miscellaneous other" which is dominated by maple syrup production (Clay et al. 2006).

However, the amount of these habitats are currently declining in the Northeast. During European settlement millions of hectares of forests were cleared for agriculture in the eastern U.S. creating habitat for grassland dependent birds. As agricultural activities declined, open areas dominated by herbaceous vegetation began to convert back to forests, causing a drastic decline in grassland species in the region. Naturally occurring grassland ecosystems were not uncommon in the eastern U.S., but, were found closer to the coast rather than inland (Brennan et al. 2005). These grassland ecosystems have since been impacted by development and fragmentation.

Some level of grassland conservation and, where appropriate, restoration, is warranted based on the historic evidence and the desirability of retaining grassland species (often state-listed) in each state. The PIF plan for the Southern New England Physiographic region set a broad level goal of protecting 25,000 to 38,000 acres of grassland, to produce 250 breeding pairs of upland sandpipers, 800 pairs of grasshopper sparrows, and 15,000 pairs of bobolinks. In Connecticut, Connecticut Audubon recommended a 5,000-acre network of natural grasslands in patches at least 500 acres in size, 3,500-acre late harvest working hayfields (greater than 25 acre blocks), and giving priority to currently existing grasslands (Comins et al. 2005).

Considerable work has been done to identify grasslands suitable for conservation in New England. However, many potentially suitable lands, such as pastures and hayfields, are increasingly being converted into residential developments. The highest quality habitats for grassland birds in the watershed typically are in conservation areas or airports which delay mowing until the middle of July to allow the ground-nesting birds to fledge their young. The Northeast Grassland Bird Working Group is currently identifying important grassland focus areas within the watershed and for the northeast generally. Some initial work for New Hampshire illustrates four large focus areas occurring near the Connecticut River Valley. In the Massachusetts portion of the watershed there are four large functional grasslands: Westover Air Reserve Base (approximately 1,600 acres), Barnes Municipal Airport/Air Reserve Base (approximately 500 acres), Massachusetts Audubon Society's Arcadia Sanctuary (approximately 750 acres); and the Fort River farmland area where the Service purchased land that is now the Fort River Division. There are other large areas currently in row crops with grassland potential, such as the Meadows in Northampton, the Honeypot in Hadley, or the area around the Hatfield oxbow in Hadley. Smaller airports in Turners Falls and the Orange Municipal Airport have been managed for grassland birds in the past.

The CTDEEP started a new Grasslands Habitat Conservation Initiative in 2006 aimed at conserving grassland habitat in order to protect critical nesting and breeding grounds for bird and other species (CTDEEP 2006). This initiative was selected as the first major statewide action to be addressed under Connecticut's WAP. Grasslands are a priority identified in this strategy because this habitat is important for 80 bird species in Connecticut, 13 of which are listed under the Connecticut ESA, and several mammal, amphibian, and reptile species and many

invertebrate species. In support of the Grassland Habitat Conservation Initiative, the DEEP has committed $3.2 million for the acquisition of grassland habitat and has set aside an additional $4.5 million for future acquisitions.

Grasslands in New Hampshire are generally in hay fields, croplands, airports, capped landfills, and military installations. New Hampshire has over 232,000 acres (94,000 hectares) of grassland complexes at least 10 hectare in size, mostly occurring in Grafton County (20 percent) followed by Merrimack and Coos Counties (13 percent and 12 percent, respectively). A number of programs exist that protect critical grasslands and farmland from development, including New Hampshire's Land and Community Heritage Investment Program (LCHIP), conservation easements through the New Hampshire Department of Agriculture, and Current Use Advisory Board within the Department of Revenue Administration, for the protection of agriculture and wildlife resources via reduced taxes. At the local level, many municipalities have passed open space bonds to help protect natural resources of local and statewide importance. At the Federal level, the NRCS administers the Farmland Protection Program through the USDA which provides funds to help purchase development rights to keep farmland in agriculture. New Hampshire Fish and Game also recognizes the importance of grassland habitats (NHFG 2006).

Old Fields and Shrublands

Old fields and shrublands are often agricultural lands that are no longer in production. Vegetation may range from herbaceous dominance to a mixture of shrubs and herbaceous species, to shrub dominance. Species composition is influenced by past disturbances (e.g., mowed, plowed, or grazed), soil type and saturation, and seed availability. In the absence of disturbance, this upland habitat tends to be ephemeral, typically succeeding to young forests.

Birds dependent on habitats such as old fields and shrublands, are experiencing steep population declines over the last decade in the Northeast (ACJV 2008). These include: American woodcock, chestnut-sided warbler, blue-winged warbler, brown thrasher, Eastern towhee, and field sparrow. Other species that rely on these habitats include New England cottontail, a candidate species for endangered/threatened species listing, and snowshoe hare, which is the main prey for Canada lynx, a Federal listed species.

The decline of these habitats is a consequence of historic and current land uses (Litvaitis 1993; Lorimer 2001, Trani et al. 2001, Brooks 2003). Prior to European colonization, the northeast was predominately forested with seedling-sapling areas likely comprising only 3 percent of inland forests (Lorimer and White 2003). Beaver flowages probably contributed another 3 to 4 percent to the amount of these habitat types during this time period (Gotie and Jenks 1982). European settlement resulted in widespread clearing of forests for agriculture, timber, and fuelwood (Whitney 1994). Later, as more lands were settled in the Midwest, fossil fuels replaced fuelwood as the primary energy source, and better economic and social opportunities became available in the industrialized cities, the agricultural fields of the northeast were abandoned (Whitney 1994; Lorimer 2001). A period of relatively abundant grassland and shrubland habitat resulted during the early part of the 20th century (Lorimer 2001). Since that time, the amount of these habitats has generally declined, especially in southern New England.

State and Federal wildlife agencies are generally charged with conserving all native wildlife species and their habitats found within their state or refuge. Grassland and shrubland habitats are known to be declining, and many ecologists assert that for a variety of reasons natural disturbance alone will not provide sufficient habitat to sustain populations of wildlife that rely on these habitat types (Litvaitis 2003). Creation and maintenance of shrublands can be problematic. Only 11 percent of timberland in New England is publicly owned (Brooks 2002).

Although those owning more than 50 acres still own greater than 75 percent of the timberland, the trend is for small parcel subdivision development that are less likely to be harvested or managed (Brooks 2002). In Maine, where there is more industrial timberland, 25 percent of the forest is in seedling/sapling stage, whereas in Massachusetts, where individual ownerships prevail, only 5 percent is in seedling/sapling stage (DeGraaf and Yamasaki 2003). Utility rights-of-way provide a relatively large and dependable amount of early successional forest.

Inland Aquatic Habitats

Open Water

Open water habitats include rivers, streams, ponds, lakes and associated transitional habitats influenced by fluctuating water levels. Diadromous and indigenous fish, freshwater mussels, mayflies, dragonflies, and amphibians rely on these communities for some stage of their life cycle. These habitats also provide foraging opportunities for other species including waterfowl, herons, egrets, mink, and otter.

Rivers and Streams: Many of the rivers and streams within the watershed are influenced by man-made dams and roads. The watershed has 38 flood risk reduction dam projects operated by the USACE, and almost 1,000 small dams on the tributaries that were built to power mills in the 1700s and 1800s. Flows, especially during low flow periods, are highly regulated and restricted by the numerous dams on the river system (Kapala and Brown 2009). Unrestricted free flowing streams, those that flow freely without restrictions from dams and roads, are considered one of 13 imperiled habitats in the State of Connecticut (Metzler and Wagner 1998). According to the Connecticut WAP, nearly all the State's streams have been influenced by dams, and the regulation of discharges and diversions. Segments of Hollenbeck River (South Canaan to Cornwall), Moore Brook (Salisbury), Eight-Mile River (East Haddam, Salem, Lyme), Moodus River (East Haddam), and Natchaug River (Eastford, Chaplin, Mansfield, Windham) provide examples of unrestricted free-flowing stream habitat (CTDEEP Bureau of Natural Resources 2005). The Fort River is the longest free-flowing tributary of the Connecticut River in Massachusetts (town of Amherst 2013). The White River in southern Vermont and several of its tributaries are free-flowing. Waterpower and flood risk reduction dams, land development and the introduction of nonnative species are affecting water temperatures, migration routes, and the structure and diversity of plant and wildlife communities.

Many fish species rely on specific river and stream habitats within the watershed. Many diadromous fish, such as American shad, blueback herring, and sea lamprey, as well as resident fishes, such as hogchoker, and mummichog use head-of-tide habitat as staging areas critical for spawning and migration. Head-of-tide is the farthest point on a river where the tide from an ocean or bay influences water levels. There is generally a defined maximum point, but may vary due to storm, seasonal and annual precipitation, snow melt, and subsequent water flows. Tides tend to extend farther upriver during summer low-flow periods. The head-of-tide for various rivers within the watershed may be many miles upstream from the Atlantic Ocean, but concentrated toward the southern portion of its region, generally south of Hartford, Connecticut. There are few head-of-tide areas that are truly pristine, as most of these habitats are adjacent to developed urban areas *(http://library.fws.gov/pubs5/ramsar/web_link/area.htm#Salinity Distribution*; accessed December 2014).

Other species are sensitive to the warmer temperatures in the southern portion of the watershed. Species such as Eastern brook trout, slimy sculpin, white sucker, common shiner, longnose dace, and blacknose dace rely on cold water habitats. These streams are fed by small headwater streams, surface springs, or seeps, and flow rapidly over gravel or cobble substrate. Upland forest communities are often adjacent to the channel, where shade from

the forest canopy help to maintain suitable and stable water temperatures (CTDEEP 2005).

Cold water streams are found throughout the watershed, though a higher concentration is found in the northern and central portions of the region due to higher elevations. Cold water streams are sensitive areas that are impacted by development and forest fragmentation (CTDEEP 2005).

Pond and Lakes: Ponds and lakes are large inland bodies of still water located in basins or low areas, and are often fed or drained by a river or stream. They provide habitat for a diversity of aquatic dependent species, as well as foraging habitat for birds and mammals, including osprey, bald eagles, waterfowl, herons, mink, and otter. Lakes and ponds within the watershed include those created during the glacial period, and man-made reservoirs that provide drinking water, energy production, recreational opportunities and flood risk reduction.

Coastal Non-forested Uplands

Dunes and Maritime Grasslands

These habitats include the Atlantic coastal plain northern dune and maritime grassland, and heathland and grassland. These systems occur along the coast of Connecticut, and are dominated by grasses and shrubs. The dune and maritime grassland communities are predominately herbaceous, with shrublands, resulting from succession from grasslands, occurring in limited areas. Both upland and non-flooded wetland vegetation are also included in this system. Small patches of natural woodland may also be present. Dominant ecological processes are those associated with the maritime environment, including frequent salt spray, saltwater overwash, and sand movement (Gawler 2008).

The coastal plain healthland and grassland communities may occur as heathlands, grasslands, or support a patchwork of grass and shrub vegetation. This system is related to dune grasslands but occurs on sandplains, not dunes, and lacks significant amounts of American beachgrass. In the absence of disturbance (fire, grazing, mowing), coverage by pitch pine and scrub oak can increase, creating vegetation similar to a pitch pine-scrub oak barren; or in some cases, a tall-shrub community can develop in the absence of fire (Gawler 2008).

Coastal dune communities are fragile habitats that support priority species in need of protection from human development and disturbances. Barrier beaches protect salt marsh from storms and provide nesting and feeding habitat for piping plovers, least terns, and American oystercatchers. The most challenging issues facing dune habitat are recreational activities, oil spills, and rising sea level resulting from climate change.

Rocky Coast and Islands

This system encompasses coastal non-forested uplands in the watershed, and can be found at the mouth of the Connecticut River, and inland as far as the Whalebone Cove CFA in Connecticut. It is often a narrow zone between the high tide line and the upland forest; this zone becomes wider with increasing maritime influence. The substrate is rock, sometimes with a shallow soil layer, and tree growth is prevented by extreme exposure to wind, salt spray, and fog. Slope varies from flat rock to cliffs. Cover is patchy shrubs, dwarf-shrubs and sparse non-woody vegetation, sometimes with a few stunted trees (Gawler 2008).

Coastal Wetlands and Aquatic Habitats

Salt marsh

The name Connecticut is the French corruption of the Algonquin word quinetucket and means *long tidal river*. The second largest group of wetlands in the watershed is estuarine wetlands or tidal wetlands which are located in

the lower part of the main stem of the Connecticut River. Estuarine wetlands are influenced by both tidal and freshwater flows. The lower part of the Connecticut River is considered the most pristine large river tidal marsh system in the Northeast (USFWS 1994). The wetlands at the mouth of the Connecticut River are intertidal marshes vegetated by grasses such as smooth cordgrass, saltmeadow cordgrass or hay grass, salt or spike grass, saltmeadow rush or black grass, and other salt tolerant plants. Salt marshes are among the most productive ecosystems in the world.

Further upstream, the Connecticut River has extensive, high-quality freshwater and brackish tidal wetland systems which provide habitat for several federally listed species, species at risk and globally rare species, including wintering bald eagles, shortnose sturgeon, and Puritan tiger beetles. This area also provides significant American black duck habitat for breeding, wintering, and migration. It serves as an important movement corridor for migratory birds, especially waterfowl, rails, many species of neotropical migrants, and raptors. Within this group of wetlands, wild rice marshes are considered rare and valuable and function as significant resting and feeding areas for waterfowl, shorebirds, and especially the sora rail.

The lower Connecticut River tidal wetlands complex has been designated a Wetland of International Importance by the multi-national Convention on Wetlands of International Importance (aka Ramsar Convention). The Ramsar project area contains 20,570 acres and consists of 20 discrete major wetland complexes (USFWS 1994). The Ramsar designation is used for wetland complexes that have international significance in terms of ecology, botany, zoology, limnology, or hydrology. The lower Connecticut River tidal wetlands complex is considered the best example of this type in the northeastern U.S.

Bill Thompson

Ruddy turnstone

Tidal wetlands provide foraging habitat for a variety of shorebirds, including willet, various species of sandpipers, ruddy turnstone, red knot, and whimbrel. These wetlands also support migrating and wintering waterfowl, various marsh birds, sparrows, bald eagles and osprey. Its tidal marshes and mudflats support significant concentrations of waterfowl and shorebirds, as well as nesting habitat for globally significant species such as the salt marsh sharp-tailed sparrow (ACJV 2005). This habitat is also important as nursery areas for a variety of aquatic species.

Plant Communities

Many different plant communities exist in the watershed, including common types of wetlands, forests, and grasslands, as well as a number of rare communities. There are roughly 3,000 plant species in the watershed. There are many rare natural plant communities that are tracked by the state natural heritage programs. Wetland plant communities are diverse and widely occurring. Upland forests are the dominant land cover type and are increasing as abandoned agricultural lands revert to forest cover. A number of non-forested, or open plant communities occur in the watershed such as grasslands, shrublands, and unique or rare uplands types.

Natural communities were used as the basis for the habitat types discussed below. Natural communities are defined as recurring assemblages of interacting plants, animals, their physical environment, and the natural processes that affect them (Sperduto and Nichols 2004, Thompson and Sorenson 2000).

Wetland Plant Communities

Restoring and maintaining the integrity of wetlands and other waters is one of the purposes in the Conte Refuge Act. The watershed contains many diverse types of wetlands whose plant and soil characteristics reflect the geomorphology and hydrology of the area. Descriptions of wetlands, in general, are grouped into easily recognized types: coastal/tidal (estuarine); rivers and streams (riverine); lakes and large ponds (lacustrine); and vegetated freshwater wetlands (palustrine). Each of these types contains a number of subtypes.

The watershed contains over a quarter million acres of wetlands (table 3.3) which represents 3.6 percent of the land in the watershed. These wetland estimates are based on the percentage of each county in the watershed multiplied by the total number of wetland acres of that type in each county. Of the four states, Massachusetts has the most wetlands in the watershed (39 percent). The Service's National Wetland Inventory (NWI) acreage estimates were used for the States of Massachusetts, Connecticut, and Vermont. In New Hampshire, the best available data was the 1973 USGS land cover data. The NWI figures should be considered conservative because of the inherent limitations of the mapping techniques used. NWI maps do not identify farmed wetlands, except cranberry bogs. Also, some of the drier wetland soils areas are difficult to identify by aerial photo interpretation and may require extensive field checking.

Table 3.3. Estimated Amount of Wetlands in Connecticut River Watershed by State.

State	Acres of Wetland Type in Each State within the Connecticut River watershed				Total Wetland Acres in watershed for Each State
	Palustrine Wetlands	Lacustrine Wetlands	Riverine[1] Wetlands	Estuarine Wetlands	
Connecticut	44,336	304	154	6,596	51,390
Massachusetts	98,978	1,583	42	0	100,603
Vermont	69,175	368	17	0	69,560
New Hampshire	35,209	0	0	0	35,209
Watershed Totals	247,698	2,255	213	6,596	256,762

[1] *Includes tidal and non-tidal riverine wetlands.*

Sources:
Metzler, K. and R.W. Tiner. 1992. Wetlands of Connecticut, Report of Investigations No. 13, Department of Environmental Protection, Hartford, CT.

U.S. Geological Survey GIRAS 1:250,000 scale data based on 1978-83 satellite photography.

Tiner, R.W. 1992. Preliminary National Wetlands Inventory Report on Massachusetts' Wetland Acreage, U.S. Fish and Wildlife Service, Region 5, Newton Corner, MA, 5p.

Tiner, R.W. 1978. Preliminary National Wetlands Inventory Report on Vermont's Wetland Acreage, U.S. Fish and Wildlife Service, Region 5, Newton Corner, MA, 5p.

Trends in Wetlands Plant Communities

Unfortunately, significant portion of the wetlands in the watershed have already been destroyed or degraded. Although the conversion and loss rates have been reduced due to the increased effectiveness of state and Federal regulations, incremental losses continue to occur due to exempted filling and those permits which are granted under the Section 404 provisions of the Federal Clean Water Act. Some states also regulate activities affecting wetlands that are not covered by the Clean Water Act, Section 404 program. A net loss of wetlands in both quantity and functional quality is anticipated to continue, although at lower rates than occurred historically.

Connecticut: The CTDEEP states that Connecticut may have lost 40 to 50 percent of its freshwater wetlands and approximately 65 percent of its coastal wetlands (Metzler and Tiner 1992). Tiner et al. (1989) completed a wetland trend analysis for central Connecticut comparing 1980 aerial photos with 1985 to 1986 photos. The study area covered 780 square miles and contained 28,177 acres of wetland (6 percent of the area). Vegetated wetlands were the most abundant type (91 percent). A total of 117 acres of vegetated wetlands were converted to non-wetlands and 28 acres were made into ponds. Palustrine emergent wetlands (59 acres) and forested wetlands (53 acres) experienced the biggest losses. Although this 1989 study covers only part of the Connecticut River watershed, it provides the best available information on what has recently occurred in the watershed. Commercial development and highway/road construction were the most significant causes of wetland loss. Also, there were losses due to golf courses and home construction. Another serious threat to wetlands is the discharge of materials (i.e., direct discharges of industrial and municipal waste and indirect discharges of urban and agricultural runoff) into waters and wetlands which degrades water quality and functional value for wildlife habitat. The most threatened wetlands are located close to urban areas. Large acreage of floodplain wetlands have been filled and/or diked for industrial and commercial development along the Connecticut River in Hartford and East Hartford. With a substantial increase in development activity and land values, impacts to wetlands are not likely to decrease in the near future. It has been estimated that even with Connecticut's strong wetland regulatory program, 1,200 to 1,500 acres of inland wetland will be filled each year (CEQ 1986, Metzler and Tiner 1992).

Massachusetts: An NWI analysis (Tiner 1992) estimated that 6 to 7 percent of Massachusetts was classified as wetlands. According to Tiner (1987), 16.5 percent of Massachusetts consists of hydric soils, providing an estimate of the original wetland acreage. This means Massachusetts likely lost between 58 percent and 64 percent of its wetlands by the mid-1980s (Commonwealth of Massachusetts 1988). A 1978 U.S. Soil Conservation Service (now National Resources Conservation Service) report estimated an annual statewide wetland loss rate of 0.4 percent (compared to U.S. average loss rate of 0.5 to 1.0 percent in the mid 1970s). In Massachusetts, the primary cause of wetland loss has been urbanization. The 1988 Wetlands Report and Action Plan (Commonwealth of Massachusetts 1988) lists agriculture, road construction and other building as the chief cause of wetland loss in Massachusetts. Historically, inland wetlands were lost to agricultural conversions because they do not require section 404 permits. Such activities are usually either covered by nationwide permits or are exempt because they entail no dredge or fill activities.

Vermont: Vermont has lost as much as 35 percent of its original wetland acreage (Parsons 1988). Approximately half of the wetlands lost have been palustrine emergent marshes. Wetlands continue to be lost at a rate of 100 to 200 acres annually (State of Vermont 1993). In Vermont, road construction, residential and commercial development, as well as the draining of wetlands for agricultural production, account for the majority of the loss.

New Hampshire: There are no known wetland trend studies completed in New Hampshire. The New Hampshire Wetlands Priority Conservation Plan (State of New Hampshire Office of State Planning 1989) lists agriculture as the major cause of freshwater wetland losses. Wetlands have been drained for timber cutting, and ditched and drained for hay, grain, forage, and vegetable crops. Also, the Plan states that inland wetlands have been lost to road and highway construction, building construction, and peat and mineral/gravel

mining. According to the Plan, there has been a net loss of wetlands in New Hampshire and the quality of many existing wetlands has been reduced by adverse environmental impacts, developmental pressures, and improper land use management practices (*http://des.nh.gov/organization/divisions/water/wetlands/index.htm*; accessed December 2014).

Special Designation Areas

Refuge lands often have areas subject to special management. Special management status may arise from legislation, administrative decision making, or the actions of other agencies and organizations. The influence that special designations have on the management of refuge lands and waters varies considerably. Authority for designation of some special management area types (e.g., Research Natural Areas) on refuges lies solely with the Service. Wilderness designations are passed only by Congress (USFWS 2013b).

Wilderness Areas

Wilderness is set aside by Congress to be part of the NWPS. There are over 109 million acres of wilderness across the U.S. managed by several agencies: National Park Service, Bureau of Land Management, Forest Service, and Fish and Wildlife Service. The Service manages over 20 million acres of wilderness. Generally, this designation means that special rules direct management to maintain or achieve an area's wilderness character. For example, motorized and mechanized equipment for transport, management, or recreation are not allowed. The Wilderness Act of 1964 defines wilderness in this way: "A wilderness, in contrast with those areas where man and his own works dominate the landscape, is hereby recognized as an area where the earth and its community of life are untrammeled by man, where man himself is a visitor who does not remain .... retaining its primeval character and influence, without permanent improvements or human habitation, which is protected and generally appears to have been affected primarily by the forces of nature, with the imprint of mans work substantially unnoticeable … has outstanding opportunities for solitude or a primitive and unconfined type of recreation; … is of sufficient size as to make practicable its preservation and use in an unimpaired condition; and may also contain ecological, geological, or other features of scientific, educational, scenic, or historical value. The refuge does not, to date, include any areas designated as wilderness. The White Mountain National Forest contains approximately 148,000 acres of congressionally designated wilderness, and the Green Mountain National Forest includes about 58,600 acres of designated wilderness. However, much of these wilderness areas are outside of the Connecticut River watershed.

Wetlands of International Importance

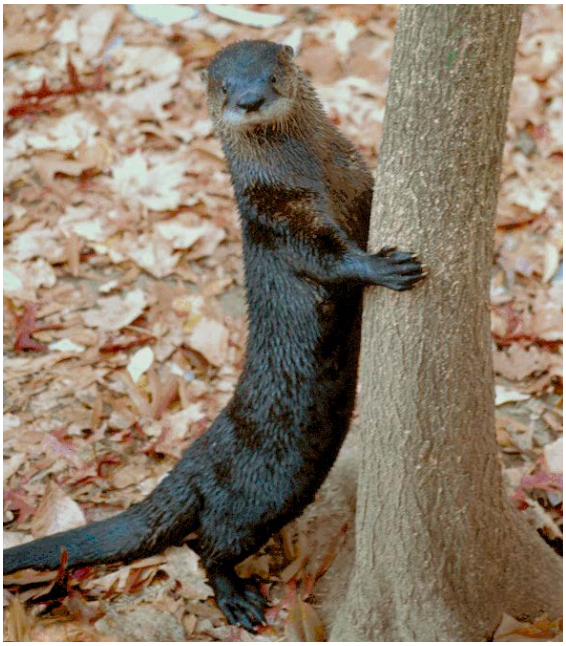
The lower Connecticut River tidal wetlands complex has been designated a Wetland of International Importance by the Convention on Wetlands of International Importance (Ramsar Convention of 1971). The Ramsar project area contains 20,570 acres and consists of 20 discrete major wetland complexes (USFWS 1994). The Ramsar designation is used for wetland complexes that have international significance in terms of ecology, botany, zoology, limnology, or hydrology. The lower Connecticut River tidal wetlands complex is considered the best example of this type anywhere in the northeastern U.S.

Wild and Scenic Rivers

The Wild and Scenic Rivers Act, October 2, 1968, stated that: "It is hereby declared to be the policy of the United States that certain selected rivers of the Nation which, with their immediate environments, possess outstandingly remarkable scenic, recreational, geologic, fish and wildlife, historic, cultural or other similar values, shall be preserved in free-flowing condition, and that they and their immediate environments shall be protected for the benefit and

enjoyment of present and future generations. The Congress declares that the established national policy of dams and other construction at appropriate sections of the rivers of the United States needs to be complemented by a policy that would preserve other selected rivers or sections thereof in their free-flowing condition to protect the water quality of such rivers and to fulfill other vital national conservation purposes."

River otter



John White /USFWS

Protection of a designated river is provided through voluntary stewardship by landowners and river users and through regulation and programs of Federal, state, local, or tribal governments. Not all land within boundaries is, or will be, publicly owned, and the Act limits how much land the Federal government is allowed to acquire. The Act purposefully strives to balance dam and other construction at appropriate sections of rivers with permanent protection for some of the countries most outstanding free-flowing rivers. For example, it prohibits Federal support for actions such as the construction of dams or other instream activities. Designation neither prohibits development nor gives the Federal government control over private property. The act specifically:

- Prohibits dams and other federally assisted water resources projects that would adversely affect river values.
- Protects outstanding natural, cultural, or recreational values.
- Ensures water quality is maintained.
- Requires the creation of a comprehensive river management plan that addresses resource protection, development of lands and facilities, user capacities, and other management practices necessary to achieve purposes of the act as of 2012.

The NWSRS protects 12,598 miles of 203 rivers in 39 states and the Commonwealth of Puerto Rico; this is a little more than one quarter of one percent of the Nations rivers (*http://www.rivers.gov/national-system.php*; accessed December 2014). Connecticut River tributaries have been designated under the act: 14 miles of the West Branch of the Farmington River in Connecticut; 25.3 miles of the Eightmile River in Connecticut, and 78 miles of the Westfield River in Massachusetts (NWSRS 2013). In recent years, local partners have been controlling invasive plants along these stretches.

Research Natural Areas
The Service administratively designates Research Natural Areas (RNAs) on refuges. RNAs are part of a national network of reserved areas under various ownerships, often the Forest Service, National Park Service, Bureau of Land Management, and Fish and Wildlife Service. Research natural areas are intended to represent the full array of North American ecosystems with their biological communities, habitats, natural phenomena, and geological and hydrological formations. In research natural areas, as in designated wilderness, natural processes are allowed to predominate without human intervention. Under certain circumstances, deliberate manipulation may be used to maintain the unique features for which the research natural area was established. Activities such as hiking, bird watching, hunting, fishing, wildlife observation, and photography are permissible, but not mandated. Research natural areas may be closed to all public use if such use is determined to be incompatible with primary refuge purposes (USFWS 2013b).

There are no RNAs on the refuge. The nearby White Mountain National Forest contains 1,995 acres in three RNA units, all of which are outside of the watershed: Alpine Gardens (tundra), Nancy Brook (old growth spruce-fir), and The Bowl (old-growth spruce-hardwood). The Green Mountain National Forest contains one 290-acre unit known as the Cape (mesic northern hardwood) (USDA 2012).

National Natural Landmarks
The National Natural Landmarks (NNL) Program recognizes and encourages the conservation of outstanding examples of our countries natural history. It is the only natural areas program of national scope that identifies and recognizes the best examples of biological and geological features in both public and private ownership.

NNLs are designated by the Secretary of the Interior, with the owners concurrence. To date, nearly 600 sites have been designated. The National Park Service administers the program, and if requested, assists with the conservation of these important sites. There are three landmarks in the watershed, all in New Hampshire: Mount Monadnock NNL in Mount Monadnock State Park, Franconia Notch NNL in Franconia Notch State Park, and Pondicherry NNL, which is part of the refuge's Pondicherry Division. We propose a 694-acre expansion to the existing 304-acre Pondicherry NNL (see the "Actions Common to All Alternatives" section in chapter 4).

National Trails
The National Trails System Act (P.L. 90-543, as amended through P.L. 109-418, December 21, 2006) was passed: "In order to provide for the ever-increasing outdoor recreation needs of an expanding population and in order to promote the preservation of, public access to, travel within, and enjoyment and appreciation of the open-air, outdoor areas and historic resources of the Nation, trails should be established primarily, near the urban areas of the Nation, and secondarily, within scenic areas and along historic travel routes of the Nation which are often more remotely located. The purpose of this Act is to provide the means for attaining these objectives by instituting a national system of recreation, scenic and historic trails, by designating the Appalachian Trail and the Pacific Crest Trail as the initial components of that system, and by prescribing the methods by which, and standards according to which, additional components may be added to the system." The Appalachian Trail is a National Trail that passes through the watershed. The Little Cherry Pond and Mud Pond trails on the refuge's Pondicherry Division were established as a National Recreational Trail in 2006 and 2013, respectively. The Little Cherry Pond Trail is a one-mile loop that winds through six different forest communities with a view of the pond from its shore. The Mud Pond Trail is a 0.6-mile universally accessible trail with 900 feet of

raised boardwalk and rest stops that offer views of the boreal forest and wetland communities. Visitors walk through a forest to a beautiful pond and a boreal forest fen where three carnivorous plant species reside.

Important Bird Areas
The IBA of the National Audubon Society is a global effort to identify and conserve areas that are vital to birds and other biodiversity. By working with Audubon chapters, landowners, public agencies, community groups, and other non-profits, National Audubon endeavors to interest and activate a broad network of supporters to ensure that all IBAs are properly managed and conserved (Audubon 2013). IBAs are sites that provide essential habitat for one or more species of bird. IBAs include sites for breeding, wintering, and/or migration. IBAs may be a few acres or thousands of acres, but usually are discrete sites that stand out from the surrounding landscape. IBAs may include public or private lands, or both, and they may be protected or unprotected.

To qualify as an IBA, sites must satisfy at least one of the following:

(1) Species of conservation concern (e.g., threatened and endangered species).

(2) Species with restricted ranges (i.e., species vulnerable because they are not widely distributed).

(3) Species that are vulnerable because their populations are concentrated in one general habitat type or biome.

(4) Species, or groups of similar species (such as waterfowl or shorebirds), that are vulnerable because they occur at high densities due to their tendency to congregate (Audubon 2013).

The following 11 areas in the Connecticut River watershed are recognized IBAs:

(1) Pondicherry Basin IBA, which includes the Pondicherry Division, is a low elevation wetland complex featuring black spruce, tamarack, balsam fir, balsam poplar, red maple and a variety of wetland plant communities (*http://www.nhbirdrecords.org/bird-conservation/IBA-library/Pondicherry%20Basin%20IBA.pdf* ; accessed December 2014). The IBA supports populations of species such as Rusty Blackbird, Yellow-bellied Flycatcher, Lincoln's Sparrow, and several warblers. Emergent wetlands provide habitat for Virginia rail, American bittern, and the occasional sora or pied-billed grebe. Other forest types at higher elevations support hardwood species like veery and early successional species like American woodcock and chestnut-sided warbler. Extensive grasslands associated with an airport within the IBA boundary are used by bobolinks and northern harriers. The area is also home to seven species of breeding waterfowl, and as such is one of the more diverse assemblages of this group in New Hampshire.

(2) The Lower Connecticut Valley IBA stretches from the northern Massachusetts border up river to the vicinity of Claremont, New Hampshire (*http://nhbirdrecords.org/bird-conservation/IBA-library/Lower%20Connecticut%20River%20IBA.pdf*; accessed December 2014). This area is used by a wide variety of waterfowl in migration and winter and supports nesting pairs of bald eagles. Important habitats include floodplain forests, emergent wetlands, and agricultural fields. The IBA boundary is defined as roughly 200 feet above the average river level, which covers an area roughly corresponding to the lower river terrace.

(3) The Northwest Park IBA in Windsor, Connecticut, is located along the Farmington River and has successional habitat with forest, wetland, shrub, and fields (Davison 2007). Of the 128 bird species recorded, 59 are considered high-conservation priorities. The majority of these are associated with actively

managed early successional forest, grasslands, and shublands, including the State-endangered grasshopper sparrow.

(4) The Station 43 Marsh IBA in South Windsor, Connecticut, consists of a pond and associated fresh water wetland complex (Morrison 2006). It is situated in the Connecticut River floodplain in a large undeveloped block of several thousand acres of farmland, shrubland and floodplain forest on both sides of the river. Over 200 bird species have been recorded on the IBA with 9 of those listed as State-endangered, 7 as State-threatened, and 10 of special concern.

(5) Herricks Cove IBA consists of two parcels of about equal size in the town of Rockingham, Vermont. Herricks Cove is located where the Williams River enters the Connecticut River north of Bellows Falls (*http://netapp.audubon.org/iba/Reports/1754*; accessed December 2014). It consists primarily of agricultural lands bordered by wetlands to the west and floodplain forest to the south. The location along the Connecticut River and the diversity of habitats make this IBA ideal stopover habitat for migrating birds. At least 221 species have been recorded there including several priority marsh birds (e.g., pied-billed grebe, American bittern, sora, and Virginia rails).

(6) The Nulhegan Basin IBA is Vermont's largest IBA comprising a mosaic of forest and wetland habitat types (*http://netapp.audubon.org/iba/Reports/1780*; accessed December 2014). The predominance of boreal habitats is typical of forest found further to the north and as such supports a number of species rarely found in Vermont. The largest population of the State-endangered spruce grouse is found in the IBA. The common loon, another State endangered species inhabits several ponds. Other State priority species include the gray jay, boreal chickadee, black-backed woodpecker, Cape May, bay-breasted, palm, and Tennessee warblers.

(7) Barton Cove-Poet's Seat IBA in Gill and Greenfield, Massachusetts includes the large impoundment of the Connecticut River main stem behind the Turners Falls dam and a wooded ridge on the west side of the river (*http://www.massaudubon.org/our-conservation-work/wildlife-research-conservation/statewide-bird-monitoring/massachusetts-important-bird-areas-iba/important-bird-area-sites/(id)/32*; accessed December 2014). Bald eagle pairs have been present during nesting season since 1989, with several successful nestings. The cove is an important feature for waterfowl including ducks, loons, and grebes. The Rocky Mountain Ridge (e.g. Poet's Seat area) in Greenfield, Massachusetts, is important for breeding and wintering birds.

(8) The Mount Holyoke/Mount Tom/East Mountain Range IBA in Amherst, Granby, and South Hadley (Amherst, Belchertown, Easthampton, Granby, Hadley, Holyoke, South Hadley, West Springfield, Westfield) is a forested area near the main stem, and includes the Mount Tom Unit of the refuge (*http://www.massaudubon.org/our-conservation-work/wildlife-research-conservation/statewide-bird-monitoring/massachusetts-important-bird-areas-iba/important-bird-area-sites/(id)/39;* accessed December 2014). It is primarily oak-conifer forest with lesser amounts of northern hardwoods, pitch pine/scrub oak, shrubland, grassland, and wetlands. This area is prime migratory habitat and supports nesting peregrine falcons. The ranges are a migration route for large concentrations of broad-winged, sharp-shinned and Coopers hawks, and American kestrel, as well as several other species including the northern goshawk, red-shouldered hawk, merlin, peregrine falcon, osprey, and bald eagle. It is also an important nesting habitat for many important species including the whip-poor-will, Louisiana waterthrush, worm-eating, black-and-white, blackburnian, black-throated blue, and cerulean warblers.

(9) Longmeadow Flats IBA is a floodplain area along the main stem of the river in Longmeadow, Massachusetts, ownership is divided among the Fannie Stebbins Wildlife Refuge, the town of Longmeadow, and private landowners

(*http://www.massaudubon.org/our-conservation-work/wildlife-research-conservation/statewide-bird-monitoring/massachusetts-important-bird-areas-iba/important-bird-area-sites/(id)/37;* accessed December 2014). At least eight State-endangered, threatened, or special concern species use this site on a regular basis including peregrine falcons, bald eagles, American and least bitterns, blackpoll warblers, Northern parula, and pied-billed grebes.

(10) Montague Sandplains IBA is a pitch pine/scrub oak area in Montague, Massachusetts, owned by the Massachusetts Division of Fisheries and Wildlife and the town of Montague (*http://www.massaudubon.org/our-conservation-work/wildlife-research-conservation/statewide-bird-monitoring/massachusetts-important-bird-areas-iba/important-bird-area-sites/(id)/38*; accessed December 2014). The sandplains support State-threatened vesper and grasshopper sparrows, as well as numerous other important bird species.

(11) The Quabbin River watershed IBA is in the area surrounding the Quabbin Reservoir in several towns (*http://www.massaudubon.org/our-conservation-work/wildlife-research-conservation/statewide-bird-monitoring/massachusetts-important-bird-areas-iba/important-bird-area-sites/(id)/30;* accessed December 2014). It is a large reservoir that hosts wintering bald eagles, surrounded by thousands of acres of watershed forests managed by the Massachusetts Department of Conservation and Recreation. Three State-listed species are documented breeders: common loon, bald eagle, and pied-billed grebe. Thirty-five PIF priority bird species have been documented as breeding in this IBA including several forest-interior and early successional species.

American Heritage River
The entire 410-mile length of the Connecticut River is designated an American Heritage River. It stands at the heart of this regions human settlement and commerce; at the core of its history and culture; and represents the essence of its environmental quality and economic vitality. The American Heritage Rivers is an innovative non-regulatory partnership-based initiative designed to help river communities that seek Federal assistance and other resources to meet some tough challenges.

The Federal role is solely to support community-based efforts to preserve, protect, and restore these rivers and their communities. Without any new regulations on private property owners, state, local and tribal governments, the American Heritage Rivers initiative is about making more efficient and effective use of existing Federal resources, cutting red-tape, and lending a helping hand.

Federally Endangered, Threatened, and Candidate Species
Twelve federally listed endangered, threatened, or candidate species occur within the watershed. A brief description of each follows.

Canada Lynx—Threatened: Lynx were historically found from Alaska to the Canadian Maritime Provinces, extending south in the Rocky Mountains, around the Great Lakes, and into New England. Today the species is secure in Alaska and Canada, but imperiled or extirpated in the continental United States. Lynx occur in boreal and montane landscapes dominated by coniferous or mixed forest with thick undergrowth interspersed with more open habitats and young forests that support their principal prey, snowshoe hare.
Lynx are relatively rare in the contiguous U.S. because of habitats that are inherently unable to support cyclic, high-density snowshoe hare populations and are thus unable to sustain cyclic lynx populations (USFWS 2009). The principal factor affecting softwood forest types favored by lynx is timber harvest on non-Federal lands, however the influence of current forest practices on lynx is not known.

Lynx have been confirmed breeding in northeastern Vermont and New Hampshire. A family group was detected in the winters of 2012 and 2013 within the refuge's Nulhegan Basin Division. Lynx may also use habitats within the refuge's Pondicherry and Blueberry Swamp Divisions, though evidence of lynx at these divisions has not been detected. The Upper Connecticut River Valley is included as a peripheral recovery area in the Recovery Outline for this species, an interim document in advance of a Recovery Plan (USFWS 2005).

Piping plover—Threatened: The piping plover is a threatened shorebird which breeds along the sandy coastal beaches of eastern North America. Historically, it was severely reduced in numbers by hunting, although now the major threats are habitat degradation, human or human-related disturbances during the nesting season, and nest predation (USFWS 1996). The only suitable habitat for this species within the watershed is a one-mile long sand spit at the mouth of the Connecticut River known as Griswold Point. Owned by TNC, this beach provides nesting habitat for several nesting pairs.

Piping plovers also breed in several other nearby areas along the Long Island Sound in Connecticut, including the Stewart B. McKinney Refuge, but these areas are outside of the Connecticut River watershed. Over the last decade, up to two breeding pairs have attempted nesting at the Milford Point Unit of the Stewart B. McKinney Refuge, with very limited success (Long Island Sound Study 2011; *http://longislandsoundstudy.net/wp-content/uploads/2010/07/From-the-Shore-111.pdf*; accessed December 2014).

Atlantic sturgeon—Endangered: In 2012, five distinct population segments of Atlantic sturgeon were listed as either threatened or endangered under the ESA: the Gulf of Maine, New York Bight, Chesapeake Bay, Carolina, and South Atlantic distinct population segments (NOAA 2014). Atlantic sturgeons living in the Connecticut River are part of the New York Bight distinct population segment and are listed as endangered (77 FR 5880, 2/16/2012). According to the Connecticut River Coordinator's program, the Connecticut River population is considered extirpated. Currently, only a small amount of migrating individuals are found in the mouth of the Connecticut River and, therefore, it is likely no spawning activity is occurring in the river (CRCO 2010).

The Atlantic sturgeon is an anadromous fish, meaning they spend part of their lives in saltwater and part in freshwater (NOAA Fisheries 2012). Adult Atlantic sturgeons spawn in large, deep freshwater rivers. For spawning, they require clean, cold, moderately flowing water. Juvenile and non-spawning adults live in shallow, nearshore coastal waters, and estuaries.

The major historical threat to Atlantic sturgeons was overharvest, but in 1998 the Atlantic States Marine Fisheries Commission (ASMFC) put in place a coast-wide moratorium on Atlantic sturgeon harvest. Current threats include "by-catch" from commercial fisheries targeting other species, habitat degradation from

Atlantic sturgeon

Duane Raver/USFWS

dredging, dams, water withdrawals, and development; ship strikes; and barriers to movement, including locks and dams (NOAA Fisheries 2012). ASMFC's Atlantic Sturgeon Fishery Management Plan and its amendments outline measures to help preserve existing sturgeon habitat, restore and improve degraded habitat, and monitor by-catch and species recovery (ASMFC 1998). The plan also describes protocols for breeding and stocking captive-reared sturgeon.

Shortnose sturgeon—Endangered: The shortnose sturgeon was first listed as endangered in 1967. The National Marine Fisheries Service (NOAA Fisheries) published a shortnose sturgeon recovery plan in 1998. Although it has disappeared from some rivers, it is still found in many rivers from Florida to New Brunswick. The Connecticut River population is considered one of 19 separate distinct population segments of this species in need of recovery.

Although it inhabits the Connecticut River from Turners Falls, Massachusetts, to Long Island Sound, the Holyoke dam separates the shortnose sturgeon into two populations. The total upriver population estimates ranged from 297 to 714 adult sturgeon (with less than 100 of those spawning in a given year), while the downriver population (which cannot reach the upstream spawning area) was estimated at around 875 adults. Recent evidence indicates that no successful reproduction occurs in the population below the Holyoke dam. This downstream population is sustained by the influx of out-migrating sturgeon from the upstream group. Spawning in the Connecticut occurs from the last week of April to mid-May, as the spring flows wane, in specific rubble/boulder substrate. Not all females spawn every year, and a percentage of adult females with tumors are unable to spawn (B. Kynard, pers. obs.). Breeding adults migrate north to their spawning grounds in the fall and stay there until spring. Most fish stay in freshwater all year, concentrating in decreased flow areas where they seek out freshwater mussels, a major prey item. Shortnose sturgeons forage day and night, and have a summer home range of about 10 kilometers. They overwinter in deep holes, usually within their summer range. Some adults from the downriver population spend several weeks in low salinity river reaches below Hartford in May and June, presumably feeding, and then return to the fresher upriver areas (NOAA 1998, UMass-Amherst 2013). The primary impediment to sturgeon recovery is the presence of dams that obstruct migration and modify the historic flow regimes that cued the fish to spawning at appropriate times and places. There is also mortality associated with accidental by-catch by fishermen (NOAA 1998).

Dwarf wedgemussel—Endangered: This freshwater mussel is an inhabitant of muddy sand, and sand or gravel bottoms of rivers and streams. It once occurred throughout the Atlantic coastal plain from North Carolina to New Brunswick, but has been lost from a majority of known sites. Primary threats include habitat loss and habitat fragmentation, and altered natural river processes; specifically, these threats include loss of riparian buffers, loss of floodplains, altered channel processes and sediment transport, altered hydrology, bank erosion, and dams. Pollutants from industrial and agricultural activities and other sources substantially impact mussel populations which are sensitive to pesticides, chlorine, potassium, zinc, copper, and cadmium (Nedeau 2009, USFWS 1993a).

This mussel once occurred along much of the Connecticut River and many of its tributaries, but is no longer found in the main stem in Connecticut and Massachusetts (USFWS 1993a). The species was rediscovered in the upper Connecticut River in 1995, including 68 sites in the main stem and 77 sites in tributaries. It occurs along a 16-mile main stem reach of the river between Orford and Haverhill (New Hampshire) in an area referred to as the Middle Macrosite, and along a 21-mile reach from Dalton to Northumberland (New Hampshire) in an area referred to as the Northern Macrosite (Nedeau 2009). Small populations also exist in the Farmington River in the vicinity of Simsbury; Fort River, Mill River near Northampton, Massachusetts; a different Mill River

in Deerfield and Whately, Massachusetts; and Ashuelot River near Keene, New Hampshire (Susi von Oettingen, 2010, pers. comm., USFWS). The Recovery Plan for this species was last issued in 1993 (USFWS 1993a).

Puritan tiger beetle—Threatened: The Puritan tiger beetle is an inhabitant of sandy riverine beaches along the Connecticut River and sandy bluffs along Chesapeake Bay in Maryland. The Puritan tiger beetle has declined along the Connecticut River due to inundation and disturbance of its shoreline habitat from dam construction, riverbank stabilization and human recreational activities. Of 11 known historic populations along the Connecticut River, 2 remain (USFWS 1993b). One occurs in Northampton, Massachusetts, on a river beach owned by the City of Northampton and the Massachusetts Division of Fisheries and Wildlife. The numbers of adult beetles in this population decreased in the late 1980s, dropping below 50 adult beetles. The refuge and it partners have been making a concerted effort there since 1996 to protect and augment this population. In 2005 the number of adult beetles rose to 200, but unfortunately has declined to only 2 adults in 2014. The other population is near Cromwell, Connecticut, and comprises 350 to 500 individuals at three sites in close proximity. The refuge's Deadman's Swamp Unit protects one of theses sites and supports adult beetles, although no larvae have been found there to date. The Recovery Plan for this species was issued in 1993 (USFWS 1993b).

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Puritan tiger beetles

In 2015, the Service awarded $220,000 in funding, under the Cooperative Recovery Initiative (CRI), for the Refuge and partners to conduct a habitat enhancement and population stabilization project for the Puritan tiger beetle populations in the watershed. CRI is a strategic, cross-programmatic approach to recover federally listed species on refuges and surrounding lands. The goals and objectives of the Puritan tiger beetle project are to:

- Secure the existing metapopulation in Connecticut.
- Establish two metapopulations in New England to meet recovery criteria.
- Restore beach habitat.
- Establish captive rearing lab at Cronin National Fish Station in Sunderland, Massachusetts.

Project activities planned include debris removal and control vegetative encroachment using mechanical and herbicide treatments, collecting adult tiger beetles for the captive rearing program, and translocating captive reared beetles into restored habitat. Other species benefitting from this project include the tide water mucket, yellow lampmussel, cobra clubtail, midland clubtail, hairy necked tiger beetle, and sandbar willow.

Jesup's milk-vetch—Endangered: This plant exists only in the Connecticut River watershed and is confined to calcareous bedrock outcrops which are ice scoured annually (USFWS 1989). The only three known sites occur along a 16-mile stretch of the Connecticut River in the towns of Plainfield and Claremont, New Hampshire, and Hartland, Vermont. Habitat alteration and botanical collecting have been the major impacts to this plant. Trampling by humans also poses a threat due to canoe and kayak portaging near one site. An invasive plant, black swallow-wort, has expanded into the area from the nearby railroad tracks and threatens to displace the milk-vetch. The Recovery Plan for this species was

issued in 1989 (USFWS 1989b). Partners have worked to control the black swallow-wort.

Small whorled pogonia—Threatened: This threatened plant, also known as the green five-leaf orchid, inhabits upland sites in deciduous or mixed deciduous and coniferous forests in second or third growth forests. It is rare but widely occurring at about 85 sites in 15 states and Canada (USFWS 1992). There are only two known sites within the Connecticut River watershed, one in Connecticut and one in Massachusetts. Both are extremely small. Destruction of habitat from commercial and residential development has been a primary threat. Plant collectors decimated the only known population in Connecticut several years ago after its location was published in a newspaper. The species was originally listed as endangered in 1982 but that status was changed to threatened in 1994. The status of this species as threatened has been undergoing a prescribed 5-year reevaluation to assess the accuracy of that listing. The Recovery Plan for this species was issued in 1992 (USFWS 1992).

Northeastern bulrush—Endangered: This plant is found in alluvial meadows and small headwater or coastal plain ponds characterized by seasonally variable water levels. Approximately 113 populations are known from 7 eastern states, with most of the populations occurring in Pennsylvania and Vermont (USFWS 2008). Within the Connecticut River watershed, 2 sites are known in Massachusetts, 9 in New Hampshire, and 22 in Vermont. Habitat alterations that make conditions consistently wetter or drier are the major threat to this species (USFWS 2006b). Other threats include agricultural runoff, logging roads, fire roads, off-road vehicle use, and unauthorized collection. The refuge's Putney Mountain Unit in southern Vermont was purchased to protect a population of this plant. The Recovery Plan for this species was issued in 1993 (USFWS 1993c), and the Service completed a 5-year status review for the species in the fall of 2008 (USFWS 2008).

Northern long-eared bat

Al Hicks/NYDEC

Rufa red knot—Threatened: In December 2014, the Service listed the *rufa* red knot as federally threatened (79 FR 73706-73748). The "rufa" subspecies of red knot (*Calidris canutus rufa*) winters near the tip of South America and begins its long journey north to Arctic breeding grounds in mid-February, when they spend time at a number of coastal habitats along eastern North America, particularly Delaware Bay beginning in mid-May. The species has been recorded during migration along the coasts of Connecticut, Massachusetts, and New Hampshire. Major threats to the subspecies include loss of breeding and nonbreeding habitat, predation during breeding, reduced prey availability, and mismatches in the time of the species migrations and the availability of food and favorable weather conditions.

Northern long-eared bat—Threatened: In April 2015, the Service listed the northern long-eared bat as federally threatened. The northern long-eared bat occurs in 39 states in the eastern and north central U.S. This medium-sized bat is currently being decimated by white-nosed syndrome, a fungal disease that affects certain types of bats. In the Northeastern U.S., northern long-eared bat populations have dropped by 99 percent from pre-white-nosed syndrome numbers. As white-nose syndrome continues to expand throughout the remainder of the species range, scientists expect high losses will continue. For more information on this species, visit: *http://www.fws.gov/midwest/nleb/* (accessed April 2015).

New England cottontail—Candidate: The range of this once widespread rabbit has shrunk by about 86 percent since 1960 (Fuller and Tur 2012). The

primary cause is loss of early successional forest and shrubland habitat. Other factors include high predation rates due to small, fragmented habitat patches, and gradual displacement by introduced Eastern cottontails which use a wider variety of habitats and appear to be less susceptible to predation.

Recent surveys have revealed that the New England cottontail still occurs in scattered areas of Rhode Island, New Hampshire, southern Maine, western Connecticut, and in parts of Massachusetts (western Hampden County, southeastern Berkshire County, and Plymouth County). In the watershed, it has only been found in Hartland, New Hartford, East Haddam, and Lyme, Connecticut and in Hampden and Berkshire Counties in Massachusetts. Given this conservation urgency, a range wide New England Cottontail Initiative was established. This initiative involves collaboration from multiple agencies, including the Service, state wildlife agencies, universities, Natural Resources Conservation Service, TNC, and Wildlife Management Institute, to address cottontail conservation on a landscape scale (USFWS 2011).

Forty-nine focus areas were identified as locations to manage and restore habitat for New England cottontail. Three of these focus areas are within the refuge acquisition boundary. Early successional forest management and protection of adjacent natural shrubland habitat will meet the conservation goals set for the New England cottontail. "A Conservation Strategy for the New England Cottontail" was developed and approved in November 2012, and provides the conservation and habitat management goals and strategies for this species (Fuller et al.2012).

The Service published an updated summary for this petitioned candidate that summarizes the status of the New England cottontail (*Federal Register* 77(225):70009-70010).

Birds

The Connecticut River watershed serves as one of the major "north-south" migration corridors within the expansive Atlantic Flyway, flanked by the Atlantic coastal corridor to the east and the Champlain Valley corridor to the west (Browne 2009). Hundreds of species of migratory and resident birds inhabit the Connecticut River watershed. These species encompass 17 taxonomic orders and 46 families of birds ranging from the well-known Canada goose and American robin to the rare golden-winged warbler and boreal owl (DeGraaf and Yamasaki 2001). Twenty-seven species of ducks, geese, and swans; 15 species of shorebirds; and 24 other water-dependent species such as rails, grebes, and herons use the watershed for breeding, wintering, or migration (USFWS 1995a).

The watershed is also host to 181 passerine and raptor species. Of these, 88 are neotropical migrants that breed in the watershed, 77 are residents that breed and winter here, and 16 are winter residents that migrate to the watershed from the north. Certain species such as mourning dove, American robin, red-tailed hawk, American crow, cedar waxwing, and American goldfinch have both migratory and resident populations (DeGraaf and Yamasaki 2001). For a complete list of birds in the watershed, please visit: *http://www.fws.gov/r5soc/library/natural_resources/watershed_birds.pdf* (accessed December 2014). We summarize studies on birds conducted on individual refuge divisions and units in Part III of this chapter.

Below, we provide some general information on different bird groups (e.g., waterfowl, raptors, etc.) in the watershed.

Waterfowl

The lower Connecticut River has abundant waterfowl year-round and has some of the highest and most significant concentrations of black duck in the Northeastern

U.S. (Dreyer and Caplis 2001). The freshwater and tidal wetlands along the Connecticut River, particularly in the lower portion of the watershed, provide important stopover habitat during both spring and fall migrations of waterfowl, such as American black duck. The habitats most important to black duck are the tidal wetlands along the main stem, as well as the tidal wetlands and bays along the coast. In the winter, the river provides relatively ice-free open water habitat providing access to submerged aquatic vegetation, invertebrates and high calorie wetland vegetation. Many waterfowl also nest along the river, including mallards, black duck, Canada goose, green-winged teal, and gadwall. The lower Connecticut River (from Salmon River to the mouth) has been designated a Ramsar Wetland of International Significance, as well as an ACJV waterfowl focus area.

Further north in the watershed, many migrating ducks use flooded agricultural fields, floodplains, emergent wetlands, shrub swamps and backwater areas along the Connecticut River for stopover habitat. In fact, the Connecticut River is a waterfowl focus area under the ACJV for New Hampshire and Vermont, highlighting the importance of the river habitats to breeding and migrating waterfowl (ACJV 2005, NHFG 2006). Species such as Canada geese, teal, mergansers, American black ducks, mallards, wood duck, and some sea ducks use the river corridor during spring and fall migration. The river provides prime breeding habitat for American black duck, wood duck, mallard, common merganser, and Canada geese. Other species nest along the river, but are less common.

Wood ducks are ubiquitous nesters in the watershed requiring large tree cavities which are associated with freshwater forested or shrub wetlands. They especially favor beaver ponds with heavy forest cover. Black ducks are a species of special management concern as previously described and are specifically mentioned in the Conte Refuge Act.

Forest, Shrubland, and Grassland Birds
According to the national species richness maps produced by the Breeding Bird Survey (Price et al. 1995), the watershed has a very high richness of nesting flycatchers and thrushes, and the northern watershed has the highest richness of nesting warblers, distinguishing it as nationally significant for this taxon. Within the watershed, the White Mountains to the east, Green Mountains to the west and the Berkshire Hills to the west provide the northern hardwood/spruce forest breeding habitat required by neo tropical migrants and residents. Species dependent on this type of habitat include the black throated blue warbler, black throated green warbler, American redstart, least flycatcher, veery, pileated woodpecker, and Northern goshawk.

A number of birds associated with old fields, pastures, and grasslands are declining in New England and are of special concern (Askins 2000, Vickery 1992). Grassland birds comprise one of the most imperiled groups of birds in the U.S., although the responsibility for recovering them belongs to bird conservation regions (BCRs) that include their core ranges in the Midwest. Grassland-dependent species, such as upland sandpiper, savannah sparrow, vesper sparrow, grasshopper sparrow, and bobolink, are declining across the Northeast as meadows succeed to forest stands or are replaced by development (Askins 2000). According to USGS Breeding Bird Survey, continental declines of grassland birds have been steeper, more consistent, and more geographically widespread than those of any other ecological group of birds (Sauer et al. 2001). The Wildlife Management Institute has estimated that natural grasslands have declined by 99 percent in the Northeast. The remaining grasslands are mostly agricultural and are under increasing pressure to be converted into residential developments.

Grassland-dependent birds in the watershed include: upland sandpiper which requires large contiguous grassland area with a mixture of tall and short

grasses—minimum 150 acres and even fields as large as 300 acres or more (Vickery et al. 1994, Carter 1992); sedge wren (prefers wet fields); savannah sparrow (generalist—minimum 20 to 40 acres); vesper sparrow (areas with thin grasses and bare ground—minimum 30 acres); grasshopper sparrow (dry areas with bunch grasses and bare ground—minimum 30 acres); bobolink (prefers thick grass in old fields—minimum 5 to 10 acres); and Eastern meadowlark (old fields with dead grass layer—minimum 15 to 20 acres) (Jones and Vickery 1997).

Westover Air Force Reserve Base in Chicopee, Massachusetts, hosts the largest populations of grasshopper sparrows and upland sandpipers in the watershed (U.S. Air Force 2013). The Connecticut River valley in Massachusetts provides the greatest potential for grassland habitat restoration in the watershed, as it has the greatest abundance of prime grassland habitat in the watershed and the river serves as an important migration corridor for birds (CT DEEP 2006). As New England becomes increasingly forested and urbanized, habitat for these species will continue to decline.

Neotropical migrants were surveyed in four sub-watersheds of the Connecticut River including the Farmington River watershed in Connecticut, the Deerfield River watershed in Massachusetts, the Ashuelot River watershed in New Hampshire, and the White River watershed in Vermont. The goal was to determine the importance of the Connecticut River watershed to neotropical migrants, and the habitat types used most often during migration. Twelve transects were established in each sub-watershed at specific geographic locations, and each transect was surveyed 6 different times throughout the spring each year, for 3 years (1996-1998). This survey effort was part of a study conducted by Smith College and Manomet Center for Conservation Sciences.

Waterbirds
The Connecticut River valley is inhabited by six species of colonial nesting heron: great blue heron, great egrets, black-crowned night herons, yellow-crowned night herons, snowy egrets, and little blue heron. Great blue herons forage in almost every type of shallow, open wetland including fresh, brackish, and saltwater wetlands. They are colonial tree nesters in wetlands, and many colonies can be found in the watershed; breeding is increasing. Great egrets are uncommon local breeders, common migrants and summer residents, and are generally increasing. Black-crowned night herons, another colonial nester, are locally common breeders; this species has experienced declines in the watershed and is restricted to the seacoast. Yellow-crowned night herons as well as little blue herons are rare breeders, both tending to use wooded wetlands and marshes. Double-crested cormorant are colonial nesters and their populations are increasing; there are one or two reports of them nesting near the Connecticut River (Bevier 1994).

The common loon nests on small and large ponds and lakes from Quabbin Reservoir north and winters along the coast.

Secretive Marsh Birds
Virginia, clapper, and sora rails are all fairly common nesters in the marshes along the river. King rail are rare and found almost exclusively in high salt marshes at the mouth of the Connecticut River. Freshwater tidal marshes with wild rice are important stopover areas for sora rails in the fall (Dreyer and Caplis 2001). Least and American bitterns are relatively uncommon across the watershed, although the latter is known to breed at the Pondicherry Division. American bitterns have declined of late due to loss of freshwater wetlands. Least bittern are rare local breeders preferring tall dense freshwater marshes (DeGraaf and Yamasaki 2001).

Shorebirds
During migration, mud flats along the main stem of the Connecticut River and sandy areas around the mouth of the river provide essential foraging habitat

to several species of shorebirds such as the willet, solitary sandpiper, lesser yellowlegs, and federally endangered roseate terns. The mouth of the river also provides nesting areas for piping plovers, least terns, and common terns. The spotted sandpiper is common, frequenting shorelines along rivers, streams, lakes and ponds. Upland sandpipers rely on expansive grassland habitats and are generally rare in the watershed, most often seen at large airports. The American woodcock is found throughout the watershed in early successional forests, and locally is a common breeder. Declining early successional forests pose a challenge to this species (DeGraaf and Yamasaki 2001).

Ospreys

Bob Weiss/USFWS

Raptors

The Connecticut River valley is a major corridor for raptor migration. Mount Tom in Massachusetts, Mount Monadnock in New Hampshire, and Putney Mountain in Vermont, are well known sites to observe raptor migrants in the fall. On certain days when strong fronts follow periods of harsh weather, thousands of broad winged hawks can be observed. At least a dozen other raptor species including red-tailed hawks, sharp shinned hawks, American kestrels, merlins, red-shouldered hawks, and osprey are common migrants. Many of these species and other raptors nest throughout the watershed.

Fish

The watershed supports a diversity of fishery resources. Cold, cool and warm-water species are in general abundance throughout the watershed. The watershed did not historically support as diverse a group of fishes as it does presently; many of the species considered resident were introduced (e.g., smallmouth bass, brown trout). The main stem and many of its tributaries were impounded following early European settlement. Prior to environmental regulations, many industries in the river corridors discharged pollutants directly into the water. Many lakes, ponds, and wetlands were similarly degraded. The creation of reservoirs and subsequent degradation of aquatic habitats resulted in native species declines and provided opportunities for exotic species establishment.

There are 142 fish species found within the watershed: 33 native freshwater; 35 nonnative freshwater; 11 diadromous fish (migrate between salt- and freshwater for breeding purposes); 15 amphidromous (migration between fresh water and the sea for other than breeding purposes); and 48 saltwater (*http://www.fws.gov/refuge/Silvio_O_Conte/about/library.html*; accessed December 2014). Indigenous freshwater fish are, with few exceptions, generally found throughout the watershed. Diadromous fish are primarily found in the lower reaches of the watershed, south of Bellows Falls, Vermont, with higher numbers and more species near the mouth of the main stem. Saltwater species generally occur within Long Island Sound and amphidromous species are found in the lower reach of the Connecticut River and its tributaries.

The northern reaches of the river provide habitat for lake and Eastern brook trout and land-locked Atlantic salmon. The mid-section of the river supports chain pickerel, largemouth and smallmouth bass, Northern and walleyed pike, and a variety of panfish such as bluegill, summer flounder, and striped bass are found at the mouth of the river. Common carp, suckers, American eels, and catfish such as the channel catfish and brown bullhead are present in many areas. The native population of Atlantic salmon in the watershed is extirpated; efforts to reestablish the population through hatchery stock persisted for decades, however the Service recently terminated the program due to poor success. A previously sustainable American shad population, a species with less precise habitat requirements, has experienced recent declines in spite of habitat restoration efforts.

Migratory Fish
Atlantic salmon, American shad, shortnose sturgeon, and river herring (i.e., alewife and blueback herring) are all specifically mentioned in the purposes of the Conte Refuge Act. In addition, each is a trust responsibility of the Service via the Magnuson Stevens Fishery Conservation and Management Act, the Anadromous Fish Conservation Act, the Atlantic Coastal Fisheries Cooperative Management Act, and the Atlantic Striped Bass Conservation Act (*http://www.fws.gov/laws/lawsdigest/FISHCON.HTML; http://www.fws.gov/laws/lawsdigest/ANADROM.HTML, http://www.fws.gov/laws/lawsdigest/ATLSTRI.HTML*; all accessed December 2014).

Atlantic Salmon
Based on historical accounts from Native Americans and early European settlers, there used to be large Atlantic salmon runs in the Connecticut River. However, the salmon population declined rapidly as Europeans colonized American and constructed dams for power. The first dam across the main stem Connecticut River was constructed in 1798 near the present site of Turners Falls, Massachusetts. This and other dams blocked salmon migrations to their breeding areas in the northern portion of the river. Dams were also constructed along the lower basin tributaries. Additionally, unregulated harvest of salmon depleted the population. By the 1800s, salmon had disappeared from the Connecticut River.

There have been several attempts to restore Atlantic salmon to the Connecticut River. An interagency state/federal program to restore salmon to the Connecticut River was initiated in the 1860s. Although the effort resulted in the return of hundreds of adult salmon for several years in the 1870s and 1880s, the program eventually failed due to both uncontrolled harvest of fish in Connecticut waters and the failure to construct effective fish passage at dams in Massachusetts.

Another attempt began in 1967 when the Service, Connecticut, Massachusetts, New Hampshire, Vermont, and the National Marine Fisheries Service signed a statement of intent to restore anadromous fish, including Atlantic salmon, to the Connecticut River. The Service discontinued the Atlantic salmon portion of this program in 2012 due to reviews of scientific literature, low numbers of adults returning to the river since the 1990s, and severe damage to the White River National Fish Hatchery from flooding in fall 2011 (*http://www.fws.gov/cronin/;* accessed December 2014). Following the Service's announcement, Massachusetts decided it would no longer culture salmon at its Roger Reed State Hatchery. As of 2014, Vermont and New Hampshire have no plans for future stocking of any Atlantic salmon. However, Connecticut is considering continuing to operate an "Atlantic Salmon Legacy Program." The purpose of this program would be to maintain Atlantic Salmon in some select watersheds in the lower Connecticut River watershed and continue to run school programs. As part of the legacy program, CTDEEP continues to stock the Salmon River with juvenile salmon.

Other Diadromous Fish Species
Prior to dam construction, migratory fish returning to the Connecticut River formerly consisted of larger numbers of American shad, alewife, blueback herring, and lesser numbers of Atlantic sturgeon, shortnose sturgeon, rainbow smelt, striped bass, sea lamprey, and gizzard shad. This last species is a relative newcomer to the watershed; it has expanded its range northward to the Connecticut River, where it was first observed at the mouth in 1980. Migratory fish life histories are described by Scarola (1987) and Scott and Grossman (1973).

American shad are broadcast spawners using the river and larger tributaries for reproduction. Blueback herring spawn in the river and tributaries while alewives seek the smaller tributaries, upper sections of larger tributaries and coves for spawning. Blueback herring habitat is mainly south of Longmeadow,

Massachusetts, and alewives rarely are found as far north as Holyoke. Rainbow smelt spawn in the tributaries and coves. Historically, American shad, blueback herring, and American eel ascended farther upriver than today. Currently, American shad ascend the river to Bellows Falls, Vermont.

Migratory fish populations were impacted by overharvesting, pollution, and dam construction that blocked migration routes. Since the late 1700s there has been a steady decline in migratory fish populations. Recognition of the impact to the migratory fish populations was quickly apparent to the inhabitants of the river valley upon completion of the dams. Migratory fish returns above dams ended and steadily and dramatically declined below the Holyoke Dam (built in 1849), the lowermost impassable dam on the main stem of the Connecticut River, and, until it breached in the 1970s, the Enfield Dam (built in 1880).

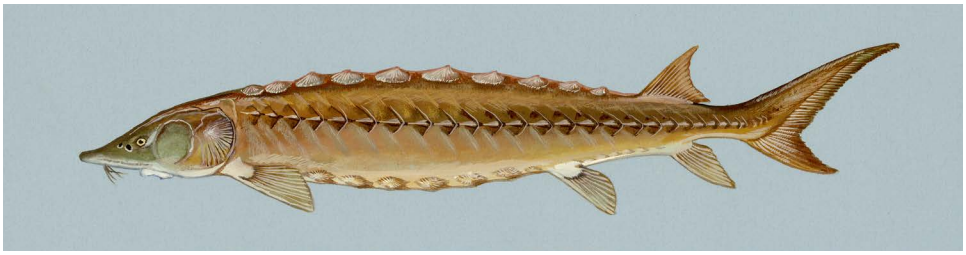
Two early (1873 and 1940) attempts to provide fish passage at the Holyoke Dam, Massachusetts, failed, then in 1955 an elevator-type fishway was constructed and was successful in passing a portion of the remnant population of American shad, blueback herring, sea lamprey, and American eel.

The enactment of the Anadromous Fish Conservation Act in 1965 provided the states and Federal agencies with the means to initiate anadromous fish enhancement and restoration programs within the watershed. Additionally, there is a planning document for American shad within the watershed that has been endorsed by the Connecticut River Atlantic Salmon Commission (CTASC 1992). American shad fish passage is presented in that document. There is also a management plan for Connecticut River herring, written by CRASC (2004).

The populations of American shad within the Connecticut River vary considerably, but generally increased after 1955, when the fish lift was installed at the Holyoke Dam. Numbers close to or above 600,000 (with a peak of 1,630,000 in 1992) were common from 1978 to 1998, but lower numbers have prevailed since then. Blueback herring had a similar pattern, with a peak year (count at Holyoke 630,000) in 1985, but their numbers declined drastically in the late 1990s, and runs have been practically non-existent since 2004. The reason for the population declines in shad and herring remain unknown.

Connecticut River shortnose sturgeons were thought to be extirpated until an isolated population was located between the Turners Falls Dam and Holyoke Dam in Massachusetts. Individuals are found below the Holyoke Dam, but they are isolated from upstream breeding habitat. Recovery of the shortnose sturgeon is being undertaken cooperatively among Federal and state fishery agencies.

Shortnose sturgeon



Duane Raver/USFWS

Blueback herring and sea lamprey use many of the major tributaries to the Connecticut River for spawning. Blueback herring is a prolific fish that can ascend the river as far as American shad. Blueback herring and sea lamprey presently migrate into the Vernon Pool passing through the Vernon Dam fishway located in southern Vermont and New Hampshire. Alewife, similar in appearance to the blueback herring, occurs in the lower reaches of the Connecticut River. Alewives migrate upriver to the vicinity of the former Enfield Dam. Together,

blueback herring and alewives are referred to as "river herring." A February 2015 report prepared by the CRASC, Technical Subcommittee for River Herring, identifies river herring restoration status and plans in the Connecticut River basin (CRASC 2015). This 2015 report supplements the existing CRASC plan, "Management Plan for River Herring in the Connecticut River Basin" (CRASC 2004).

Gizzard shad is another diadromous fish occurring in the lower reaches of the Connecticut River. They were first observed in the main stem in 1985, and have been observed in limited numbers in the Holyoke Dam fish lift in Massachusetts. Gizzard shad may occur in greater abundance below the Holyoke Dam.

Striped bass, a coastal species, have been observed in limited numbers at the Holyoke Dam fish lift. Below the Holyoke Dam, the population is estimated at over a million fish. A sport fishery has developed since 1990 in the rapids below the breached Enfield Dam.

Rainbow smelt are reported in the lower main stem. The size of the population and the utilization of spawning areas are not well known. There is a limited sport fishery for this species. Occasionally, rainbow smelt have been collected incidental to sampling for other species.

The American eel, which is petitioned for federally threatened status under the ESA, is another important migratory fish in the Connecticut River. Life history information for the American eel is presented in Stone et al. (1994), Scott and Grossman (1973), Bigelow and Schrodeor (1953). American eel are ubiquitous throughout the watershed with abundance decreasing from south to north. It is rarely observed above the confluence with the White River in Vermont.

The Service initiated a status review for American eel in 2004 at the request of the Atlantic States Marine Fisheries Commission, representing 15 states from Maine to Florida, along with a formal listing petition filed by others shortly thereafter. The Service determined in 2005 that substantial biological information existed to warrant a more thorough examination and began a comprehensive review of all the available scientific and commercial information. The Service examined all available information about the American eel population from Greenland south along the coast to Brazil and as far inland as the Great Lakes and the Mississippi River drainage. While the eel population has declined in some areas, the species' overall population was not considered in danger of extinction or likely to become so in the foreseeable future, thus formally concluding that protecting the eel as an endangered or threatened species under the ESA was not warranted. However, in 2011 in response to another petition, the Service published a finding that the petition presented substantial scientific or commercial information indicating that listing this species may be warranted (76 FR 60432-60444).

Amphidromous Fish
Amphidromous fish (fish that migrate between freshwater and the ocean during some stage of their lives other than breeding) use the estuary of the Connecticut River and the marine environment of Long Island Sound. Fifteen amphidromous fish species occur in this classification. The most commonly recognized species in this category are: white perch, mullets, and killifishes.

Resident Fish
Resident fish are defined by two categories: indigenous (native) and nonindigenous (introduced). Species distribution is strongly correlated to temperature regimes. Cool and cold-water fishes (e.g., trout, sculpin, and burbot (cusk)) are found in the northern part of the watershed and in mountainous tributary streams. Bass, pickerel, bullhead (horned pout), and white perch

are found in the southern part of the watershed, the lower reaches of the main tributaries and the impounded areas of the main stem where warm waters occur. Forage fishes are abundant in the main stem of the river and in the larger tributaries. They include blacknose dace, spottail shinner, fallfish, white or common sucker, and common shiner. There are 33 native species in addition to the diadromous fish discussed previously.

One resident fish of conservation concern is the eastern brook trout. In 2005, a group of public and private entities formed the Eastern Brook Trout Joint Venture (EBTJV) to address the decline of native brook trout and restore fishable populations. The group spearheaded a range-wide population and threats assessment to the species and its habitat in the eastern U.S. The long-term goals of the EBTJV are to develop a comprehensive restoration and education strategy to improve aquatic habitat, raise education awareness, and raise Federal, state, and local funds for brook trout conservation.

Although not currently threatened with extinction across the entire range, brook trout were extirpated from 21 percent and greatly reduced in 27 percent of sub-watersheds in a study by Hudy et al. (2005). Large portions of Maine, New Hampshire, New York and smaller portions of Vermont, Massachusetts, and West Virginia need increased monitoring. Most of the Connecticut River sub-watersheds still support brook trout to varying degrees. More subwatersheds in Vermont and New Hampshire have self-sustaining populations, whereas streams in Connecticut and Massachusetts have experienced more widespread declines due to habitat loss and degradation. The most important factors impacting brook trout across their range are increased water temperature, agriculture, urbanization, exotic fish species, and degraded riparian habitat.

In Connecticut, brook trout populations tend to be small and fragmented. The only sub-watershed in the State considered "intact" by the EBTJV is in the Litchfield Hills area which is outside the Connecticut River watershed. Intact means at least 50 percent of this subwatershed has a self-sustaining population. Within the watershed in Massachusetts, there is one intact sub-watershed located along the New Hampshire border east of the Connecticut River. Vermont has the most sub-watersheds designated as intact. A substantial portion of that is in the Northeast Kingdom, where the Nulhegan Basin Division is located. Although only qualitative information is available for most of New Hampshire, there are intact sub-watersheds near the Pondicherry and Blueberry Swamp divisions, and within the proposed Ashuelot River area (EBTJV 2006).

Mammals

The watershed hosts a diverse assemblage of mammal species, from the widespread white-tailed deer to the rare and largely unfamiliar pygmy shrew found in a variety of forested habitats in the northern third of the watershed. Sixty-one mammal species occur in the watershed today. A number of species have been extirpated over the last hundred years due primarily to habitat loss and/or unregulated hunting/trapping. These include the Eastern cougar, gray wolf, wolverine, Eastern elk, and woodland caribou. Two species have immigrated into the watershed in the last century: coyote and Virginia opossum (DeGraaf and Yamasaki 2001).

Most mammals within the watershed are forest inhabitants and include species such as near ubiquitous eastern chipmunks, gray squirrels, raccoon, and deer mouse, to the more solitary porcupine, black bear, bobcat and Canada lynx. Although heavily forested, the watershed holds a wide variety of wetland habitats (see below) which support a number of species well suited or limited to riparian and/or wetland habitats such as river otter, beaver, muskrat, and mink. Other species that commonly use wetland habitats include, water shrew, star-nosed mole, Eastern pipistrelle bat, New England cottontail, meadow vole, Southern


Craig Lewis/USFWS

White tailed deer

and Northern bog lemming, meadow jumping mouse, gray fox, raccoon, American marten, and ermine (DeGraaf and Yamasaki 2001).

The rocky and steep topography in the northern portion of the watershed provides natural caves and manmade mines for hibernating bats. Millions of North American bats have been killed by white-nose syndrome, a fungal disease discovered in a cave in New York State in 2006 (USFWS 2012). Winter surveys have shown 100 percent mortality in bat populations using hibernacula in Vermont (Bennett pers.com. 2013). This disease may be blamed as the principle cause for some bat species' extinction. Little brown, tricolored, and eastern small-footed bats have been decimated by this disease, and have been petitioned for listing under the ESA. As mentioned above, the northern-long eared bat is proposed as federally endangered.

For a complete list of mammals found in the watershed, visit: *http://www.fws.gov/refuge/Silvio_O_Conte/about/library.html* (accessed December 2014).

Reptiles and Amphibians

There are 23 species of amphibians and 25 species of reptiles in the watershed. Reptiles include species such as wood turtle, Eastern box turtle, spotted turtle, musk turtle, common snapping turtle, painted turtle, Northern red-bellied slider, Northern black racer, Eastern timber rattler, Eastern ribbon snake, Eastern milksnake, and Eastern hog-nosed snake. Amphibians include species such as Northern leopard frog, wood frog, Eastern American toad, spotted salamander, red-backed salamander, marbled salamander, and Jefferson salamander. The painted turtle is probably the most ubiquitous turtle frequently seen basking in ponds, oxbows, and other quiet shallow bodies of water. The Northern diamondback terrapin, an estuarine species, is restricted to the tidal creeks and bays at the mouth of the Connecticut River. It may nest on some of the sandy spoil islands. The Eastern box turtle is the only completely terrestrial turtle within the watershed and is a resident of woodlands, field edges, and well-drained forest bottomlands (USFWS 2013c).

For a complete list of amphibians and reptiles found in the watershed, visit: *http://www.fws.gov/refuge/Silvio_O_Conte/about/library.html* (accessed December 2014).

Redback salamander


USFWS

The redback salamander, probably the most widespread and abundant salamander within the watershed, is a small woodland salamander with a completely terrestrial life history. It inhabits deciduous or mixed conifer-deciduous forests residing beneath wet leaf litter, within or beneath logs or other retreats. The common mudpuppy salamander is the only aquatic species within the watershed and occurs primarily in the main stem Connecticut River and immediate tributaries from Massachusetts to central Connecticut. The Northern spring peeper is a diminutive woodland frog widely distributed throughout the watershed. It is the earliest frog to call in the spring, breeding in a variety of wetlands including woodland swamps and ponds, vernal pools, and roadside ditches.

Amphibians and reptiles have only recently become fauna of management concern by conservation agencies and organizations, but are now a prominent part of wildlife and natural heritage programs (Mitchell et al. 2006). All of the state wildlife action plans provide information on species of herpetofauna that are of greatest conservation need (GCN) (NHFG 2005, Connecticut Department of Energy and Environmental Protection 2005, Vermont Fish and Wildlife Department 2005, Massachusetts Department of Fish and Game 2006). These species in total embrace a broad range of habitats within the Connecticut River watershed. Examples of GCN species listed by watershed states include the blue-spotted salamander, Eastern spadefoot toad, wood turtle, Eastern box turtle,

spotted turtle, Eastern ribbon snake, Jefferson salamander, marbled salamander, Northern leopard frog, and Fowler's toad. Suitable habitats include tidal wetlands, freshwater bogs, vernal pools, interior forests, grasslands, shrublands, streams, and rivers.

One of the most seriously declining vertebrate species in New England is the Eastern timber rattlesnake. This species is listed as State-endangered in all watershed states and is classified as "Near Threatened" on the Red List of Threatened Species by the International Union for the Conservation of Nature (IUCN) (IUCN 2012). Originally this rattlesnake had a nearly continuous range from New England to northern Georgia with scattered populations in the Midwest to southern Ontario. The historical distribution has contracted substantially. In the watershed, this snake is no longer found in central New Hampshire, or most of Vermont (Tyning n.d.). This rattlesnake is an inhabitant of deciduous forests, but it also requires rock ledges or outcroppings with southerly exposures for winter denning. There are nine known timber rattlesnake den sites within the watershed in Massachusetts and Connecticut, the majority of which have been severely impacted by development, collecting, and/or persecution. The Eastern spadefoot toad is listed as "threatened" in Massachusetts and is most common on Cape Cod and in the Connecticut River Valley. Spadefoots breed only after very heavy or prolong rain events. When they do breed it may be as early as April or as late as September. This burrowing frog is associated with sandy, well drained soils and open forest or sparse shrub or fields (MA NAAMP 2009).

Invertebrates

Invertebrates are the most diverse and abundant group of animals within the watershed and encompass many large groups of animals such as single-celled protozoa, freshwater sponges, flatworms, snails, freshwater clams, worms, insects, arachnids, and crustaceans. These range from familiar insects such as butterflies, dragonflies, bees, and beetles to more obscure invertebrates such as clam shrimp and bryozoans. Perhaps the rarest invertebrate species in the watershed is Faxon's clam shrimp (also known as Agassiz's clam shrimp (*Eulimnadia agassizii*)). This crustacean is less than one-half inch long and enclosed by a chitinous clam-like shell. This species only occurs in three locations in Massachusetts (one in the Connecticut River watershed); it has also been recorded in Florida and Europe.

There are also several rare tiger beetles in the watershed. As mentioned under the section on federally listed species, several populations of threatened Puritan tiger beetle occur along the Connecticut River in Massachusetts and Connecticut. The cobblestone tiger beetle, currently petitioned for Federal listing, lives in riparian cobble bars and sandy beaches along rivers. Isolated populations of cobblestone tiger beetles occur along the Connecticut River in Massachusetts, Vermont, and New Hampshire, as well as in the White River in Vermont (NHWAP 2005).

Extensive information on invertebrates is presented in the State WAPs (NHFG 2005, Connecticut Department of Energy and Environmental Protection 2005, Vermont Fish and Wildlife Department 2005, Massachusetts Department of Fish and Game 2006). These plans identify many invertebrates of GCN such as the precious underwing moth and boreal turret snail, both endangered in Massachusetts and listed as "special concern" in Connecticut.

The role of invertebrates in the watershed cannot be underestimated. There are numerous species of invertebrates such as stoneflies, mayflies, and caddis flies that process stream detritus in their larval stage and serve as prey for fish (larvae) and birds and bats (adults). Trout are well known for their reliance on aquatic insect larvae such as mayfly, stonefly, caddis fly, midges, ants, and worms. Some species are common, while others are recognized as rare by

M. Poole

Dragonfly

individual states. Many species of invertebrates are excellent indicators of environmental health. Muskrats thrive on clams and mussels, and salamanders and frogs rely on aquatic insect larvae, snails, beetles, spiders, and earthworms.

Many invertebrates spend part or all of their lives in an aquatic environment. Most infamous are the various mosquitoes and black flies whose larvae grow in still waters and moving waters, respectively. Although their adult bloodsucking forms are seen as a nuisance, the larvae are important in the aquatic food chain, and winged adults are food for many birds such as cedar waxwings, swifts, and flycatchers, and all bats in the watershed such as little brown and hoary bats. Certain native and nonnative mosquitos, however, serve as vectors for serious diseases such as West Nile virus, which is well established in the watershed.

Mussels

The U.S. has the greatest diversity of freshwater mussels in the world, but of the nearly 300 species residing in North America, researchers believe that only 23.6 percent of the species are stable—the rest being either endangered, threatened, undetermined (5 percent) or of special concern, and 35 species are extinct or believed to be extinct (Williams et al. 1993, Nedeau 2008a). An extensive discussion of freshwater mussels for the watershed is provided in "Freshwater Mussels and the Connecticut River watershed" (Nedeau 2008a); much of the discussion on their critical ecological role was derived from this reference. As noted earlier, there are 12 species in the watershed, 8 of which are endangered, threatened, or of conservation concern by managing agencies and/or organizations. These include the federally endangered dwarf wedgemussel, the rare brook floater, and triangle floater. The yellow lampmussel is another rare species. The Tidewater mucket was documented from the Connecticut River in Massachusetts in 2005 and also occurs in Connecticut. The Eastern pearlshell and the Eastern pond mussel are both uncommon.The only relatively common mussels are the Eastern elliptio and alewife floater, the former having many cool and warm-water host fish species, and the latter being somewhat restricted to alosids (i.e., American shad, blueback herring, alewife). The Eastern elliptio is the most widely distributed of the mussels in the watershed, and the alewife floater is moderately well distributed, as are the Eastern pearlshell, triangle floater, creeper, and Eastern lampmussel (Nedeau 2008a).

As filter-feeders, freshwater mussels are recognized for being excellent indicators of watershed health, and they play an essential and significant role in the food web, improving water quality, nutrient cycling, and habitat quality. They are unique in their reproductive cycle in that their larvae, or glochidia, must attach to the gills or tail of fish, or as is sometimes the case in creepers, amphibians may be the host (Nedeau 2008a). As a group, they inhabit a wide range of riverine and stream habitats; however, individual species often have strict habitat requirements.

Federally endangered dwarf wedgemussel

Susi Von Oettingen/USFWS

Eight of the native species have broad distributions, four occur in the southern portion of the watershed (Nedeau 2008a), and nine species have been found within a 1-mile stretch of the Farmington, Fort, and Salmon rivers (Nedeau 2005a, 2005b, 2008b). Other rivers with high occurrence include the Mill River in Massachusetts and Eight Mile River in Connecticut. Of 47 recognized tributaries, seven contain between nine and 11 mussel species, 18 contain six, and 19 contain less than five. Each state has tributaries containing no mussels, such as the Mohawk River in New Hampshire and Fall River in Massachusetts (Nedeau 2008a).

Threats to freshwater mussels include dams and other aquatic blockages, destruction of riparian habitat, dredging, intensive agriculture and urbanization, stream flow alterations, and all aspects of water pollution: eutrophication, organic and heavy metal contaminants, acid rain, turbidity, power plant and urban source thermal pollution, anoxia and hypoxia, pH, pesticides, endocrine disruptors. Invasive fish, including the nonnative smallmouth bass, often displace native host fish, disrupting mussel breeding behavior, and mussels also are threatened by the invasive zebra mussel and quagga mussel, although these mussels are not currently in the watershed (Nedeau 2008a).

Blueberries

Ken Sturm/USFWS

Pollinators

The health of the watershed and its habitats is greatly affected by pollinators, and quality habitats such as those found on national wildlife refuges are essential to pollinators. Pollinators (insects, birds, bats) are essential to our environment, including that of the watershed. The ecological service they provide is necessary for the reproduction of nearly 70 percent of the world's flowering plants, including more than two-thirds of the world's crop species. The U.S. alone grows more than one hundred crops that either need or benefit from pollinators, and the economic value of these native pollinators is estimated at $3 billion per year. Fruits and seeds derived from insect pollination are a major part of the diet of about 25 percent of all birds, and of mammals ranging from red-backed voles to black bears.

Four previously abundant species of native *Bombus* bumblebee have declined by 96 percent in the U.S., and their ranges collapsed by 87 percent (Cameron et al. 2011). A good example of an important wild pollinator is the rusty-patched bumble bee, once commonly distributed throughout the east and upper Midwest that has steeply declined in recent years. This bumble bee is an excellent pollinator of wildflowers, cranberries, and other important crops, including plum, apple, alfalfa, and onion seed. In many places, the essential service of pollination is at risk from habitat loss, pesticide use, and introduced diseases (The Xerces Society 2013).

Rare Plants

The New England Plant Conservation Program (NEPCoP), a collaboration between the New England Wild Flower Society and the state botanists in the natural heritage programs examined the status of all the rare plants in New England. They most recently published their findings in the 2012 *Flora Conservanda* (available online at: *http://www.newfs.org/conserve/flora-conservanda*; accessed December 2014). NEPCoP then commissioned and published conservation plans for about 120 species of the rarest plants. The refuge supported the development of conservation plans for the following six rare plants that had most of their occurrences in the watershed.

Yellow corydalis

This plant is at the northeastern limit of its range in Connecticut and occurs in only four populations in five towns in the south-central part of the State. It is listed in *Flora Conservanda* as a "regionally rare" species and by the State of Connecticut as threatened. It is restricted to a narrow belt of open outcrops and

sparsely wooded summits along trap-rock ridges. Property supporting one of the populations is owned by a conservation organization, and another population is under the jurisdiction of two towns. The final two are privately owned. Trampling and damage from all-terrain vehicles is a threat at three of the four sites. Competition from invasive plant species and climate change are potential threats (Farnsworth 2001).

Garber's Sedge and Sticky False Asphodel
These two plants are considered together because they inhabit similar habitats. They often co-occur along calcareous river shores and riverside seeps, on sites that are regularly inundated and ice-scoured. Garber's sedge is considered a "globally rare species occurring in New England," while the more common sticky false asphodel is "locally rare." The watershed contains 11 occurrences of the former and 8 occurrences of the latter (they co-occur at six sites). Most of the sites are on the main stem of the Connecticut River in New Hampshire and Vermont, although there are two occurrences along the White River and one on the Passumpsic (Brumback 2001).

Many-fruited false-loosestrife
This perennial is a "regionally rare" species. It is listed as endangered in Vermont (two sites) and threatened in Massachusetts (seven sites in the Connecticut River watershed). The species occurs on floodplain and pond shore habitats. It is threatened by invasive plant species, recreational activities, and hydrological changes (Ramstetter and Mott-White 2001).

Musk flower
Also a "regionally rare" species, it is found at only three sites in Vermont, three in New Hampshire, and three sites in Massachusetts. It grows in wet, cool soils along brooks, springs, and wet seeps. Most occurrences contain only small numbers of plants, and invasive species are present at several of the sites (Ewing 2001).

Toothcup
Another "regionally rare" species, this plant is at the northern edge of its range with seven populations (four in the watershed) documented in Massachusetts and three in Connecticut. Toothcup inhabits exposed gravel or cobble shores of lakes, ponds and reservoirs that have wide fluctuations in water levels. It occupies the zone between low and high water, and does not compete well with other plants. Of 26 historic sites, the plant has only been observed at five since 1990. Invasive species, sedimentation, and habitat succession are all threats (Mattrick 2001).

Invasive Species
Introduced species that multiply in large numbers, displace native species, and cause ecological damage (i.e., loss of rare species and plant communities, loss of habitat value, change in soils, changes in fire regimes), economic damage (e.g., weeds, forest pests, zebra mussels), or impact human health (e.g., giant hogweed) are called invasive species. Since our Nation's founding, the U.S. has experienced the introduction of more than 30,000 species of plants, animals, fungi, and viruses, most introduced directly or indirectly by humans. Although many are valuable crops and livestock, others are serious pests that have claimed the habitats of native species, forcing many of them to extinction, causing crop damage and human and animal disease. Economic damage is estimated to be $123 billion annually, and more than 40 percent of Federal endangered and threatened species are at risk due to the impacts associated with introduced species (Hall 1999).

Invasive species have been introduced, purposefully or accidently, into the watershed from other countries or other regions of this country. Often these exotic species establish in natural ecosystems, becoming naturalized, but without

noticeably affecting natives or their habitats. However, some outcompete and displace native species, especially if there are no natural population control mechanisms (e.g., habitat competition, predation, disease, and parasitism) in their new location. In fact, introduced species frequently have been introduced specifically because they were easy to establish, hardy, and disease resistant. In addition to the initial introductions, human activities that relocate surface soil layers and disturb existing stands of invasive plants or that result in generally disturbed soils, contribute excessive nutrients, and remove native plant cover, can favor the spread of exotics.

Invasive Exotic Fish
Nonindigenous fish species are found throughout the length of the Connecticut River and its tributaries. There are more introduced fish species (35) in the watershed than native species (33). Many species were introduced to provide additional recreational fisheries, specifically, trout, bass, pike, and sunfish. Native species populations often suffered from exploitation, habitat loss, and water quality degradation. Land management practices including unregulated timber harvest, some agricultural practices, dam installation, and industrial discharges resulted in altered habitat and water quality conditions that were better suited for hardier nonindigenous species. The distributions and populations of fish are better known than those of any other aquatic species. State and Federal agencies work together to avoid the loss of native fish species as a result of the purposeful or accidental introduction of nonnative plant and animal species.

Invasive Plants
Invasive, exotic plants like Oriental bittersweet, Japanese stiltgrass, purple loosestrife, garlic mustard, glossy buckthorn, water chestnut, and shrub honeysuckles can substantially degrade native plant communities in the watershed. Since the last ice age, the native plants and animals have co-evolved, and developed intricate interdependences. While there are an estimated 4,000 introduced plants in the U.S., only 400 are considered potentially invasive. Many of the alien plants, such as dandelion, naturalize and blend in with the native plants. A few others have a remarkable competitive advantage, and can overcome the native vegetation reducing their biomass and in turn impacting the wildlife dependent on them. Some introduced plant species can alter the soil chemistry and produce chemicals that inhibit or prevent other species from growing in close proximity; others elevate erosion potential; some are so attractive to pollinators that native plants are avoided; others impact habitat suitability (UVPLC 2002).

Based on figures for Massachusetts, 950 of the 2,700 (or 35 percent) of plants in that State have been introduced (Bickford and Dymon 1990). In Massachusetts alone, at least 66 species are considered invasive, likely invasive, or potentially invasive, including Norway maple, autumn olive, mile-a-minute vine, burning bush and garlic-mustard (Somers et al. 2006). Although common reed and purple loosestrife degrade wetlands throughout the watershed, these plants are much more widespread in Connecticut, affecting a large number of wetlands. In general, the southern watershed has more and larger, well-established invasive plant populations, likely due to the warmer climate and larger human populations that cause the soil disturbance known to benefit invasive plant establishment.

Another plant affecting both wetland and upland habitats in Connecticut and Massachusetts is Japanese stilt grass and refuge staff are working with partners to try to keep it from spreading northward. Mile-a-minute vine is being controlled where found in Connecticut and refuge staff and volunteers have assisted partners to control the few sites in the watershed in Massachusetts. It has newly been found in New Hampshire, but not at all in Vermont. Oriental bittersweet, Japanese knotweed, multiflora rose, buckthorns, and Japanese

barberry are widespread in upland areas, with the knotweed extending into northern New Hampshire and Vermont. Eurasian milfoil is a problem in many ponds and lakes in the watershed, including Lake Morey in Fairlee, Vermont; Halls Lake in Newbury, Vermont; and Mill Pond in Windsor, Vermont (LaSala 1994).

Water chestnut, a floating invasive aquatic plant that can rapidly become established and cover the entire surface of shallow coves, ponds, or lakes, was discovered in the watershed in 1997. Since the late 1990s, the refuge has led a partnership effort comprised of local and state agencies, conservation partners, landowners, and many volunteers to find and remove this plant. Seeds of this annual weed can remain viable in bottom sediment for a dozen years. As of 2013, the refuge and partners are actively controlling or evaluating success at approximately 50 known sites in the watershed of Massachusetts and Connecticut. It was newly reported from Hinsdale, New Hampshire in 2012.

Rock snot or didymo, a diatom that creates large mats in flowing water, was found in the upper Connecticut River and White River in 2007. Didymo can form extensive "blooms" on the bottoms of rocky river beds, and it is thought that these smother aquatic life forms such as aquatic insects, native algae, and other organisms fed on by fish (NH DES 2008).

A more comprehensive discussion of the status of various invasive plants in New England is available on the IPANE Web site: *www.IPANE.org* (accessed February 2013). Conte Refuge was one of the founding partners of IPANE. Under a grant from the USDA from 2001 to 2005, refuge staff administered the networking arm of IPANE, working with IPANE partners at the University of Connecticut and New England Wild Flower Society to network New Englanders concerned about the invasive plant issue via email newsbriefs and regional conferences. This work was done under the name "New England Invasive Plant Group (NIPGro)." Staff continued to compile and send the newsbriefs until 2010 and sporadically since.

Invasive Invertebrates

Zebra mussels were first found in the U.S. in 1988 in Lake St. Clair, Michigan, and later spread to all five of the Great Lakes, the Finger Lakes area of New York, and the Mississippi River basin. Zebra mussels are currently found in at least 30 states, although have not been found in the Connecticut River watershed. This invasive mussel could have a profound effect on the native freshwater mussels in the watershed. This mussel attains a size of one half inch to an inch and one half as an adult. It is of great concern because, similar to the Asiatic clam (below), this exotic mussel has an incredible propensity to reproduce. Once established, zebra mussels have the capacity to clog water intake pipes of waste water treatment plants, electric generation plants, and industrial operations. This mussel poses a serious threat to aquatic ecosystems because it can outcompete and displace native species, particularly mollusks and impact natural processes. Large, established populations of these filter feeders can remove vast amounts of algae, phytoplankton, and zooplankton greatly reducing food supplies for native organisms. The discovery in July 2009 of zebra mussels in Laurel Lake, located in western Massachusetts (Housatonic River watershed), prompted Massachusetts to develop an Interim Zebra Mussel Action Plan (MDCR

Zebra mussel on native mussel

USFWS

and MDFG 2009) and later a series of recommendations from the Zebra Mussel Task Force (MEOEEA 2009).

Asiatic clam is a freshwater invertebrate that first entered North America in the early 1900s, reaching the Mid-Atlantic States in the 1970s and 1980s. The animal grows to one-half inch as an adult. It has been identified in the lower reach of the Connecticut River, and is of great concern because of its reproductive capacity: an average of 70,000 offspring per adult per year. This clam poses a serious economic threat because of its ability to clog industrial water intake pipes. It also is a serious environmental menace because it can outcompete and displace native mollusks. In suitable environments, Asiatic clam densities can reach 10,000 to 20,000 individuals per square yard, impacting a diverse array of aquatic plants and animals (USGS 2013b).

The quagga mussel (named after the quagga, an extinct African relative of the zebra) was first sighted in the Great Lakes in September 1989. This mussel is now well established in the lower Great Lakes, but has not been found in great numbers outside this region. Its occurrence in the St. Lawrence Valley presents a clear concern for its spread into the Connecticut River watershed (USGS 2011). Although not yet documented in Massachusetts, the education and action components of the State's 2009 Interim Zebra Mussel Action Plan is designed to prevent the occurrence and spread of quagga mussels as well.

Introduced forest pests are a concern throughout the watershed. The scale insect responsible for beech bark disease (BBD) was introduced to the northeastern U.S. from Europe in the 1890s (Koch 2010). BBD causes significant mortality and defect in American beech (*Fagus grandifolia*). The disease results when bark, attacked and altered by the insect beech scale (*Cryptococcus fagisuga*), is invaded and killed by native fungi, primarly (*Nectria coccinea*). Currently BBD affects all of the Refuge forests where American beech occurs. After the killing front has moved through a stand, the aftermath zone areas where heavy mortality occurred at some time in the past, is characterized by some residual larger trees and many stands of small trees, often of root-sprout origin. Larges trees, over about 8 inches in diameter, succumb more readily than small ones, leaving landscapes devoid of larger-diameter mature beech trees. Gypsy moths have caused widespread damage over the years. In addition, attempts to control them severely affected non-target native species. Dichlorodiphenyltrichloroethane (DDT) spraying for gypsy moth control in the 1950s and 1960s severely depressed the populations of many butterflies and other insects. The hemlock wooly adelgid (HWA), an introduced aphid, is presently killing Eastern hemlock trees and compromising hemlock forest associations throughout the eastern U.S. HWA is now established from northeastern Georgia to southeastern Maine and as far west as eastern Kentucky and Tennessee, and may spread northward with climate change. Biological control of HWA using lady beetles is showing some promise (Cheah et al. 2004). Emerald ash borer (EAB) was discovered in Michigan in 2002 and has since spread to three of the four states in the Conte's acquisition boundary. New Hampshire is the most recent and most northerly discovery. EAB kills 99 percent of ash trees and infects all ash species. Eradication efforts are underway in many states, and often involve complete removal of all ash trees in front of the advancing EAB population. The Asian longhorn beetle is established in Worcester, Massachusetts, and efforts are in effect to restrict activities with infected trees and wood within regulated, designated areas (city of Worcester 2013). The current goal of Federal and state agencies is complete eradication of Asian long-horned beetle. The beetle is able to attack and kill healthy trees across a wide range of species including maples. Eradication efforts are currently underway and involve removal, chipping, and burning of any and all material from infested trees.

Invasive Fungi
A number of introduced fungi have had devastating effects on the plant and habitat characteristics of Eastern North America and Connecticut River Valley. Most prominent are the 1904 American chestnut blight, 1930 Dutch elm disease, and 1967 butternut tree canker, all of which have impacted forest composition and ecology in New England. The chestnut blight caused the collapse of the most dominant hardwood in the Appalachian Mountains and beyond, completely eliminating a critical mast source and shelter for wildlife and food and fiber for mountain communities. Ironically, stunted American chestnut remain ubiquitous as the fungus prevents trees from maturing and producing nuts; eastern woods are abundant with stump sprouts with some immature trees reaching 20 to 30 feet. in height (Bolgiano 2007).

Dutch elm disease (DED) was introduced to the U.S. from Europe in the 1930s, and by 1977, the disease had spread throughout most of the country, killing an estimated 46 million American elms. DED has mostly affected urban populations of American elm, a widely planted shade tree. In forest stands where elms are relatively isolated from one another, spread of the disease is sporadic. The USDA Forest Service's Northern Research Station, has established demonstration plantings of DED-tolerant American elms on many of its sites in the east and mid-west to develop DED-tolerant elms. Disease resistant elms are often planted as replacement to diseased and destroyed trees (USFS 2011). Currently, TNC is evaluating the efficacy of disease resistant elm plantings in the watershed, including a possible planting at the Fort River Division in 2014. Butternut, also known as White walnut, is a highly valued hardwood species native to eastern North American forests. Like Chestnut blight and DED, Butternut canker has effectively eliminated butternut as a thriving tree species within the northeast forest ecosystem. In 1995, the Forest Service estimated that 77 percent of the butternuts in the Southeast were dead. Surviving butternuts are often found in riparian zones, and, in contrast to American chestnut, butternuts usually will not sprout after stem death. Most butternut dies within 15 years of infection and virtually all known populations of butternut are now infected (Schlarbaum et al. n.d., Lombard n.d.).

Socioeconomic Environment

We enlisted the assistance of economists with the USGS, Fort Collins Science Center, to assist us in a regional economic report. The full report is included as appendix I. Among other details and analysis, the report includes a description of the current economic setting and illustrates the refuge's contribution to local economic communities. The refuge management activities of greatest, direct economic impact in the watershed are:

- Refuge purchases of goods and services within the local communities.
- Refuge staff salary spending.
- Refuge visitor spending in the local communities.
- Revenues generated from timber harvesting for habitat management on the refuge.
- Refuge land purchases and changes in local tax revenue.

The report also notes that the economic value of a refuge encompasses more than just the direct impacts to the regional economy. Refuges also provide substantial nonmarket values (values for items not exchanged in established markets) such as conserving threatened and endangered species, preserving wetlands, and helping to maintain clean water and air (Caudill and Henderson 2003). These natural

"services" (often called ecosystem services) provided by the conserved landscape can be extremely valuable to one's well-being and to society in a more traditional economic sense. Ecosystem service values can be substantial, and should be recognized as a contribution when evaluating refuge management activities. However, quantifying individual ecosystem service values is beyond the scope of the economic impact analysis.

Some highlights of the economic setting description follow. Please refer to appendix I for the full narrative.

In its entirety, the watershed encompasses an area of over 11,000 square miles and contains nearly 400 towns and cities. The 7.2 million-acre watershed is home to over 2.3 million people (Clay et al. 2006). The waters of the Connecticut River have played an important role in the watershed's social and economic history. The river itself provided a source of energy to power mills, factories, and entire communities, irrigation water for working farmlands, and a means of transportation for the watershed's people and goods. The regional economy has evolved from the original agricultural colonists and small goods traders, to robust manufacturing production and supporting commodity extraction industries, to relying more on the services sector and travel and tourism spending. Currently, large urban centers within the southern counties of the watershed serve as hubs to the greater New York City area with many residents employed in the service industry. Counties near the northern headwaters continue to provide a more rural way of life and are still highly dependent on manufacturing jobs.

Many of the towns within the watershed are attempting to capture more of the valuable tourism market by hosting annual festivals and cultural events that attract crowds from beyond the community borders. Many of these events are centered on the historic, cultural, and economic makeup of the region. Area farmers and artisans are once again finding local markets for their goods, while catering to buyers and their overall experience. Agritourism seems to be expanding at a considerable rate, with each State in the watershed now having a Web site and interactive map just for these enterprises.

There are abundant recreation opportunities within the counties of the watershed, including a range of opportunities on tracts under refuge management. Traditional activities on refuge lands include fishing, hunting, wildlife observation, photography, environmental education, and interpretation. Snowmobiling is very popular in various regions of the watershed, and is permitted on refuge land. The Appalachian Trail meanders through the northern-half of the watershed, making its way through the impressive White Mountain National Forest in New Hampshire. The middle portion of the watershed in Massachusetts is bordered by the Berkshire Mountains to the west, which have been attracting tourists and recreationists for decades. Towns in the southern portion near the mouth of the Connecticut River heavily promote recreation opportunities associated with saltwater experiences. While large tracts of the watershed remain undeveloped, sprawling communities, particularly in the southern portion of the watershed, have begun to alter the dynamics in the region.

Given the vastness of the watershed, and the extensive diversity within, the economic report focuses on describing and assessing six focal sub-regions. The sub-regions incorporate 11 counties that make up the bulk of the watershed and are central to the refuge's existing and proposed future land base. The sub-regions described are:

(1) Northern Sub-Region: Essex County, Vermont, and Coös County, New Hampshire.

(2) White River Junction Sub-Region: Orange County, Vermont, Windsor County, Vermont, and Grafton County, New Hampshire.

(3) Tri-State Border Sub-Region: Windham County, Vermont, Cheshire County, New Hampshire, and Franklin County, Massachusetts.

(4) Greater Amherst Sub-Region: Hampshire County, Massachusetts.

(5) Greater Hartford Sub-Region: Hartford County, Connecticut.

(6) Southern Connecticut Sub-Region: Middlesex County, Connecticut.

Section 1 of the report provides detailed socioeconomic demographic profiles for each focal sub-region. Each sub-region profile addresses historic and current trends in the area, and highlights important demographic and economic statistics. Included are population, regional employment and income, commodity industries, recreation and tourism industries, and land use and ownership. Few of these trends are consistent across all the sub-regions in the watershed, so we recommend the reader review the sub-region description of interest.

Part II: General Refuge Information

Refuge Administration and Facilities

Refuge Staffing and Administrative Facilities

The Conte Refuge is managed by a staff of nine full-time employees and one shared employee. As funding allows, the refuge also has additional temporary staff to help support visitor services or biological programs. The refuge also administers the Stewart B. McKinney National Wildlife Refuge along the Connecticut coast and the John Hay National Wildlife Refuge in Newbury, New Hampshire.

The refuge includes three staffed facilities. The headquarters office in Sunderland, Massachusetts, has the lead wildlife refuge manager (also known as the project leader), wildlife refuge manager, general biologist, cartographer, and an office manager. There is one permanent visitor services staff person stationed at the Great Falls Discovery Center in Turners Falls, Massachusetts. Full-time staff at the Nulhegan Basin Division office in Brunswick, Vermont, includes a wildlife refuge manager, forester, and wildlife biologist. The refuge shares a full-time law enforcement officer with the Umbagog National Wildlife Refuge (Errol, New Hampshire). Temporary positions vary between two and five per year and there are Youth Conservation Corps (YCC) crews, comprised of adult supervisors and local youths at the Nulhegan Basin Division, Pondicherry Division, and Fort River Division. During 2013 and 2014, 10-month Student Conservation Association crews were stationed at the Fort River Division. Please see appendix H for the current refuge staffing chart.

The three facilities for the refuge—Sunderland headquarters, Great Falls Discovery Center, and Nulhegan Basin Division Office—currently provide adequate space and amenities. The Sunderland headquarters office was made available following a renovation of the existing Connecticut River Fisheries Coordinator's facility, allowing for more cost effective office space in contrast to former leased space in Turners Falls, Massachusetts. Solar panels were installed on the roof of this building in 2012 to reduce long-term energy costs and utilize a renewable resource.

The Great Falls Discovery Center offers adequate space for one full-time visitor services specialist, and the public facilities are described below under "Public

Use Facilities." Working with our state partner, this building has undergone an energy audit and steps (e.g., cleaning climate control duct work, furnace repair) have been taken to make this old building more energy efficient.

Kathy Fournier/USFWS

Nulhegan Basin Division office

The Nulhegan Basin Division office and visitor contact station was constructed in 2006 and provides space for the three full-time staff and the shared law enforcement officer as noted above. This office/visitor contact station is one of the first in the Northeast Region to employ a standard design approach for refuge buildings. Its energy efficient design made it the first Energy Star building in the Service, and garnered a Silver designation from the "Leadership in Energy and Environmental Design for Existing Buildings" version 2.0 rating standard. This division also has two storage barns/garages and two heated quarters buildings: a 1990s era house occupied by permanent staff and the other is a 2004 modular home used for interns and visiting staff.

The Fort River Division includes a quarters building (i.e., three-bedroom house), a pole barn, stables building with two decrepit apartments, and office. Attached to the stables is a large indoor riding arena which has a former horse hot-walker room attached. The stables building has been determined to be surplus to the refuge's needs and will eventually be removed. Several water lines in this building are broken, leaving only barn water spigots functioning, which are used for cleaning equipment. The riding arena is used as a secured storage facility for vehicles and equipment. Utilities to this building have been shut off, although once the stables are removed, water and electrical services will be necessary. The arena is not insulated, but that is not necessary for its storage purposes. The quarters building was remodeled in 2009, including replacement of a large single-pane bow window and the entry doors. The original appliances also were replaced with energy efficient units. Potential additional energy conservation projects include installing energy efficient windows, replacing the water heater, additional insulation, solar and/or wind power.

The Salmon River Division includes a 1970s era two-story home on the shore of the Salmon River. At the present time this house has no functioning utilities and is not occupied. It will need a new electrical line from the house to the power lines and will likely require a new furnace, hot water heater, and some appliances should it be used as a quarters or support building. There are opportunities to incorporate energy efficient appliances and possibly solar panels.

There are some additional buildings on other units, such as the Pondicherry and Blueberry Swamp Divisions and the Roger Tory Peterson Unit.

Budget

Annual budgets are appropriated by Congress, and therefore, can vary year to year. Budget allocations are typically broken out into the following categories: wildlife and habitat, facility maintenance, visitor services, and law enforcement. Table 3.4 shows the refuge's budget for fiscal year 2012.

Table 3.4. Refuge Budget for Fiscal Year 2012.

Budget Category	2012 Budget
Wildlife and Habitat	$830,256
Facility Maintenance	$175,527
Visitor Services	$411,717
Law Enforcement	$71,033
2012 Total Budget	**$1,488,533**

Young Adult Programs

Youth Conservation Corps

YCC is a Government-funded summer program that gives young people (ages 15 to 18) paid opportunities to help work on public lands. While on board, participants conduct projects for the refuge while learning about the environment. Depending on annual appropriations, we host three or four crews at our divisions, with at least one each in Vermont, New Hampshire, and Massachusetts (and a crew at Stewart B. McKinney Refuge for which we handle the administrative aspects). Crews are typically comprised of a crew leader, an assistant leader, and four crewmembers. During the past 5 years, this program has served nearly 200 youth and young adults. The YCC crews provide valuable support to all refuge programs. Recent projects include boundary posting, multiple trail construction and maintenance projects, and invasive species control efforts.

The YCC crews working on the refuge are being administered through a cooperative agreement with Northwoods Stewardship Center, an established organization with a focus on youth employment in the outdoors. This provides us an opportunity to support this important program, but given our limited staff, allows us to rely on a partner to administer the program.

AmeriCorps

AmeriCorps is a Federal community service program for young adults ages 18 to 23. In 2013, an AmeriCorps crew worked at the Fort River Division helping with trail construction, invasive plant control, and boundary posting. They also participated in visitor services programs at the Great Falls Discovery Center and WoW Express.

Career Discovery Internship and Pathways Programs

The Career Discovery Internship Program (CDIP) program is a recruitment tool that provides college-age individuals the opportunity to experience the refuge system from the perspective of a staff member, often filling roles in the biological or visitor services programs. CDIP was created in 2008 through a partnership with the Student Conservation Association (SCA). Designed to target diverse populations, the CDIP serves approximately 30 students every year, giving them the opportunity to pursue gainful summer employment on any of the Northeast's national wildlife refuges. These internships provide students with career experience in the field of conservation as well as the opportunity to develop professional networks with service employees. The Nulhegan Basin Division employed an intern the past 3 years: year one the intern worked with invasive plants, including the mapping of *Phragmites* locations on a neighboring parcel; the last 2 years interns have served at the visitor contact station.

The refuge has hosted a Pathways Program student in visitor services the past 2 years, and previously hosted a biological student under a similar program. In both cases, these students engaged in many diverse projects including field studies, administration, invasive plant control, in visitor services for the Great

Falls Discovery Center and WoW Express, and to support the new Adopt-a-Habitat program. The goal of the Pathways Program is to offer students with internships in their field of study and prepare these students for future employment with the Service.

Other Interns
Partner relationships allow us to support interns in unique ways. Often the partner organization recruits, hires, and pays the interns, and the Refuge supplies housing, an office, or logistical support. A current partnership with Trout Unlimited (TU) serves as an example: interns with TU have stayed in Refuge quarters while conducting fish habitat and population surveys on and off Refuge lands. The Upper Connecticut River Cooperative Invasive Species Management Area hired interns who began mapping invasive plants along tributaries of the Connecticut River while staying in Refuge quarters. Nulhegan Basin staff supervised their day-to-day activities and provided logistical support to the CISMA effort through geographic information system (GIS) mapping.

Volunteer Program
Volunteers are vital to all our refuge programs. Individuals involved in volunteering range from youth to adults, and include local residents, clubs, and organizations. Some are long-term volunteers and have been with us for years, while others volunteer for a few hours in one day. In 2012, for example, 149 volunteers provided 2,773 hours of work on refuge lands. Projects range from invasive plant control, particularly water chestnut removal, outreach at visitor contact facilities, maintenance of infrastructure, biological surveys, public use and environmental and interpretive programs.

Refuge Operational Plans (Step-down Management Plans)
Planning for the refuge occurs at three levels: a CCP, step-down refuge management plans, and annual work plans. The CCP addresses topics of species and habitat management, visitor use, refuge operations, and development in general terms. The refuge management step-down plans take the strategic direction from the CCP and provide more specificity on when, where, and how programs will be run, or how natural and cultural resources will be protected. The annual work plans identify fiscal year priority projects needed to implement the CCP and associated management plans.

Step-down Management Plans, identified in policy 602 FW 4, generally are prepared to provide detailed strategies and implementation schedules for meeting goals and objectives identified in CCPs, although they are also prepared to meet select policy requirements (e.g., Station Safety Plan). There are more than 25 step-down management plans that may be appropriate to ensure safe, effective, and efficient operation on every refuge, ranging from habitat management to pesticide use and disposal. Some plans require annual revisions; others are on a 5 to 10 year revision schedule. Step-down management plans prescribe a host of activities (i.e., Federal actions) and are, consequently, subject to NEPA compliance, public involvement, compatibility determinations, and the like. Often CCPs provide sufficient management detail, provided adequate public involvement and NEPA compliance has occurred (along with necessary compatibility determinations), so that subsequent development of associated step-down management plans called for by a CCP may be done without further NEPA compliance considerations. Ideally, a CCP either contains the detailed management elements, thus precluding need for step-down plans, or it clearly sets the stage for needed step-down plans.

The following step-down plans have been through NEPA compliance and are current; they will be subject to possible revision following approval of the final CCP:

- Visitor Services Plan–Nulhegan Basin Division (completed in 2002).
- Hunt Management Plan–Pondicherry Division.
- Hunt Management Plan–Nulhegan Basin Division and Putney Mountain Unit.
- Furbearer Management Plan–Nulhegan Basin Division (completed in 2000).

We anticipate developing the following step-down plans after finalizing the CCP. This list is only tentative, once the CCP is complete we will better know which step-down plans are necessary. Additional plans may be required depending on the alternative selected for the final CCP.

- Hunt Plan–Fort River Division, Salmon River Division, Blueberry Swamp Division, Mill River Division, Westfield River Division, Dead Branch Division, Mount Toby Unit, Third Island Unit, Honeypot Wetlands Unit.

- Fishing Plan–Salmon River Division, Fort River Division, Mill River Division, Third Island Unit, Dead Branch Division, Westfield River Division, Pondicherry Division, Blueberry Swamp Division, Nulhegan Basin Division.

- Habitat Management Plan.

- Visitor Services Plan.

- Law Enforcement Plan.

- Fire Management Plan.

- Integrated Pest Management Plan.

- Cultural Resources Management Plan.

- Inventory and Monitoring Plan.

- Furbearer Management Plan.

Friends of Silvio O. Conte National Fish and Wildlife Refuge and Other Refuge Friends Groups

The refuge benefits from a strong, productive, and cohesive partnership with the non-profit Friends of Conte who provide a forum and a foundation to forge creative partnerships. The group is a broad based partnership of 22 conservation, education, and outdoor recreation organizations with representation from the local, state, and national level. The Friends of Conte is particularly focused on refuge goals related to conservation, education, and recreation in order to contribute toward the refuge's legislated purposes established by Congress. The Friends of Conte routinely collaborates on mutually beneficial projects under the umbrella of the NWRA mentored Friends initiative.

Several refuge units and divisions also have their own Friends groups. Existing Friends groups include: Friends of Nulhegan Basin, Friends of Pondicherry Wildlife Refuge, Friends of the Great Falls Discovery Center, Friends of the Connecticut River Paddler's Trail, Friends of Salmon River, and Friends of the Roger Tory Peterson Unit. New Friends groups are a consideration on other units of the refuge. These groups play a vital role in outreach, education, and assisting in day-to-day refuge operations and maintenance. We discuss the importance of Friends groups under goal 4 in chapter 4.

Special Use Permits

The refuge manager issues special use permits on a case-by-case basis after determining whether the use is appropriate and compatible with refuge purposes. Most special use permits have a 1-year or shorter term (5-year permits for

privately owned cabins at Nulhegan Basin Division). Since 2000, we have issued annual special use permits for: snowmobile trail maintenance and use; wildlife research; access to privately owned hunting camps; horse hauling of moose during hunting season; furbearer trapping; surveying and monitoring wildlife; all-terrain vehicle (ATV) access for disabled hunters; group environmental education; and use of blinds to observe or photograph wildlife.

We also issued special use permits for use and occupancy of privately owned hunting camps located on the Nulhegan Basin Division. Lands on which the cabins sit were previously leased to cabin owners by the owner of the larger forested tracts and were included in the Service's original land acquisition effort. The environmental documentation describing the land acquisition noted the Service's intention to continue the camp lease program for the life of the camp leaseholders or 50 years, whichever period is shorter. If current owners decide to sell their camps, the Service will pay market value and then remove them and restore the site if not needed for refuge purposes. No change in camp management is expected with development of the CCP.

Research

Conducting research is one of the purposes of the Conte Refuge Act. Refuge staff, graduate students, conservation organizations, and others have conducted surveys and studies on the refuge. A sampling of those efforts follows; other research projects are identified in the descriptions of existing divisions and units at the end of the is chapter. Additional information on these studies can be obtained from refuge headquarters.

The U.S. Forest Service, Northern Research Station has included the Pondicherry Division in long-term northern goshawk nest monitoring, when there is an active nest. This work is ongoing. The station also included the Fort River Division in a pilot study of nesting American kestrels that began in 2012. To date, several nest boxes have been erected at the division to evaluate use during the 2013 nest season.

In 2002 through 2004, researchers from Salve Regina University in Newport, Rhode Island, conducted a study on Canada warblers at the Nulhegan Basin Division. The study measured habitat-specific estimates of Canada warbler productivity and survivorship in the Nulhegan Basin. The results of this study are available on the Center for Northern Forest Research Web site at: *http://cnfr.us/research.php* (accessed December 2014).

A basin-wide evaluation of floodplain forests by TNCs Connecticut River Program included sampling locations at the Fort River and Mill River divisions (TNC 2011). Results of the initial study are available at: *http://www.nature.org/ourinitiatives/regions/northamerica/unitedstates/connecticut/connecticutriver/ct-river-floodplain-forests-paper.pdf*; accessed December 2014.

The refuge has sponsored long-term monitoring of the federally threatened Puritan tiger beetle population in Northampton, Massachusetts, since 1998. The focus of this work has been to estimate adult numbers, monitor larvae and their habitats, enhance larval habitat, and augment the population from an intact meta-population in Connecticut. During the mid-2000s there was an effort to educate beachgoers about these beetles. Numbers remain precariously low at this site and continued work at the site is needed to recover this species.

The University of Massachusetts initiated a study of the diversity and abundance of native bees in gravel and sand pits that included the Fort River Division in 2011. No results are yet available.

To help refuge staff choose the most effective control of pale swallow-wort, the invasive plant threatening rare plants on Mount Tom, the Connecticut Agricultural Experiment Station conducted a small experiment on-site to test various herbicides from 2007 to 2008.

Invasive Plant Control Program
Refuge staff are very active in invasive plant issues in the New England region and work with partners to control invasive plants on both public and private lands. In 1999, the refuge published "The Invasive Plant Control Initiative Strategic Plan for the Connecticut River watershed/Long Island Sound Region," which highlighted agencies and organizations already working on invasive plant issues in the watershed and New England, identified needs, and described the actions that would best serve the region within the following 5 years (1999 to 2004). Many of the priority actions outlined in the document were undertaken by various agencies and organizations including the refuge.

The main priority actions undertaken by the refuge following this plan and then subsequent initiatives include:

- A watershed-wide effort with partners to find and control invasive water chestnut populations.
- Inventorying and controlling invasive plants on the Pondicherry, Nulhegan Basin and Fort River Divisions and the Mount Tom Unit, often within larger partnerships and with the help of Friends groups, volunteers, YCC and SCA members.
- Helping secure funding for the establishment of the Invasive Plant Atlas of engaged citizen-scientists to collect distributional data on invasive plants throughout New England and continue to serve as a comprehensive web-based informational resource.
- Facilitating communications and networking among numerous organizations and individuals through the formation and administration for several years of the NIPGro, including an informational e-newsletter distributed to more than 1,000 individuals.
- Planning and holding three large conferences on the invasive plant topic in cooperation with IPANE partners.
- Conducting numerous workshops on important topics such as prioritizing control on large parcels, control of key species, and early detection and rapid response.
- Working with partners to stop the spread of Japanese stiltgrass and mile-a-minute vine, two new invaders to Massachusetts and northward.

For nearly a decade, the refuge has been a leader on the issue of invasive plant management through:

- Our coordination of the NIPGro.
- Our involvement in the Invasive Plant Atlas of New England project.
- Being a catalyst for water chestnut control in the southern portion of the watershed.
- Through our encouragement for the formation of subwatershed-based invasive species partnerships.

- Participating in educational offerings such as workshops and conferences with partnering organizations and landowners.

We also have actively controlled invasive species on several refuge divisions and units, including chemical and mechanical (cutting) treatment of Japanese knotweed and common reed on the Nulhegan Basin and Pondicherry Divisions, and served as a pilot for a national program enlisting volunteers to aid with invasive plant control (pulling) and monitoring efforts at the Pondicherry Division.

In 2011, the refuge participated in a national inventory and monitoring project that brought in experts to conduct an invasive plant inventory of the Salmon River, Blueberry Swamp, and Fort River Divisions, engage partners in discussions, and teach refuge staff how to continue with the inventory and prioritize invasive plant management. Subsequent inventories were conducted by seasonal staff on the refuge's Mill River Division, Putney Mountain Unit, and Peterson Unit.

Lewis Pond, Nulhegan Basin Division

Sharon Lindsay

Since 2010, refuge staff have encouraged subwatershed-based CISMA partnerships that actively work locally on inventory, public outreach, and control. A grant was secured to provide six such partnerships with limited funds for projects in 2012 and 2013. Through this grant, refuge staff members are working with state and regional experts to prioritize invasive plant control in the watershed, with a focus on protecting important natural resources and planning for better early detection and rapid response.

The following principles will continue to guide our program:

- Focus on controlling invasive species that cause the greatest potential for harming native ecosystems and/or threaten refuge management goals on individual properties.
- Focus on protecting sensitive or rare habitats and species, those with high natural diversity, and/or those most resilient to climate change.
- Strive for early detection and rapid response.

Land Acquisition History

The 1995 Final EIS identified 48 SFAs for land protection encompassing 65 individual sites, for potential protection by the Service and its partners. While the Service was identified as the lead for 26,250 acres of the total, it was also identified as an alternate for acquisition on the total acres in the event a partner was not in a position to accomplish the habitat protection objective. The 1995 FEIS land protection approval, coupled with subsequent NEPA document decisions, currently gives authority to the Service to acquire up to 97,830 acres for the refuge. The 1995 Final EIS also indicated that the refuge would seek to

offer challenge cost-share matching grants to assist partners in acquiring the land where they were identified as the lead; however, funding resources have not been adequate to meet both the operational needs of the refuge and support a viable grants program since 2001.

The refuge was officially established in October 1997 when the Connecticut River watershed Council donated Third Island located in Deerfield, Massachusetts, to the Service. Currently, the refuge consists of nine divisions, eight smaller units, and two conservation easements totaling approximately 35,987 acres (table 3.5).

About 75 percent of the current refuge land base was acquired when Champion International Corporation liquidated nearly 133,000 acres in northeastern Vermont. The Conservation Fund purchased the entire liquidation package, of which, about 26,000 acres was ultimately acquired by the Service and became the Nulhegan Basin Division on July 20, 1999 (USFWS 1999). The other large Service holding, the Pondicherry Division was established on December 22, 2000, and is about 6,400 acres of fee and easement land. The area was primarily purchased from Hancock Timber Resource Group in 2003 when they liquidated some of their land assets.

Although both divisions were SFAs in the 1995 FEIS, decisions by industrial forest owners to liquidate holdings in the Northern Forest necessitated a change in the refuge conservation strategy to protect important habitat that was previously considered secure. Due to the changes in the scope of what was identified in the 1995 FEIS for these two SFAs, the Service initiated the NEPA compliance process completing individual environmental assessments for these two divisions. Findings of No Significant Impact decisions for both projects were issued. In consultation with the public, these decisions allowed the Service to respond to the unanticipated changes and acquire these two high wildlife-value areas.

There are seven other divisions in the initial stages of acquisition: one in New Hampshire, four in Massachusetts, and two in Connecticut. The Blueberry Swamp Division (formerly called the Mohawk River Division) in New Hampshire was established in 2007. The divisions in Massachusetts include the Fort River (2005), Mill River (2007), Dead Branch (2011), and Westfield River (2013). The first acquisition for the Salmon River Division in Connecticut occurred in 2009, while the Whalebone Cove Division was established in 2013. In addition to these divisions, the Service owns several smaller units in Massachusetts, Connecticut, and Vermont that were identified in 1995 FEIS.

A full description of the refuge's existing divisions and units are provided below in part II of this chapter. Table 3.5 lists the acquisition history for the refuge as of October 7, 2013. Refuge acquisitions have been ongoing since 2013. Contact refuge headquarters for an update.

Table 3.5. Land Acquisition History for Conte Refuge as of October 7, 2013.

Refuge Division/Unit	State	Funding[1] Source	Acquisition Year	Acres[2]
Dead Man's Swamp Unit	CT	LWCF	2005	30.75
Salmon River Division	CT	LWCF	2009	285.00
Salmon River Division	CT	LWCF-R	2011	40.00
Roger Tory Peterson Unit	CT	LWCF-R	2011	1.84
Roger Tory Peterson Unit	CT	LWCF	2011	54.26

Refuge Division/Unit	State	Funding[1] Source	Acquisition Year	Acres[2]
Salmon River Division	CT	LWCF	2012	48.52
Salmon River Division	CT	LWCF	2012	4.80
Salmon River Division	CT	LWCF	2013	38.00
Salmon River Division	CT	LWCF	2013	9.00
Whalebone Cove Division	CT	LWCF	2013	25.50
Whalebone Cove Division	CT	Donation	2013	41.00
Total Connecticut Acres				**578.67**
Third Island Unit	MA	Donation	1997	3.80
Honeypot Road Wetlands Unit	MA	LWCF	1999	20.26
Wissatinnewag Unit	MA	LWCF	2001	20.81
Mount Tom Unit	MA	LWCF	2002	140.82
Mount Toby Unit	MA	LWCF	2003	30.04
Fort River Division	MA	LWCF	2005	22.70
Fort River Division	MA	LWCF	2007	1.80
Mill River Division	MA	MBCF	2007	197.00
Fort River Division	MA	LWCF	2008	82.00
Mill River Division	MA	MBCF	2008	13.86
Mill River Division	MA	MBCF	2008	19.52
Fort River Division	MA	LWCF	2009	66.52
Fort River Division	MA	LWCF	2010	24.40
Mill River Division	MA	LWCF	2010	18.50
Fort River Division	MA	LWCF	2011	19.32
Dead Branch Division	MA	LWCF	2011	80.00
Fort River Division	MA	LWCF	2012	32.07
Dead Branch Division	MA	LWCF	2012	17.54
Westfield River Division	MA	LWCF	2013	125.00
Fort River Division	MA	LWCF	2013	12.00
Total Massachusetts Acres				**947.96**
Pondicherry Division	NH	LWCF	2000	670.82
Pondicherry Division	NH	LWCF	2003	3,039.68
Pondicherry Division	NH	LWCF	2004	143.00
Pondicherry Division	NH	MBCF	2004	472.44
Pondicherry Division	NH	LWCF	2005	286.00
Pondicherry Division	NH	LWCF	2005	166.00

Refuge Division/Unit	State	Funding[1] Source	Acquisition Year	Acres[2]
Pondicherry Division	NH	MBCF	2005	3.40
Pondicherry Division	NH	MBCF	2005	499.69
Pondicherry Division	NH	LWCF	2005	19.67
Pondicherry Division	NH	LWCF	2006	12.54
Pondicherry Division	NH	LWCF	2006	16.23
Blueberry Swamp Division	NH	LWCF	2007	13.00
Pondicherry Division	NH	LWCF	2007	2.28
Pondicherry Division	NH	LWCF	2007	71.55
Pondicherry Division	NH	MBCF	2008	101.59
Blueberry Swamp Division	NH	MBCF	2009	51.50
Blueberry Swamp Division	NH	MBCF	2009	56.00
Blueberry Swamp Division	NH	MBCF	2009	419.50
Pondicherry Division	NH	MBCF	2009	80.09
Pondicherry Division	NH	Donation	2009	18.50
Pondicherry Division	NH	MBCF	2009	11.23
Blueberry Swamp Division	NH	MBCF	2010	62.50
Blueberry Swamp Division	NH	MBCF	2010	105.00
Blueberry Swamp Division	NH	MBCF	2010	113.00
Blueberry Swamp Division	NH	LWCF	2010	5.10
Blueberry Swamp Division	NH	LWCF	2010	5.00
Blueberry Swamp Division	NH	LWCF	2010	5.00
Blueberry Swamp Division	NH	MBCF	2010	66.00
Blueberry Swamp Division	NH	MBCF	2010	96.00
Blueberry Swamp Division	NH	LWCF	2010	25.42
Pondicherry Division	NH	MBCF/LWCF	2010	46.90
Pondicherry Division	NH	LWCF	2010	6.20
Pondicherry Division	NH	LWCF	2010	79.89
Pondicherry Division	NH	LWCF	2010	11.58
Pondicherry Division	NH	Donation	2010	21.15
Pondicherry Division	NH	LWCF	2010	65.00
Pondicherry Division	NH	LWCF	2011	18.00
Pondicherry Division	NH	MBCF	2011	510.00
Pondicherry Division	NH	LWCF	2011	31.84
Blueberry Swamp Division	NH	LWCF	2012	6.80
Blueberry Swamp Division	NH	LWCF	2012	136.00

Refuge Division/Unit	State	Funding[1] Source	Acquisition Year	Acres[2]
Total New Hampshire Acres				**7,571.09**
Nulhegan Basin Division	VT	LWCF	1999	9,042.12
Nulhegan Basin Division	VT	MBCF	1999	16,868.00
Nulhegan Basin Division	VT	Donation	1999	76.00
Putney Mountain Unit	VT	LWCF	1999	278.69
Putney Mountain Unit	VT	Donation	1999	5.86
Nulhegan Basin Division	VT	LWCF	2002	5.66
Nulhegan Basin Division	VT	LWCF	2002	13.47
Nulhegan Basin Division	VT	MBCF	2002	74.20
Nulhegan Basin Division	VT	MBCF	2002	170.11
Nulhegan Basin Division	VT	LWCF	2006	40.00
Nulhegan Basin Division	VT	MBCF	2007	76.90
Nulhegan Basin Division	VT	LWCF	2010	57.18
Nulhegan Basin Division	VT	LWCF	2011	29.87
Nulhegan Basin Division	VT	LWCF	2012	72.58
Nulhegan Basin Division	VT	LWCF	2013	79.12
Total Vermont Acres				***26,889.76***
Refuge Total Acres				***35,987.48***

[1] *LWCF = Land and Water Conservation Fund; MBCF = Migratory Bird Conservation Fund*

[2] *The Services owns all acreage in full fee title, except for two conservation easements on about 170 acres at the Pondicherry Division; acres compiled as of October 7, 2013.*

Refuge Revenue Sharing

Refuge lands are not on the local tax rolls. The Refuge Revenue Sharing Act (16 U.S.C. §715s) offsets the loss of local tax revenues from Federal land ownership through payments to local taxing authorities. In the four-state area, those payments go to the towns. The annual payments are calculated on the federally appraised value for tax purposes, and are reduced proportionally based on the amount appropriated by Congress. Lands are reappraised by the Department of the Interior every 5 years. Table 3.6 shows the Service made the following refuge revenue sharing payments to local townships in recent years.

Table 3.6. Refuge Revenue Sharing Payments to Towns, 2007 to 2013.

Refuge Division/ Unit	Town	County	Refuge Revenue Sharing Payments in Dollars by Fiscal Year						
			2007	2008	2009	2010	2011	2012	2013
Connecticut									
Dead Man's Swamp Unit	Cromwell	Middlesex	3,562	2,763	2,597	176	188	177	208
Salmon River Division	East Hampton	Middlesex	-	-	-	-	-	388	2,162
Salmon River Division	Haddam	Middlesex	-	-	-	1,629	1,746	1,887	2,393
Whalebone Cove Division and Roger Tory Peterson Unit	Old Lyme	New London	-	-	-	-	-	937	1,375
Massachusetts									
Third Island Unit	Deerfield	Franklin	7	5	5	6	6	6	7
Wissatinnewag Unit	Greenfield	Franklin	781	606	569	94	101	95	112
Mount Toby Unit	Sunderland	Franklin	778	604	567	1,063	1,139	1,070	1,256
Mount Tom Unit	Holyoke	Hampden	3,124	2,424	2,278	5,120	5,487	5,156	6,051
Honeypot Road Wetlands Unit	Westfield	Hampden	463	359	338	19	21	20	23
Westfield River Division	Becket	Hampshire	-	-	-	-	-	-	370
Dead Branch Division	Chesterfield	Hampshire	-	-	-	-	-	517	607
Fort River Division	Hadley	Hampshire	1,484	5,975	5,615	4,233	6,901	8,141	9,678
Mill River Division	Northampton	Hampshire	-	900	846	211	258	243	285
New Hampshire									
Blueberry Swamp Division	Columbia	Coos	-	95	212	2,975	3,632	3,413	4,398
	Jefferson	Coos	4,868	3,777	4,161	15,187	17,209	16,171	18,979
Pondicherry Division	Whitefield	Coos	950	737	692	339	895	841	987
Vermont									
	Bloomfield	Essex	3,201	2,483	2,334	1,914	2,050	1,927	2,261
	Brunswick	Essex	2,745	2,151	2,021	2,126	2,278	2,141	2,570
	Ferdinand	Essex	2,069	1,605	1,508	1,063	1,139	1,483	1,740
Nulhegan Basin Division	Lewis	Essex	13,952	10,863	10,208	7,335	8,402	7,984	9,370
	Brookline	Windham	191	148	139	109	117	110	129
Putney Mountain Unit	Putney	Windham	444	345	324	975	1,045	982	1,152
Total Payments by Fiscal Year			**$38,619**	**$35,840**	**$34,414**	**$44,574**	**$52,614**	**$53,689**	**$66,454**

Conte Refuge General Public Use

Hunting, fishing, wildlife observation and photography, environmental education and interpretation were established as priority public uses by Executive Order 12996 (March 25, 1996), and legislatively mandated by the Refuge Improvement Act. These activities are appropriate uses of national wildlife refuges, as long

as they are compatible with the mission of the System and the purposes of the refuge, and are often referred to as the "Big 6" wildlife dependent public uses. All six priority public uses are available to the public at the Nulhegan Basin, Pondicherry, Blueberry Swamp, Salmon River, and Fort River Divisions, while certain wildlife-dependent uses are available at most refuge lands. With the exception of the Putney Mountain Unit, none of the smaller units have been officially opened to public uses. Certain non-priority uses are allowed and have been found to be appropriate and compatible. These include snowmobiling on designated trails at the Nulhegan Basin, Pondicherry, and Dead Branch Divisions

It is difficult to accurately characterize the amount or type of outdoor recreational activities occurring within the entire watershed, and numbers for refuge lands are broad estimates. This section will first provide an overview of the general hunting, fishing, and wildlife viewing trends occurring within the States based on the Service's 2011 National Survey which is available at (USFWS 2012). The 2011 survey shows that 90.1 million U.S. residents 16 years and older participated in wildlife-related recreation—a 3 percent increase from 2006. The number of hunters and anglers increased from 33.9 million in 2006 to 37.4 million in 2011. The most recent survey also showed 71.8 million people engaged in wildlife observation, an increase of about one percent since 2006, spending about $55.0 billion on their activities. Table 3.7 illustrates participation in wildlife-associated recreation by State residents both inside and outside their state of residence. Table 3.8 shows the estimated annual refuge visitation for the six priority public uses.

Table 3.7. Results from the 2011 U.S. Fish and Wildlife Service National Survey of Fishing, Hunting, and Wildlife-associated Recreation for Connecticut, Massachusetts, Vermont, and New Hampshire.

	Connecticut	Massachusetts	New Hampshire	Vermont	Total
Participation in wildlife-associated recreation by state residents (either inside or outside of their own state)					
Number of individuals participating in hunting	82,000	66,000	44,000	71,000	263,000
Number of individuals participating in fishing	340,000	457,000	164,000	105,000	1,066,000
Number of individuals participating in wildlife watching	1,093,000	1,530,000	388,000	273,000	3,284,000
Total number of participants	1,515,000	2,053,000	596,000	449,000	4,613,000
Percent (%) of Total Population	42.4%	31.4%	45.3%	71.8%	38.2%
Total expenditures for wildlife-related recreation in state (by both state residents and nonresidents)					
Hunting	$302 million	$87 million	$61 million	$292 million	$742 million
Fishing	$436 million	$455 million	$209 million	$131 million	$1.2 billion
Wildlife-watching	$935 million	$ 1.3 billion	$281 million	$289 million	$2.8 billion
Total	**$1.7 billion**	**$1.8 billion**	**$551 million**	**$712 million**	**$4.7 billion**

* *View entire report at: http://www.census.gov/prod/www/abs/fishing.html (accessed December 2014).*

Table 3.8. Estimated Annual Refuge Visitation for Priority Public Uses, 2008 to 2012.

	Estimated Annual Visitation				
Priority Public Use Activity	**2008**	**2009**	**2010**	**2011**	**2012**
Fishing	191	186	205	210	210
Hunting	2,109	2,108	2,095	2,105	2,105
Environmental Education	1,345	1,388	1,334	4,022	1,833
Interpretation	1,007	1,280	1,220	10,873	9,743
Wildlife Observation	4,775	5,354	5,581	5,850	4,786
Wildlife Photography	1,000	1,078	1,051	1,050	1,000
Total Visitation	**175,654**	**177,803**	**199,960**	**198,880**	**226,169**

Public Use Facilities

The Conte Refuge Act mentioned establishment of "up to four visitor centers" but the preferred alternative in the 1995 FEIS recommended "multiple cooperative centers." The refuge currently has three partnership visitor centers, as well as a visitor contact station with exhibits at the Nulhegan Basin Division.

Great Falls Discovery Center

The Great Falls Discovery Center is owned by the State of Massachusetts and administered by the Massachusetts Department of Conservation and Recreation (DCR). DCR manages cooperatively with a number of partners, including the Service. Located near the intersection of the major north-south interstate (I-91) and the principal east-west route in northern Massachusetts (Route 2), it is convenient for local families, school groups, and tourists. The site and building are both fully accessible. Other nearby recreational opportunities include a multipurpose biking/hiking path along the Turners Falls canal and observation of a fish ladder at the nearby dam. In addition, Route 2, also known as the Mohawk Trail, is a popular highway for tourists during the fall leaf season.

Great Falls Discovery Center also is an important part of an ongoing effort by local, State, and Federal officials to revitalize downtown Turners Falls. The center is located in historic mill buildings purchased and renovated by the DCR for $3,000,000 in the early 1990s. The Service received an $850,000 appropriation in 1998 to design and build ecological exhibits. DCR spent over $350,000 retrofitting the building to house the Service's exhibits. The Center is staffed by the refuge, DCR, and the Friends of the Great Falls Discovery Center, while the grounds and facilities are maintained by DCR. Other partners assisted in the planning stages, some of which remain involved by offering programs at the center: Conte Anadromous Fish Research Center, USGS; Connecticut River Watershed Council; Massachusetts Division of Fisheries and Wildlife; Massachusetts Audubon Society; Northeast Utilities; Friends of the Great Falls Discovery Center; Hitchcock Center; and the Montague Economic and Industrial Development Corporation.

The Friends of the Great Falls Discovery Center is a non-profit group focused on a cooperatively managed visitor facility in Turners Falls, Massachusetts. Their mission is to "support and enhance the Great Falls Discovery Center and the Connecticut River watershed; to educate the public about the unique features of the Silvio O. Conte National Fish and Wildlife Refuge and the Commonwealth of Massachusetts' Connecticut River Greenway State Park; and to foster public use and enjoyment of the Center, the Park, and the refuge." The Friends group

assists in running the visitor facility, maintaining exhibits, and coordinating exceptional programs. The facility and program schedules, as well as information on the Friends group, can be viewed at: *www.greatfallsdiscoverycenter.org* (accessed August 2013).

The Center's exhibits are a key component for delivering the refuge's messages to citizens of the watershed. The theme of the exhibits is "Our Shared Home," which emphasizes the concept that actions and choices of watershed citizens greatly affect wildlife habitats, and wise choices can conserve, protect, and enhance native species. Major exhibits include: a wall with portraits of our plant and animal neighbors; a watershed model; an introductory video that explains the concept of wildlife habitat; life-size walk-through dioramas depicting principal species and habitats of the watershed; text panels and interpretive walls with dioramas that reinforce key concepts regarding trade-offs in habitat resulting from human activities; and a video that describes habitat challenges facing diadromous fish; a photo gallery with pictures of agency personnel, volunteers, and citizens promoting "Our Shared Home," and an exhibit that offers the visitor opportunities to participate in upcoming events and partner-sponsored volunteer projects.

A variety of programs for different age groups and interests is offered during open hours and occasionally in the evenings. Events are posted at: *www.greatfallsdiscoverycenter.org* (accessed February 2013). The non-profit Friends of Great Falls Discovery Center hosts a monthly coffee house with live music, assists in supporting programs, and many of its members voluntarily assist in staffing the center. Because of refuge and DCR staff limitations, the Center is only open Fridays and Saturdays 10 a.m. to 4 p.m. or for groups by appointment during the winter and spring. In the summer, both the refuge and DCR provide seasonal employees allowing the center to be open 7 days a week.

Montshire Museum of Science
The Montshire Museum of Science located in Norwich, Vermont, is home to the "Silvio O. Conte National Fish and Wildlife Refuge Education Center" (*http://www.montshire.org/;* accessed December 2014). The museum is a hands-on museum, offering dozens of exhibits relating to technology, astronomy, and the physical sciences. In cooperation with the refuge, the museum has several exhibits that illustrate the natural history of the Upper Connecticut River Valley, the refuge, and its resources. The facility is located on a 110-acre site adjacent to the Connecticut River.

Great Northwoods Interpretive Center
The Great Northwoods Interpretive Center is a rest area and information center on U.S. Route 3 just north of Colebrook, New Hampshire, that is administered by the New Hampshire Department of Transportation. The Service financially contributed to the construction of a community multi-purpose room which opened in 2002. The refuge has no staff at the Center. At the front desk, visitors can get tourism information about the local area. The multi-purpose room contains interpretive displays informing visitors about the Service, System, and refuge, in addition to information about the Nulhegan Basin Division, Pondicherry Division, and Umbagog National Wildlife Refuge. It has displays with local themes. The room also contains a number of historical photographs and displays from the Colebrook area and other memorabilia. The interpretive center is open from Memorial Day to Columbus Day.

Nulhegan Basin Division Visitor Contact Station
The Nulhegan Basin Division has a headquarters office and visitor contact station on Route 105 in Brunswick, Vermont. The facility includes an exhibit hall where visitors can learn about "The Nulhegan Basin- Sculpted by Nature, Worked by Human Hands-A Unique Landscape Conserved for Habitat, Wildlife,

and People." Informational exhibits include the cultural history of the basin, refuge partners, refuge research, geology and geography, habitat management, the watershed, the System, and northern forest habitats and species. Visitors can talk to staff to find out more about public uses, trails, and other refuge opportunities. The contact station is open 7 days a week, from 8 a.m. to 4:30 p.m.

Closed Refuge Units
Both the Dead Man's Swamp and the Wissitinnewag units are closed year-round to protect sensitive resources. The Mount Tom Unit is currently closed due to public safety and vandalism concerns. The refuge also has a seasonal closure on the Third Island Unit during the bald eagle nesting period (January 1 to July 31).

Hunting
Currently, there are hunting opportunities on the Nulhegan Basin, Pondicherry, Fort River, Mill River, Dead Branch, Blueberry Swamp, and Salmon River Divisions, and Putney Mountain Unit. In 2011, it was estimated there were 2,165 hunting related visits to these divisions. Game species include moose, white-tailed deer, black bear, waterfowl, ruffed grouse, American woodcock, and small game such as snowshoe hares.


Richard Tetreault

Hunting deer on Nulhegan Basin Division

Fishing
Currently, there are fishing opportunities on the Nulhegan Basin, Pondicherry, Blueberry Swamp, Fort River, Mill River, and Salmon River Divisions. In 2011, there were an estimated 210 fishing trips to the refuge. The Nulhegan Basin Division is often fished for Eastern brook trout, and stocked rainbow and brown trout.

Wildlife Observation and Photography
Wildlife observation and photography are popular activities on refuge lands. Both the Nulhegan Basin and Pondicherry divisions are designated IBAs, drawing many bird watchers during the spring and summer. Driving to see wildlife is a popular activity at the Nulhegan Basin Division where there are 40 miles of gravel roadway open during the summer. During the winter, many of these same routes become snowmobile trails totaling 37 miles. During 2011, an estimated 7,750 visits were made to refuge lands to view and photograph wildlife.

Interpretation and Environmental Education
There are numerous opportunities in the watershed for environmental education. Environmental education is available through public and/or private organizations in 121 of the 384 towns and cities in the watershed. Environmental education related to the watershed resources is available in written materials, educational programs and workshops, hands on activities, and public forums. Prominent examples include MassAudubon, Connecticut River Watershed Council, Connecticut River Joint Commission, and New England Wildflower Society. Additionally, conservation districts, conservation commissions, and university extension programs in the four-state region provide invaluable education and outreach resources. The private and public organizations or providers are too numerous to list here. For more information see Five College/Public School Partnership (1992), Hale and Schwartz (1991), National Wildlife Federation (1995), State of Connecticut (1994), and the Vermont State-wide Environmental Education Programs Web site at: *http://www.vermontsweep.org/* (accessed December 2014).

Small private groups have been active, not only in the watershed as a whole, but also in several tributary watersheds. Many tributaries are being monitored by local associations, such as the Farmington River Watershed Association in Connecticut, and the Deerfield and Chicopee River watershed associations in Massachusetts, as well as a growing network of local River Watch groups. These organizations strive to develop an awareness of these tributaries, and

provide water quality monitoring and restoration through localized education programs. Scarce funding often hampers their ability to achieve goals. Larger organizations, however, such as the Connecticut River Watershed Council, Joint River Commissions, Vermont Institute of Natural Science, TNC, and Mass Audubon provide important educational services. In chapter 4, goal 2 we describe other existing programs occurring on refuge lands. We also describe environmental education and interpretation partnerships in chapter 4 under goal 4.

Watershed-On-Wheels (WoW Express)
In the fall of 2010, the refuge launched a new mobile visitor center known as the WoW Express. The WoW Express is a traveling exhibit designed to engage children of all ages in the beauty and wonder of the Conte Refuge. It includes three components: a walk-through immersion exhibit featuring the diverse sights and sounds of plants and animals from habitats found in the Connecticut River watershed; a watershed table showing how rivers form and change; and seven interactive kiosks exploring the cultural, economic, and environmental significance of the watershed which the Conte refuge seeks to conserve.

The WoW Express travels throughout the watershed visiting schools, natural resource-related fairs, festivals, and conferences. From April 2012 to July 2013, the WoW Express visited over 70 communities within the watershed. The more structured environmental education visits touched nearly 4,000 students and 377 teachers from 30 schools in four states. Including visits to summer camps and over 50 special events, the WoW Express reached over 18,500 people across the watershed in the most recent 11-month period. The exhibit has become popular in recent months.

Adopt-a-Habitat
The refuge recently initiated an Adopt-a-Habitat program intended to establish long-term relationships that spur schools, organizations, and individuals (adults and youth) to adopt and manage local areas within the watershed. Program participants will manage public and private land in order to promote healthy habitat for plants, wildlife, and people. The Adopt-a-Habitat initiative poses an opportunity to accomplish more for wildlife and habitat on lands not governed by the Service. In the process, new contacts are made, awareness is elevated, relationships are established, partnerships develop, and commitment to wildlife and habitat is fostered.

The full curriculum, which is under development, will be designed for students to gain a more thorough understanding of the physical, chemical, and biological interactions within the wetland, stream, pond, or forest habitat area they have selected. The class may choose to use this understanding to implement projects to improve their adopted habitat with the assistance of refuge staff. In the course of study and implementation of projects, students have the opportunity to work with their peers, teachers, community members, and staff from the Service, other Federal and state agencies, and conservation organizations.

As part of this program's development, the refuge is currently working with a college intern to identify target audiences, develop presentations that relate certain concepts to use in the curriculum, create lesson plans, and evaluate limitations to the effectiveness of the program.

Biological Assessment Trailer (BAT)
As a project under development, the refuge will support field work, either as part of the Adopt-a-Habitat or another environmental education program, with a Biological Assessment Trailer (BAT) equipped with field gear that will be available to schools such as waders, dip nets, water quality test meters, field guides, dissecting scopes, etc. Refuge staff will bring the trailer to the

school, introduce students to the equipment, and oversee its use. In some cases equipment may be loaned to the teacher for additional field work on the habitat.

Cooperatively Managed Visitor Centers
As mentioned above, the refuge has a presence at three education or interpretive visitor centers managed cooperatively by partners: the Great Northwoods Center in Colebrook, New Hampshire; the Montshire Museum of Science in Norwich, Vermont; and the Great Falls Discovery Center in Turners Falls, Massachusetts. For more information on these centers, see "Public Use Facilities" above.

Conte Corners
The intent of a Conte Corner is to provide interpretive exhibits about the refuge System, Conte Refuge, and the natural resources in the watershed. The exhibits are housed in facilities run by partners, and are designed to complement the conservation messages of the host partner. Other than minor exhibit maintenance, the Refuge has no other overhead expenses. The partnership is also beneficial in that it provides opportunities for refuge staff to give programs and participate in partner events. Conte Corners are flexible in concept and have the ability to take many forms. There are two existing Conte Corners: one at the Springfield Museum of Science (Springfield, Massachusetts) and another in Cabela's (East Hartford, Connecticut). Both include aquariums and several informational panels. Another Conte Corner, that will include sophisticated interactive displays, is planned for the Connecticut Science Center (Hartford, Connecticut).

Part III: Description of Individual Refuge Divisions and Units

Current refuge lands are comprised of nine refuge divisions and eight refuge units ("Map 1.3. Existing Refuge Ownership"). A refuge division is a relatively large, contiguous, or semi-contiguous area; a unit is often smaller and isolated from other refuge property. Table 3.9 lists each division and unit by state. Below we provide more detailed descriptions of the physical, biological, and socioeconomic setting of each division or unit. We also provide additional information on current public use opportunities, as well as any cultural or historic information, if available.

Table 3.9. Current Refuge Ownership by Division and Unit.

Divisions (acres)*	Units (acres)*
Connecticut	
Salmon River (425 acres)	Dead Man's Swamp (31 acres)
Whalebone Cove (67 acres)	Roger Tory Peterson (56 acres)
Massachusetts	
Fort River (260 acres)	Honeypot Road Wetlands (21 acres)
Dead Branch (98 acres)	Mount Tom (141 acres)
Mill River (249 acres)	Mount Toby (30 acres)
Westfield River (125 acres)	Third Island (4 acres)
	Wissatinnewag (21 acres)
New Hampshire	
Pondicherry (6,405 acres)	
Blueberry Swamp (1,166 acres)	
Vermont	
Nulhegan Basin (26,605 acres)	Putney Mountain (285 acres)

**This ownership information is current as of August 15, 2013*

Refuge Divisions

Salmon River Division, Connecticut (425 acres)

The Salmon River Division is located in the lower Connecticut River valley at the confluence of the Salmon River and the Connecticut River in the Haddam Neck section of the Town of Haddam, Middlesex County, Connecticut. The first acquisition for the Salmon River Division occurred in 2009, comprising 285 acres. The division corresponds to portions of SFA 6 "Salmon Cove" and SFA 7 "Salmon River, including tributaries below dam" in the 1995 FEIS (USFWS 1995).

Natural Resources

The Connecticut River is affected by tidal influences as far north as East Hartford which includes Salmon River. The soils of this area consist of surface deposits of relatively thin and often discontinuous layers of glacial till overlaying bedrock. This till is a poorly sorted mixture of clay, silt, sand, gravel, cobbles, and boulders. Sediments associated with the floodplain of the Connecticut River and the Salmon River can be 10 to 100 feet thick. The uppermost portion of these sediments consists of thin (less than 20 feet deep) alluvial silts and sands deposited by the two river systems.

All stream flows associated with the Salmon River and Salmon Cove are wholly within the Connecticut River Basin. Although tidal influence in the Connecticut River extends upstream to East Hartford, saline water extends only as far north as East Haddam about two miles south of the confluence of the Connecticut and Salmon Rivers.

The aquatic habitats found within the Salmon River and Salmon Cove are recognized by the Service as a high-priority for fisheries. American shad, river herring, and a variety of other migratory fishes use this river system, and adult Atlantic salmon have entered its tributaries to spawn. Extensive beds of submerged aquatic vegetation provide significant overwintering, spawning, and feeding habitat for a large number of fish species, including commercial finfish and shellfish.

American shad

Duane Raver/USFWS

Recognized by the Service for its unusual terrestrial habitat types, the lower Salmon River/Salmon Cove complex provides an intact mosaic of diverse habitat types (table 3.10). Among them are tidally influenced rivers, internationally recognized freshwater tidal marsh and flats, riparian meadows, cold-water streams, floodplain forests, mixed hardwood forest, hemlock stands, and vernal pools. Downstream habitats include brackish tidal marshes and the estuarine system.

Table 3.10. Percentage of Salmon River Division by Habitat Type.

General Habitat Type	Percent of Division
Hardwood forest	93%
Hardwood swamp	Less than 1%
Woodlands	1%
Open water	Less than 1%
Developed	5%

** Based on a GIS analysis; actual percentages may vary slightly*

Reflecting the diversity and quality of the lower Salmon River's habitats are a diversity and abundance of mammals (e.g., river otter, bobcat, fisher), reptiles and amphibians (e.g., Eastern box turtle, marbled salamander, Northern copperhead), breeding songbirds (e.g., warblers, thrushes, cuckoos), and breeding raptors (e.g., American kestrel, barred owl, Northern goshawk). The area harbors 15 state species of conservation concern.

The lower Connecticut River system is important stopover and breeding habitat for neo-tropical migrants, as well, and supports one of the largest concentrations of migratory waterfowl in southern New England. At the mouth of the Salmon River, Salmon Cove's freshwater tidal wetlands, flats, and adjacent intact forest provide neotropical birds and shorebirds with sources of food, water, and shelter and serve as bald eagle winter roost and perch sites. Ospreys also forage in these reaches. Wetland birds breeding in Salmon Cove include American black ducks, green-winged teals, wood ducks, and mallards.

In 2011, an extensive inventory of invasive plants revealed populations of several species that could degrade habitats. The most abundant species are Japanese stiltgrass (mostly along Pine Brook riparian areas and other wetland types), Oriental bittersweet (mostly along the Salmon River riparian areas), and Japanese barberry and multiflora rose (mostly within forest interior). Garlic mustard is newer to the refuge, but has the potential to spread quickly. Local volunteers have been removing garlic mustard and Japanese stiltgrass to prevent their spread within the more pristine interior. Kudzu, one of the most prevalent invasive plants in the southeastern U.S. was found near the Salmon River Division; this is a very uncommon sighting in central Connecticut, and is of concern to State authorities.

Socioeconomic Environment

The Salmon River Division is located in the Town of Haddam, Middlesex County, Connecticut. Haddam is a rural, wooded area with a population of 8,346. There are a number of state parks and forests within the area surrounding the Salmon River drainage. Farming and small industrial production facilities are common near the Salmon River Cove. The largest industrial complex in the county which employs 3,000 workers is located in Middletown, about 5.5 miles northwest of the division. Several other small industrial facilities are located within a 10-mile radius. The nearest working farm is about 10 miles from the confluence of the Salmon River and the Connecticut River.

The population over 16 years of age in Haddam is 6,352 according to 2010 U.S. Census data (USCB Factfinder 2013). Nearly 75 percent of residents are in the labor force. Principle employment in this town includes educational services, health care, and social assistance (26 percent) and manufacturing (14 percent). Other leading professions include finance, insurance, and real estate (11 percent); and, professional, scientific, management, administrative, and waste management

services (12 percent). The largest employer in Middlesex County is the educational, health and social service industry employing 23percent of the worker force. The next largest industry is manufacturing which employees 16 percent of the work force. In 2010, the median household income of Haddam was $87,883.

Refuge Public Use
We completed pre-acquisition compatibility determinations so that hunting, fishing, wildlife observation and photography, environmental education and interpretation could continue at this division until the CCP is complete. Individual land owners control the type and amount of recreation on their property; however, a number of recreational activities occur on the Salmon Cove and Salmon River system including hiking, birding and wildlife observation, hunting, fishing, photography, snowshoeing, cross-country skiing, and environmental education. The well-defined riffles and pools and a boulder-cobble substrate of the Salmon River provide good habitat for cold-water fish; in fact, the Salmon River is considered one of the State's top trout streams.

Cove Meadow, Haddam Meadows, Haddam Island, Hurd, and Cockaponset State Parks are located near the confluence of the Salmon and Connecticut Rivers.

Cultural Resources and Historic Preservation
The Salmon River Division was not covered by the cultural resources overview that was completed for the refuge in 2011 (Waller and Cherau 2011) and no background research concerning known cultural resources has been conducted. However, the refuge recently acquired additional land on Haddam Neck in Haddam, Connecticut. This property is part of the Salmon River Division and contains multiple significant archaeological resources, including the Venture Smith Homestead archaeological site.

Lady slippers

Ryan Hagerty/USFWS

The Venture Smith Site is an 18th century homestead of African-American archaeological significance and has been identified as potentially eligible for listing on the NRHP. Venture Smith (Broteer Furro) was born around 1729 in West Africa, likely in current-day western Mali. Tradition holds that he was the eldest son of an African prince. At the age of six, he was kidnapped by an enemy tribe and sold to the steward of a Rhode Island slave ship. After a stop in Barbados, Smith was taken to Newport, Rhode Island, and then to Fisher's Island, where he was enslaved for about 13 years. In 1751, Venture married another slave. Later that year, he fled briefly from bondage, but changed his mind and returned. As a punishment for flight, he was separated from his wife. Eventually, the couple was reunited in the household of a slave owner in Stonington, Connecticut.

In 1765, Venture Smith purchased his freedom, and moved to Long Island, where he supported himself by farming, fishing, harvesting wood, river trafficking, and other activities. By 1775, Venture had purchased the freedom of his wife and children. Two years later, he sold his property on Long Island and purchased 10 acres on Haddam Neck in Connecticut, adding 70 acres abutting the Salmon River Cove where he built his dwelling house. He continued to prosper in farming, fishing, lumbering, and river commerce, adding a wharf, small warehouses, blacksmith shop, and other dwellings near his home. In 1798, Venture narrated his life story to Elisha Niles, a Yale graduate and Revolutionary War veteran of anti-slavery background. The published narrative provided an extraordinary account of the American experience of an enslaved African.

Prior to Service acquisition, extensive archaeological investigations were conducted at the Venture Smith homestead. Evidence of the various homestead buildings was identified, as well as numerous artifacts associated with the lives of Venture Smith and his family.

In addition to the Venture Smith homestead site, the Salmon River Division contains a variety of other archaeological resources, including pre-Contact Native American sites and evidence of other historical settlements. The Service is now responsible for the preservation and management of these cultural resources.

Whalebone Cove Division, Connecticut (67 acres)

The Whalebone Cove Division currently consists of a 67-acre tract at the confluence of the Connecticut River and Whalebone Cove in Lyme, Connecticut. The division corresponds to portions of SFA 1l-"Whalebone Cove" in the 1995 FEIS (USFWS 1995).

Natural Resources

The division has 2,000 feet of frontage along the Connecticut River and forms the southern entrance to Whalebone Cove. It has a diverse topography, from low, flat tidal marsh to steep slopes (TNC 2013). Its major soil type is the very poorly drained Westbrook mucky peat (Web Soil Survey 2013), found in tidal marsh areas. In the upland portions of the division, the major soil type is the moderately well-drained Pootatuck fine sandy loam.

The existing 67-acre division contains a diversity of habitat types, including high and low tidal marsh, wooded slopes, a kettle-pond wetland, floodplain forest, upland meadows, and mature forest with oak, hickory, and hemlock trees (table 3.11). The Whalebone Cove area is one of the most biologically important and undisturbed tidal marshes on the Connecticut River (TNC 2013). It also has the largest stand of wild rice in the State of Connecticut. The cove is an important wintering area for bald eagles and black ducks because the tides prevent ice from forming in the cove. It is also a significant foraging area for migratory waterfowl, including black ducks, Canada geese, mallards, and wood ducks. Other birds that use the area include green and great blue herons, sora, and least bittern, marsh wren, Carolina wren, white-eyed vireo, osprey, and red-tailed hawks.

Table 3.11. Percentage of Whalebone Cove Division by Habitat Type.

General Habitat Type	Percentage of Unit
Hardwood forest	29%
Hardwood swamp	less than 1%
Shrub swamp and floodplain forest	9%
Freshwater marshes	52%
Old fields and shrublands	2%
Pasture/hay/grassland	less than 1%
Open water	5%
Rocky coast and islands	less than 1%
Developed	2%

** Based on a GIS analysis; actual percentages may vary slightly*

To date, no biological surveys, inventories, or habitat mapping have been conducted at this newly established division.

Socioeconomic Environment
The existing division is located in Lyme, New London County, Connecticut. Lyme is a small, relatively rural town along the eastern bank of the Connecticut River (town of Lyme 2013). The town is known for its agricultural heritage, parks and recreational opportunities, and scenic Hamburg Cove along the Connecticut River. New London, Connecticut, about 20 miles southeast of Lyme, is the largest city in the area.

According to the 2010 U.S. Census, the population of Lyme is 2,406 (USCB Factfinder 2013). Lyme comprises less than 1 percent of the total New London County population of 274,055. Just over 65 percent of the citizens over 16 years old are in the labor force, with about 4.2 percent unemployed. The principal industries are educational, health and social services (16.2 percent); professional, scientific, management, administrative, and waste management services (15.2 percent), and manufacturing (13.4 percent). The median household income of Lyme is $91,522.

Refuge Public Use
Public uses at the Whalebone Cove Division will be determined through the CCP. The preferred course is to open this division to the six priority public uses: hunting, fishing, wildlife observation and photography, environmental education, and interpretation. The area is also popular with kayakers and canoeists.

Cultural Resources and Historic Preservation
The Whalebone Cove Division was not covered by the cultural resources overview that was completed for the refuge in 2011 (Waller and Cherau 2011) and no background research concerning known cultural resources has been conducted.

Dead Branch Division, Massachusetts (98 acres)

The Dead Branch Division currently consists of 98 acres in the town of Chesterfield, Massachusetts, formerly owned by Berkshire Hardwoods. The property slopes east to west toward the Dead Branch River. There are several buildings and log landings remaining from sawmill operation. A former gravel pit has been recontoured and revegetated. The Dead Branch River forms the division's western boundary. The division corresponds to portions of SFA 20 "Westfield River, including West Branch and Middle Branch" in the 1995 FEIS (USFWS 1995).

Natural Resources
The Dead Branch originates at Damon Pond in Chesterfield, Hampshire County, Massachusetts, and flows south through the Dead Branch Division eventually entering the Westfield River on the Chesterfield/Huntington town line. Seventy-one miles of river in the Westfield River watershed are classified as wild, scenic, or recreational, although the Dead Branch is not included *(http://www.nps.gov/pwsr/westfield_pwsr_sub.html*; accessed December 2014). Headwaters of the several branches of the Westfield River are in the Berkshire Hills. The watershed includes historic villages, prime farmland, natural landscapes, several waterfalls, and gorges. One of the State's largest roadless areas is in the Westfield watershed.

The current division is primarily hardwood forest, with about 10 to 15 acres containing buildings, access roads, and landings from the former sawmill (table 3.12). A small one- to two-acre gravel pit has been reclaimed and now provides grass/forb habitat, along with small areas on the north side of East Street that were mowed by the previous landowner. No biological inventories have been initiated on this newly established division, except a cursory invasive plant survey on part of the property in 2013. Two invasive plant species were found: two populations of garlic mustard, which were partially pulled by staff and volunteers, and multiflora rose in the northwest boundary and riparian area.

Table 3.12. Percentage of Dead Branch Division by Habitat Type.

General Habitat Type	Percent of Division
Hardwood swamp	91%
Freshwater marsh	1%
Pasture/hay/grassland	6%
Developed	1%

** Based on a GIS analysis; actual percentages may vary slightly*

Migratory birds expected to breed in this area include blackburnian warbler, wood thrush, Canada warbler, and American woodcock. Resident wildlife such as white-tailed deer, Eastern wild turkey, and ruffed grouse are likely found there.

We are not aware of stream surveys of the Dead Branch, but it appears to be a cool water stream that could support trout. Mussel surveys revealed two species in the Dead Branch: a large, viable population of Eastern elliptio and a small number of Eastern floater (Neadeau 2009). The former is the only viable mussel population in the upper Westfield River watershed, likely due to the low-gradient valley near the division with extensive wetland influence.

Socioeconomic Environment
The current 98-acre Dead Branch Division is located in Chesterfield, Hampshire County, Massachusetts. Chesterfield is a rural town between Northampton and Pittsfield (*http://www.townofchesterfieldma.com/*; accessed December 2014). Based on the 2010 U.S. Census, Chesterfield's population is 1,222, approximately two percent higher than the 2000 census (*http://www.sec.state.ma.us/census/hampshire.htm*; accessed December 2014). Chesterfield comprises less than one percent of the total county population (*http://censusviewer.com/county/MA/Hampshire*; accessed December 2014). Seventy-four percent of the citizens over 16 years old are in the labor force, with about 6.8 percent unemployed (USCB Factfinder 2013). The principal industries are educational, health and social services (31.7 percent) and construction (16.6 percent). The median household income of Chesterfield is $59,063.

Refuge Public Use
The refuge completed pre-acquisition compatibility determinations so that hunting, fishing, wildlife observation and photography, environmental education and interpretation could continue at this division until the CCP is complete. Hunting is a popular recreational activity in the Berkshire hill towns and the Dead Branch Division offers a small area, but good habitat for white-tailed deer and Eastern wild turkeys on the eastern and southern areas with good forest cover. Ruffed grouse also are present along with other small game. Fishing is available in the Dead Branch River on the western boundary of this Division, with trout likely being the primary game fish.

Cultural Resources and Historic Preservation
The Dead Branch Division was not covered by the cultural resources overview that was completed for the refuge in 2011 (Waller and Cherau 2011) and no background research concerning known cultural resources has been conducted.

Fort River Division, Massachusetts (260 acres)

One of the SFAs in the 1995 Conte Refuge FEIS (USFWS 1995) was the Grassland Complex, now identified as the refuge's Fort River Division. This SFA consisted of several disjunct areas totaling about 2,200 acres. Within this area, the refuge has acquired 260 acres in eight separate acquisitions since 2005. In the years following 1995, the refuge worked with Massachusetts Audubon, Amherst College, the University of Massachusetts, the town of Amherst, and a private

landowner to encourage the restoration and appropriate management of several additional grasslands within the SFA.

Natural Resources
The Fort River, located in the eastern portion of the Pioneer Valley, drains a 35,830-acre watershed, and is the longest free-flowing tributary to the Connecticut River in Massachusetts. The area lies on a valley plateau within a circle of hills. The north-south spine of hills running through the middle of Amherst are glacial drumlins that became the islands of ancient Lake Hitchcock that formed as glaciers receded. The area has a number of distinct geologic features including Rattlesnake Knob and Mount Norwottuck; and traprock formations of the former volcanic summit. The Fort River watershed is bounded by Bay Road and the Holyoke Range on the south, Route 47 on the west, the Norwottuck bicycle path on the north, and the Amherst town line on the East (town of Amherst 2009).

The area contains about 15 percent agricultural lands, and holds large farm fields, many with a high clay content which is undesirable for some higher value crops. Most farms are in Hadley and Amherst. Typically, these produce silage corn, hay, or are used for pasture. Approximately two percent of the area's 5,473 farmland acres is protected as development rights have been sold to the state through the Massachusetts Department of Agriculture's Agricultural Preservation Restriction program. About 65 percent of the watershed is forest, and 20 percent urban and other land use (TPL 2006).

Soils are mostly glacial tills of various types in the higher elevations in the east, whereas soils in the western portion of the watershed are finer, more organic sediments more suitable for agriculture. Soils in the northern portion of the watershed (Amherst) are generally sandy and loamy, including the Gloucester-Montauk-Paxton association, Hinkley-Merrimac-Windsor association, and Amostown-Scitico-Boxford association. Soils (Amostown association) in the area west of Route 116 in North Amherst have been put almost entirely into farming use, and the Mount Holyoke area also maintains more rock laden soils within the Rock Outcrop-Narragansett-Holyoke association. There are 6,185 acres of prime farmland in Amherst (town of Amherst 2009).

The Fort River and its tributaries help define South Amherst with its rich farmland and extensive wetlands. The river ranks high in freshwater mussel diversity, including the federally endangered dwarf wedge mussel that was historically found here. In 2009, 10 dwarf wedgemussels were documents in Hop Brook, a tributary of the Frot River. Also, recently, a single mussel was found (Nedeau 2008) above refuge ownership. The river also holds a naturally reproducing population of brook trout in headwater streams. Lawrence Swamp, located in the southeastern portion of the watershed, is an area rich in biodiversity. The upstream river has been heavily impacted by development in the town of Amherst, but in Hadley, where there is less development, the river has a narrow line of floodplain forest. The eastern Pelham Hills are less developed and its tributaries are generally in good condition (town of Amherst 2009).

The division has a variety of habitat types, including hardwood forest, floodplain forest, and grasslands (table 3.13). The largest tract of the division, located in Hadley, Massachusetts, was selected for Service acquisition because inventories by Massachusetts Audubon found notable populations of bobolinks and other grassland birds. In the early 2000s, owners of several of the parcels began planning housing subdivisions on their fields, so the refuge stepped up its acquisition efforts. The division land on Moody Bridge Road, Mill Valley Road, and South Maple Streets in Hadley, Massachusetts, is managed for grassland birds

such as bobolinks, savannah sparrows, and potentially grasshopper sparrows and upland sandpipers, and floodplain forests and their associated wildlife including tree swallows, warbling vireos, and red-bellied woodpeckers.

Table 3.13. Percentage of Fort River Division by Habitat Type.

General Habitat Type	Percent of Division
Hardwood forest	24%
Hardwood swamp	5%
Shrub swamp and floodplain forest	12%
Pasture/hay/grassland	54%
Developed	5%

** Based on a GIS analysis; actual percentages may vary slightly*

Wildlife management activities at the division include mowing fields after July 15 each year to retain grass-dominated habitat following the initial nesting period. These fields provide habitat for bobolinks, savannah sparrows, and potentially grasshopper sparrows and upland sandpipers. Upland sandpipers nested here in the 1980s but were not seen again until recently in late summer, outside the breeding season (Parrish, pers. com. 2013). Invasive plants are impacting priority habitats including the floodplain of the Fort River. An invasive plant inventory has been undertaken, revealing substantial infestations. Invasive multiflora rose is a predominant shrub in both riparian floodplain forests and grassland fields and some control of this species has been undertaken by the YCC crew. Volunteers have been controlling garlic mustard, which is beginning to spread in the flood plain forests, adjacent wetlands, and forest edge. Oriental bittersweet threatens the health of floodplain trees. Other invasive species present include Japanese barberry, purple loosestrife, glossy buckthorn, reed canary grass, autumn olive and black locust, among others.

Fort River Division

USFWS

The refuge has been engaged with academic and research partners on several projects at the division including: American kestrel nesting (U.S. Forest Service), abundance and diversity of native bees in sand and gravel habitats (University of Massachusetts), and smart phone use in early detection and mapping of invasive plants (University of Massachusetts).

Fields in the general vicinity of the division are often planted to either silage corn or cool season grasses to produce hay. Northern harriers hunt these fields during spring and fall migration. Red-tailed hawks and great horned owls nest in the area. Shorter grass areas in pastures provide nesting habitat for killdeer and Wilson's snipe. Horned larks are common in the winter, often in flocks of about 50 birds, often with a few Lapland longspurs and snow buntings. American woodcock, turkeys, and brown thrashers nest in the woods along the Fort River. Eastern bluebirds, Eastern kingbirds, barn swallows, and tree swallows are common breeders here. Also occurring are the sedge wren, wood turtle, marbled salamander, and spring salamander, all of which are state species of concern (town of Amherst 2009). The southern Mount Holyoke area of the watershed is a popular site of yearly hawk migrations, with thousands of birds making their way to southerly wintering grounds.

Socioeconomic Environment
Located in Hampshire County, the Fort River area embraces the towns of Hadley, Amherst, Pelham, Shutesbury, and Belchertown, and three colleges—University of Massachusetts, Amherst College, and Hampshire College—within the "Five College Area" of western Massachusetts. Amherst is the most populous town in this watershed. According to the U.S. Census, Amhersts 2010 population (including resident students) was estimated at 37,819, an 8 percent increase from the 2000 Census population. The Town's size represents nearly one quarter of the Hampshire County population. The slow steady growth rate in recent decades is in stark contrast to the significant population jump experienced in the mid-20th century (town of Amherst 2009). Hadley, the location of the current division has a population of 5,250 (USCB Factfinder 2013).

Three educational institutions, University of Massachusetts, Amherst College, and Hampshire College, employ over half of the labor force in Amherst (town of Amherst 2007) and a significant number of Hadley residents (40 percent) are employed in educational services, health care, and social assistance (USCB Factfinder 2013). Other prominent employers include the food industry and agriculture. The area is supported by public transportation, and bicycling and hiking are very popular on an extensive trail network which includes the Robert Frost Trail and the New England Scenic Trail. Public lands in the area include Skinner State Park, Mount Holyoke Range, and the Connecticut River Greenway State Park, in addition to thousands of acres protected by towns and local conservation commissions. The town of Amherst protects almost 5,000 acres of public lands (town of Amherst 2007). Median household incomes for these two towns are $52,218 for Amherst and $75,313 for Hadley (USCB Factfinder 2013).

Refuge Public Uses
The refuge currently allows hunting, fishing, wildlife observation, and photography, environmental education and interpretation. Problem activities include trash dumping, driving vehicles in the fields, and illegal spotlighting of deer. The refuge is currently constructing an approximately 1-mile long universal access trail on the division. The trail will likely be completed in 2014.

Cultural Resources and Historic Preservation
Three Native American archaeological sites occur within (or partially within) the existing Fort River Division. Information about these sites does not indicate the time period(s) of their occupation.

The Massachusetts State site files indicate that 13 Native American sites are known within a 1-mile radius of the division, providing evidence of settlement that occurred during the Middle and Late Archaic periods (7,500 to 3,000 years before present) and the Late Woodland period (1,000 to 450 years before present). The locations of a former sawmill and of a farmstead have also been documented.

The 2011 cultural resources overview for the refuge evaluated the archaeological sensitivity of the Fort River Division (Waller and Cherau 2011). The study assessed the likelihood for additional unrecorded Native American and Euro-American archaeological sites. Sensitivity for Native American sites ranges from high to low depending on the location within the unit, with well-drained areas at greater elevations having higher sensitivity. Sensitivity for Euro-American sites is considered high where documentary evidence suggests historic land use, moderate near the roadway, and low throughout the poorly drained wetland areas of the division.

The recently acquired division properties (Bri-Mar Stables area north of Moody Bridge Road, and also the area on the south side of Moody Bridge Road) were not covered by the cultural resources overview (Waller and Cherau 2011). Detailed background research has not been conducted for these areas. One Native American site of unknown date is located within the Bri-Mar Stables area, near the Fort River.

Mill River Division, Massachusetts (249 acres)

The Mill River Division is located in Northampton, Massachusetts. The refuge has worked closely with the city of Northampton and the Kestrel Land Trust (formerly the Valley Land Fund, which recently merged with Kestrel Trust to form the Kestrel Land Trust) to conserve wildlife habitat. The division is currently 249 acres in size and was acquired as four separate parcels since 2007. The division corresponds to portions of SFA 24"Mount Tom/Mill River/Holyoke Range" in the 1995 FEIS (USFWS 1995).

Natural Resources

The Mill River begins at the outlet of Upper Highland Lake in Goshen at 1,440 feet above sea level and discharges into the Connecticut River in the City of Northampton with a total drop of 1,390 feet (*http://millrivergreenway.org/?page_id=1137*; accessed December 2014). The East Branch joins the Mill River in Williamsburg forming the main stem. The river flows through Haydenville, Leeds, and Florence before entering the City of Northampton. Major tributaries include Beaver Brook and Roberts Meadow Brook which join the river below Haydenville. On its course, it flows through Hulburt's Pond, Paradise Pond, and Look Park and there are two dams, Nonotuck and Cook's, on the main stem.

Beginning at Searsville, the river follows Route 9 into Leeds. From there the river flows on the south side of Florence and Northampton (City of Northampton 2002). At the time of Anglo settlement, the river flowed through what would become Northampton. A series of disastrous floods over the course of two centuries, culminating in the floods of 1936 and 1938 spurred a major flood risk reduction project. A dike was constructed at Smith College that diverts flow south, away from town, through Pynchon Meadows at the Arcadia Wildlife Sanctuary and finally emptying into the Oxbow.

As a consequence, only a fraction of the original channel from town to the Connecticut River remains (City of Northampton 2002). Now disconnected from the rest of the watershed, there is little flow in the original channel. It was noted to be a blight in town because of stagnant water, trash, mosquitoes, and objectionable odors. The last 6,900 feet of the original channel is located on the existing Mill River Division where it joins the Connecticut River. Like the channel in the city, this reach has little to no flow most of the year.

The Mill River Division is a high priority because of the potential for floodplain forest habitat bordering the Connecticut River (table 3.14). This division was included in TNCs floodplain forest inventory and assessment that began in 2008, which concluded that the reach of the Connecticut River in Northampton and Hadley, Massachusetts, contained some of the largest patches of high quality remnant floodplain forest with some of the largest trees in the watershed (Marks et al. 2011). This floodplain forest is key stopover habitat for migratory landbirds and waterfowl during the spring and fall.

Table 3.14. Percentage of Mill River Division by Habitat Type.

General Habitat Type	Percent of Division
Hardwood forest	3%
Hardwood swamp	43%
Freshwater marsh	Less than 1%
Pasture/hay/grassland	7%
Open water	42%
Developed	Less than 1%

** Based on a GIS analysis; actual percentages may vary slightly*

Unfortunately, Oriental bittersweet threatens the health of remaining canopy trees and is preventing the growth of saplings that would otherwise become future floodplain forests. Invasive black locust is outcompeting and replacing native cottonwoods and silver maples. In 2012, refuge staff and YCC crews began cutting bittersweet that was threatening overstory trees. Success in protecting the mature floodplain forest trees from bittersweet will be a long-term process.

Water chestnut, an aquatic invasive, is also a concern, occurring in one of two ponds within the Division. This species has been controlled by refuge staff and volunteers since 2003. Other invasive species on the division include exotic bush honeysuckle, garlic mustard, purple loosestrife, Japanese barberry, and Amur corktree.

Socioeconomic Environment
Northampton has a stable population of 28,549 residents (USCB Factfinder 2013), representing about a one percent decline over the 2000 population (28,978). The workforce of 16,591 is primarily employed in the educational services, health care and social assistance sector (44 percent), retail (12 percent), and arts, entertainment, and recreation, and accommodation and food services (9 percent). Smith College, one of the "Five Colleges," is located in the city. The city is particularly known for its lively arts and music venues. Northampton hosts the oldest, continuously running agricultural fair in the country, in recognition of the important role of farming (Town of Northampton n.d.). Residents of this city have a median household income of $54,413.

Refuge Public Use
The Mill River Division has been open to all six priority public uses since the initial property was acquired by the Service. There are opportunities to hunt waterfowl on the Triangle and Magnolia ponds and in the river, as well as opportunities for white-tailed deer and small game hunting. Fishing occurs on the two ponds and from the banks of the Connecticut River. There are three native surface roads (Hockanum Road, 1st Square Road, and Parsons Swamp Road) which provide access to the refuge boundary and several unauthorized motorized trails. There is no refuge infrastructure other than boundary signs. The extent of public use is unknown. Nearby in the Mill River watershed there are extensive wood roads, trails, and forest with outstanding opportunities for hiking, hunting, fishing, walking, bicycling, mountain biking, and snowmobiling.

Cultural Resources and Historic Preservation
There are no recorded archaeological sites within the existing Mill River Division or within the division's current, approved acquisition boundary. However, the Massachusetts State site files indicate that 15 Native American sites are known within a 1-mile radius of the division, providing evidence of settlement that

occurred during the Middle Archaic period (7,500 to 5,000 years before present) and greater Woodland period (3,000 to 450 years ago).

The 2011 cultural resources overview for the refuge evaluated the archaeological sensitivity of the Mill River Division (Waller and Cherau 2011). The study assessed the likelihood for additional unrecorded Native American and Euro-American archaeological sites. Sensitivity for Native American sites is considered low except for an area at the northern edge of the Oxbow, which exhibits moderate sensitivity. Sensitivity for post-contact Euro-American sites is low throughout the division.

Westfield River Division, Massachusetts (125 acres)

The Westfield River Division currently consists of a 125-acre tract, purchased in 2013, on Benton Hill Road in Becket, Massachusetts. The division corresponds to SFA 14 "Westfield River, including West Branch and Middle Branch" in the 1995 FEIS (USFWS 1995).

Natural Resources

The northeast portion of this property has frontage on the West Branch of the Westfield River and Center Pond Brook. The West Branch of the Westfield River is the longest free-flowing river reach in Massachusetts (Westfield River Wild and Scenic Advisory Committee 2007). Over 78 miles of river in the Westfield River watershed are classified as wild, scenic, or recreational (*http://www.nps.gov/pwsr/westfield_pwsr_sub.html*; accessed December 2014). The West Branch (1993) and many of its headwater tributaries in the upper slopes of the Berkshires (2004) were designated as wild and scenic, including the reach on this division. The watershed includes historic villages, prime farmland, natural landscapes, several waterfalls, and gorges. One of the State's largest roadless areas is in the Westfield watershed.

The Westfield River is particularly important habitat for shad and American eel and has one of the largest shad runs in the Connecticut River watershed (TNC 2013). Mussel surveys conducted for the Westfield River Wild and Scenic Advisory Committee yielded both Eastern elliptio and Eastern floater in Center Pond and Yocum Pond, both in the West Branch watershed (Nedeau 2009), about 2.6 miles from the current division.

The current division property is located on the eastern slope of the Berkshires in the West Branch of the Westfield River watershed. The current 125-acre division protects over 1,000 feet of riparian habitat along the West Branch. Habitat is primarily mixed hardwoods (table 3.15), hemlock stands with limited amounts of floodplain forest, vernal pools, and spruce/fir forest (TNC 2013). Portions of the existing division have been logged within the past decade.

Table 3.15. Percentage of Westfield River Division by Habitat Type.

General Habitat Type	Percentage of Unit
Hardwood forest	100%

** Based on a GIS analysis; actual percentages may vary slightly*

To date, no biological surveys, inventories, or habitat mapping have been conducted at this newly established division. However, migratory birds expected to breed in this area include blackburnian warbler, wood thrush, Canada warbler, and American woodcock. Resident wildlife such as white-tailed deer, eastern wild turkey, and ruffed grouse are likely found there. The West Branch has excellent cold water habitat that supports a variety of fish species (Westfield River Wild and Scenic Advisory Committee 2007). In 2013, a cursory search for invasive species on the division, found very few invasive plant species.

Socioeconomic Environment
The current property comprising the Westfield River Division is located in Becket, Berkshire County, Massachusetts. Becket is a small hill town recognized for high quality trout fishing opportunities (*http://www.townofbecket.org/Public_Documents/BecketMA_WebDocs/about;* accessed December 2014). Pittsfield, Massachusetts, about 11 miles northwest of Becket, is the largest town in the area. The 2010 U.S. Census recorded a population of 1,779 (USCB Factfinder 2013) which is nearly the same as the 2000 census (1,755) (*http://www.sec.state.ma.us/census/berkshire.htm*; accessed December 2014). Becket comprises about one-tenth of a percent of the total Berkshire County population of 131,219. Just over 58 percent of the citizens over 16 years old are in the labor force, with about 9.6 percent unemployed (USCB Factfinder 2013). The principal industries are educational, health and social services (18.5 percent); arts, entertainment, recreation, accommodation, and food services (17.9 percent); retail trade (14.3 percent); and, professional, scientific, management, administrative, and waste management services (14.2 percent). The median household income of Becket is $41,852.

Refuge Public Use
Public uses at the Westfield River Division will be determined through the CCP. The preferred course is to open this division to the six priority public uses: hunting, fishing, wildlife observation and photography, environmental education and interpretation. This region in the Berkshires has long been a popular area for a variety of outdoor activities including the priority public uses.

Cultural Resources and Historic Preservation
The Westfield River Division was not covered by the cultural resources overview that was completed for the refuge in 2011 (Waller and Cherau 2011) and no background research concerning known cultural resources has been conducted.

Blueberry Swamp Division, New Hampshire (1,166 acres)

The Blueberry Swamp Division (formerly known as the Mohawk River Division) lies in northwestern Coos County in the town of Columbia, New Hampshire, about 5 miles southeast of the town of Colebrook, New Hampshire. The first 13-acre parcel for the division was purchased in 2007; since then, the division has grown to 1,166 acres. The Blueberry Swamp Division corresponds to SFA 47 "Colebrook Hill Farms" and SFA 46 "Mohawk River" in the 1995 FEIS (USFWS 1995), which included about 2,040 acres of pastureland and old field, shrubs and forest, fens, and swamps.

Natural Resources
This division lies within the Simms Stream watershed which drains into the Connecticut River about 1.5 miles south of Colebrook. Soils in this region of Coos County are derived from glacial till parent material, following the last glacial epoch and comprised of weathered phyllites, shales, and schists (Kerivan and Lanier 2006). They have a silt texture, relatively high pH, regardless of whether the substrate is granitic or sedimentary, and tend to be more productive than the igneous derived soils found south in the White Mountains region. The historic dairy farming and timber industries thrived, in large part, because of these relatively fertile soils.

The division lies in a bowl between Marshall Hill to the west, Cilley Hill to the south, and Baldhead Mountain to the west in the town of Columbia. Blueberry Swamp, the prominent wetland feature within the boundary, is drained to the west by East Branch Simms Stream, a tributary of Simms Stream.

The landscape is primarily mixed-wood forests and lowland spruce-fir (table 3.16). Blueberry Swamp is a large wetland in the northeast corner of the division

consisting of shrub swamp, freshwater marsh and cedar swamp communities. These wetlands may contain suitable habitat for waterfowl like black ducks, mallards, and wood ducks. Common snipe and spotted sandpipers are shorebirds that can be expected on the fringes of the swamp.

Table 3.16. Percentage of Blueberry Swamp Division by Habitat Type.

General Habitat Type	Percentage of Division
Conifer swamp/spruce-fir	64%
Hardwood forest	18%
Shrub swamp and floodplain forest	13%
Freshwater marsh	1%
Pasture/hay/grassland	2%
Developed	2%

** Based on a GIS analysis; actual percentages may vary slightly*

Pasture, hay, and grassland habitats are also present within this division providing breeding habitat for northern harrier, a State-listed species, American woodcock and bobolink. Simms Stream and its East Branch flow through this division. Both Eastern brook trout and brown trout are found in Simms Stream and brook trout likely inhabit the east branch that drains Blueberry Swamp.

Several invasive plants were identified on the division during a survey in 2011, including autumn olive, purple loosestrife, reed canarygrass, glossy buckthorn, Canada thistle, and common reed. These weeds may be recent invaders to the area because they are found in small clusters and individual plants and do not appear to be firmly established. Control efforts at this stage have a good chance of success.

Socioeconomics

There are two New Hampshire towns in close proximity to the division: Columbia and Colebrook. During the decade ending in 2010, the populations in Colebrook and Columbia remained stable. Like the rest of Coos County, these towns are and will continue to be rural in nature.

Both Columbia and Colebrook derive a substantial portion of their incomes from service industries. Education, health care, and social assistance (Columbia 24.5 percent, Colebrook 21.4 percent); recreation, accommodations, food services (12.7 percent, 22.1 percent, respectively) were the largest employers. Retail, manufacturing, and construction were also important in these towns. The forest products industry has been a primary employer in Coos County for decades, but divestiture by large timber corporations and the closing of paper and lumber mills has diminished this sector's contributions to the economy.

Outdoor recreation and the infrastructure to support it also are important contributors to the local economy. Coos County, named the "Great North Woods," is well-known for its rugged and remote character. Visitors come to the region throughout the year to participate in activities such as hunting, fishing, camping, hiking, canoeing/kayaking, snowmobiling, skiing, and driving the scenic roads. Hotels, restaurants, campgrounds, and the associated service industry all benefit from the infusion of tourism dollars. Today the economy is a reflection of the rural, sparsely populated nature of the county. The median household incomes in Columbia ($39,063) and Colebrook ($36,597) are similar to Coos County ($41,807) as a whole (USCB Factfinder 2013).

Refuge Public Uses
Currently the Service owns 1,166 acres at the Blueberry Swamp Division. Pre-acquisition compatibility determinations were completed for the six priority public uses prior to acquisition, so the division is currently open to hunting, fishing, wildlife observation and photography, and environmental education and interpretation. No surveys or inventory of public uses have been undertaken, but hunting, wildlife observation, general hiking, and berry picking are probably popular activities in the area. Fishing may occur in East Simms Stream. Both Eastern brook trout and brown trout are found in Simms Stream and brook trout likely inhabit the east branch that drains Blueberry Swamp. Snowmobiling occurs on designated trails.

Cultural Resources and Historic Preservation
There are no recorded archaeological sites within the existing Blueberry Swamp Division or within the division's current, approved acquisition boundary. The 2011 cultural resources overview for the refuge evaluated the archaeological sensitivity of the Blueberry Swamp Division (Waller and Cherau 2011). The study assessed the likelihood for additional unrecorded Native American and Euro-American archaeological sites. Sensitivity for Native American sites is considered low throughout the division. Sensitivity for post-contact Euro-American sites is low except for areas bordering on East Road, where it is considered moderate.

Pondicherry Division, New Hampshire (6,405 acres)

The Pondicherry Division is located in Jefferson, Whitefield, and Carroll, Coos County, New Hampshire, 5 miles south of Lancaster, New Hampshire, and 12 miles northwest of Mount Washington. The Pondicherry area was SFA 41 in the 1995 FEIS (USFWS 1995) and was identified with 1,665 acres. Division lands have been acquired from several landowners and it now comprises 6,405 acres. Prior to expanding beyond the original SFA's 1,665 acres, and to comply with NEPA requirements, refuge staff re-engaged the public and completed a separate environmental assessment and "finding of no significant impact" administratively authorizing the larger boundary for the Pondicherry Division. Officially, the division was established in 2000 when 670 acres were purchased from the Hancock Timber Resource Group.

Natural Resources
Pondicherry Division's landscape is, in part, a product of ancient glacial activity. Approximately 10,000 years ago, as glaciers from the last ice age receded, this area was at the bottom of Lake Israel. As Lake Israel drained, huge residual glacial ice blocks remained embedded in the bottom substrate. These blocks melted, leaving water-filled depressions or kettle lakes known today as Cherry, Little Cherry, and Mud Ponds.

Pondicherry Division lies about 1,110 feet above sea-level in a three-sided basin, surrounded to the north, east, and south by peaks rising from 5,000 feet (Pliny Range) to 5,580 feet (Presidential Range) above the basin. To the west, low hills separate the basin from the Connecticut River Valley. Most of the division is drained by the John's River which flows west out of Cherry Pond into Little Cherry Pond. Little Cherry Pond drains to the west through a low-gradient reach known as the Deadwater. The river is about 10 feet wide and ranges in depth from 4 inches to 3 feet. An unnamed stream drains Mud Pond flowing into the north side of Little Cherry Pond. After the John's River leaves the division, it flows through Whitefield, New Hampshire, and reaches the Connecticut River across from South Lunenberg, Vermont. Stanley (a.k.a. Slide or Mill) Brook drains the eastern quarter of the division into the Israel River which enters the Connecticut River in Lancaster, New Hampshire.

The wetland and saturated soils are very deep and very poorly drained in depressions on outwash plains, lake plains, and glaciated uplands. They are influenced by herbaceous organic deposits and underlain by sandy textured sediments. Slopes range from zero to 2 percent.

USFWS

Wood duck

Noted habitat attributes included "…a wetland complex of bogs, streams, and ponds surrounded by spruce/fir forest…" The area was recognized as good stopover habitat for several waterfowl species and the site of a great blue heron rookery.

The most abundant habitats are lowland spruce-fir which is found throughout the division and mixed-wood forests in the uplands (table 3.17). Peatlands surround Little Cherry and Mud ponds and are found between Mud Pond and the northern shore of Cherry Pond. Wet meadow/shrub habitats are concentrated along the John's River, in the Moorhen Marsh/Cedar Marsh area south of Cherry Pond, and along the edges of the ponds and the John's River. Aquatic habitats include the three ponds, the John's River and its tributaries, and Stanley Brook which flows into the Israel River.

Table 3.17. Percentage of Pondicherry Division by Habitat Type.

General Habitat Type	Percent of Division
Conifer swamp/spruce-fir	67%
Hardwood forest	16%
Shrub swamp and floodplain forest	6%
Freshwater marsh	0.5%
Pasture/hay/grassland	Less than 1%
Peatland	9%
Open water	Less than 1%
Developed	1%

**Based on a GIS analysis; actual percentages may vary slightly*

Much of the existing forest is relatively young due to past natural disturbance and recent forest management activities. A large-scale fire swept through the basin in the early 1900s resetting a substantial portion of the forest back to an early age structure. Throughout the 1900s trees were harvested on what is now Service land. The most recent harvests occurred during the 1980s and 1990s. Some of the peatlands were excluded from the last round of harvesting, because of the fragile saturated soils. A New Hampshire Public Service powerline corridor crossing the southern half of the division from east to west and a portion of the western boundary north to south is held in an early successional shrub/

sapling structure. Acquired land not previously owned by timber companies has a varied history, ranging from active to passive forest management.

Invasive plants are a growing concern at the division. Documented species include purple loosestrife, Japanese knotweed, Canada thistle, spotted knapweed, Morrow's honeysuckle, *Phragmites*, and coltsfoot. Loosestrife and knotweed appear to be the most problematic species. The former is gaining a foothold in emergent wetlands around Moorhen Marsh and in the riparian habitats of the John's River, including the Cherry Pond outlet. We released beetles of the genus *Galerucella* during the summer from 2007 to 2009 in an effort to control loosestrife. Subsequent monitoring indicated minimal success and no further releases are planned. Canada thistle is present in low numbers at log landings and on the logging road network. Volunteers and YCC crews hand pull any plants found each year. It does not seem to be spreading at this time. Spotted knapweed and Morrow's honeysuckle are confined to the railroad bed, near Waumbeck Junction. Coltsfoot has been found in an old corduroy road from the last timber harvest entry between the State Route 116 parking lot and Mud Pond. Surveys by volunteers indicate it is not a threat to spread at this time. *Phragmities* was found near the southern boundary in 2011 and chemical control was initiated in 2012. At this time the infestation is limited to a small, isolated wetland.

Pondicherry supports a broad array of wildlife, and is especially known for an abundance of breeding and migrating songbirds. A total of 238 birds have been documented on land that now comprises the division, and 129 of these are confirmed breeders. Pondicherry lies within the Atlantic Northern Forest BCR 14. Five of the six highest priority species for BCR 14 habitats found at Pondicherry are confirmed nesters. These are the American black duck, American woodcock, Canada warbler, wood thrush, and bay-breasted warbler. Ten of the 16 high priority species nest at Pondicherry and three others occasionally use the division as stopover habitat during migration.

The importance of Pondicherry to birds has been officially recognized several times. In 1963, New Hampshire Audubon and the New Hampshire Fish and Game Department collaborated to establish the Pondicherry Wildlife Sanctuary, comprised of Cherry and Little Cherry ponds and 166 acres of shoreline. The National Park Service recognized the Pondicherry Wildlife Sanctuary in 1972 for its "…relatively stable bog-forest supporting an unusual variety of birdlife…" by naming it a National Natural Landmark. The refuge subsequently purchased a conservation easement on these lands and they are now part of the refuge's Pondicherry Division. In 2003 the division and the adjacent Mount Washington Regional Airport were designated the first Important Bird Area in New Hampshire.

Aquatic habitats within the division boundary support several fish species one of which, the brook trout, has been identified as a conservation priority for the Service's Northeast Region. Other species documented from Pondicherry include chain pickerel and several perch species from Cherry Pond, and the northern red-bellied dace from riverine habitats.

This division has been part of larger studies on American woodcock habitat (Salve Regina University), the distribution and abundance of robber flies (Diptera: Asilida) (Connecticut Agricultural Experiment Station), and Northern goshawk nesting and reproduction (U.S. Forest Service). The refuge has conducted breeding bird surveys and habitat inventories. In partnership with the Friends of Pondicherry, there have been surveys of whip-poor-wills, and documentation of birds, reptiles, and amphibians on the division. In 2013, the refuge began an inventory of bats on the division.

Socioeconomic Environment
Based on 2010 census data, the population of Coos County was little changed since 2000 as was the town of Jefferson. In contrast, the town of Whitefield increased about 13.2 percent (NHOEP 2011). Both towns are rural and this characteristic is not expected to change in the near future.

The pulpwood industry in the region, particularly in New Hampshire, has been on the decline for many years. Forest products continue to be an important component of the economy of Coos County, and service sector jobs are increasing in importance (USCB Factfinder 2013). Educational, healthcare, and social services is the highest employment sector in Jefferson, and an important factor in Whitefield. The largest employer in Whitefield is recreation, accommodations, and food services industries, and these are also important in Jefferson. Other important sectors include retail trade, construction, and agriculture and forestry.

Outdoor recreation and the infrastructure to support it are important contributors to the local economy. Coos County, named the "Great North Woods," is well-known for its rugged and remote character. People come to the region throughout the year to participate in activities such as hunting, fishing, camping, hiking, canoeing/kayaking, snowmobiling, skiing, and driving the scenic roads. Hotels, restaurants, and the associated service industry all benefit from the infusion of tourism dollars. Today, the economy is a reflection of the rural, sparsely populated nature of the county. The median household income in Jefferson ($53,571) and Whitefield ($47,617) are somewhat higher than for Coos County ($41,807) as a whole.

Refuge Public Uses
Pondicherry is well known for its outdoor recreational opportunities. All six of the priority, wildlife-dependent uses (i.e., hunting, fishing, wildlife observation and photography, environmental education and interpretation) are available at Pondicherry.

Hunting has been a popular recreational activity at Pondicherry for decades. Ruffed grouse are probably the most popular game species sought by hunters, but white-tailed deer, moose, black bear, American woodcock, and snowshoe hare are also hunted. Division-specific regulations for sport hunting have been in place since the fall of 2005. Popular hunting areas include the powerline corridor, early successional forest stands, and forests adjacent to the old road network. In 1963, Cherry and Little Cherry Ponds (130 acres) and a 166-acre area around the ponds were closed to hunting by the New Hampshire Fish and Game Department and New Hampshire Audubon. In 2005, another 250 additional acres around the Little Cherry Pond Loop Trail was closed to reduce potential conflicts between hunters and non-hunters.

Fishing occurs at the Pondicherry Division, however, fishing pressure outside of the winter season is limited because the best fishing area, Cherry Pond, requires a 1.5-mile hike or bicycle ride on the State rail-trail. Most fishing probably occurs during the winter, as snowmobilers ride on the state trails to Cherry Pond. Little Cherry Pond and the John's River are less popular because they are more remote.

Wildlife observation and photography are probably the most popular activities at Pondicherry. People began birding there as early as 1911 when Horace Wright published *The Birds of the Jefferson Region in the White Mountains* (Wright 1911). Today people trek out to Cherry Pond, Little Cherry Pond, and more remote sections seeking wildlife. Guided group tours are offered by the Friends of Pondicherry each year in celebration of International Migratory Bird Day.

Photographers are drawn to the spectacular view of the Mount Washington and the Presidential Range in the background from the western shore of Cherry Pond. The Appalachian Mountain Club (AMC) has offered outdoor photography courses that included a day at Cherry Pond.

The Friends of Pondicherry have offered field trips led by visiting instructors each year. The White Mountains Regional School uses the division for educational field trips. As discussed above, organizations such as Audubon and the AMC bring people to Pondicherry for nature-based learning. There are self-service educational materials at the informational kiosks located at the parking lots on State Route 116 and at the state trailhead on Airport Road.

Within the Pondicherry boundary are the Presidential Recreational Trail, an active railroad line, and Cherry Pond, and Little Cherry Pond which are under the jurisdiction of the State of New Hampshire. Hiking and bicycling are allowed on the rail-trail throughout the year and snowmobiling occurs during the winter months. The division proper is not open to motorized or mechanized travel, except during the winter on a state snowmobile trail (Powerline Trail) located on the Public Service of New Hampshire utility corridor easement.

Cultural Resources and Historic Preservation
There are no recorded archaeological sites within the existing Pondicherry Division or within the division's current, approved acquisition boundary. However, the New Hampshire State site files indicate that six Native American sites are known within a 1-mile radius of the division, providing evidence of settlement that occurred during the Paleo-Indian period (11,500 to 9,500 years before present).

The 2011 cultural resources overview for the refuge evaluated the archaeological sensitivity of the Pondicherry Division (Waller and Cherau 2011). The study assessed the likelihood for additional unrecorded Native American and Euro-American archaeological sites. Sensitivity for Native American sites is variable. It is considered high in the level, northern plateau; moderate in areas where wetland margins are well drained; and low in poorly drained wetland areas. Sensitivity for post-contact Euro-American sites also varies. It is considered high in documented settlement areas and in proximity to historic railroad easements, moderate near historic roads, and low elsewhere.

Nulhegan Basin Division, Vermont (26,605 Acres)

The Nulhegan Basin Division was SFA 45 in the 1995 FEIS (USFWS 1995). It encompassed 71,900 acres, of which the refuge intended to acquire 11,000 acres. Since the 1995 Conte Refuge FEIS (USFWS 1995) was completed, the Service opted to purchase approximately 27,000 acres from The Conservation Fund as part of a larger land conservation effort. To comply with NEPA requirements, the refuge re-engaged the public and completed an environmental assessment and a "finding of no significant impact" which administratively modified the original 1995 Conte Refuge FEIS to allow expanded acres for refuge acquisition (USFWS 1999).

The Nulhegan Basin Division is located in Essex County in the towns of Brunswick, Ferdinand, Bloomfield, and Lewis, Vermont. The refuge headquarters and visitor contact station is located in Brunswick (about 10 miles east of Island Pond). A five-room quarters building and storage barn are located adjacent to the headquarters building. There is a 200-foot interpretive boardwalk on Four Mile Road in the area known as Mollie Beattie Bog. There are interpretive kiosks at the main entrances of the division and scenic overlooks at the headquarters and at the end of Lewis Pond Overlook road. About 15 year-

round residences and numerous seasonal cabins are within 1 mile of the division boundary, primarily along Vermont Route 105.

Natural Resources
The Nulhegan Basin was created when a pool of magma formed within existing metamorphic rock. The magma cooled into a relatively soft granitic rock called quartz monzonite. Once erosion wore away the cap of metamorphic rock, the softer monzonite eroded more rapidly than the surrounding metamorphic rock. This resulted in a relatively flat circular interior area, roughly 10 miles in diameter, surrounded by hills. Sand and gravel were later deposited in the bottom of the Basin by melting glaciers. Elevations on the division range from 1,000 feet to 2,800 feet above sea level.

Three of the four major tributaries of the Nulhegan River, the North, Yellow, and Black Branches, flow north to south through the division. A network of smaller streams feed these branches. The main course of the Nulhegan River flows adjacent to the south boundary of the division. The 68-acre Lewis Pond is in the northwest portion of the division.

The division is predominantly forested with natural small openings. These openings are most frequently associated with wetlands (e.g., bogs and beaver flowages), although windthrow events temporarily create larger openings. Twenty-three natural communities are mapped on the Nulhegan Basin Division. These include the most significant mosaic of lowland conifer natural communities in the State, including spruce-fir-tamarack swamp, black spruce swamp, northern white cedar swamp, and peatlands. Six of the natural communities have a Vermont Natural Heritage classification of S2 (rare) and 10 are classified as S3 (uncommon). Wetland and aquatic natural communities support the majority of identified rare plants. Shrublands, primarily dominated by speckled alder, are restricted to poorly drained areas, small seepage zones, and wide alluvial stretches of the Nulhegan River and its principal tributaries (table 3.18).

Table 3.18. Percentage of Nulhegan Basin Division by Habitat Type.

General Habitat Type	Percent of Division
Conifer swamp/spruce-fir	57%
Hardwood forest	40%
Shrub swamp and floodplain forest	1%
Cliff and talus	Less than 1%
Freshwater marsh	Less than 1%
Peatland	1%
Rocky outcrop	1%
Open water	Less than 1%
Developed	Less than 1%

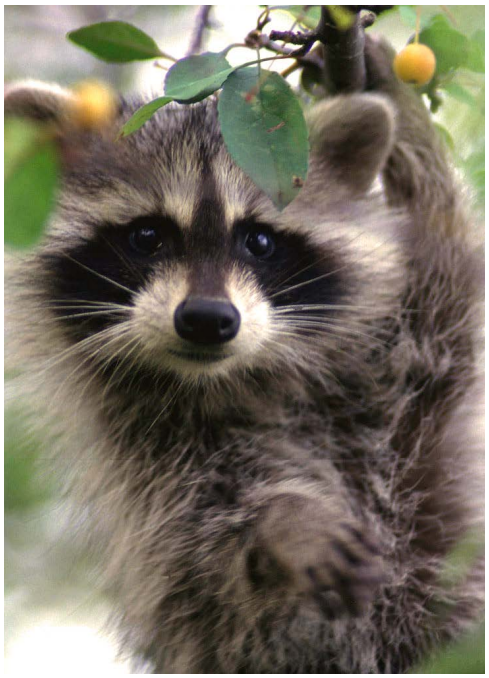
** Based on a GIS analysis; actual percentages may vary slightly*

Riparian habitats and wetlands are generally in good condition. Historically, dams and log drives impacted the area's streams. Forested habitats in the division have long supported the timber industry, dating back 150 years. The species removed and the intensity of harvesting varied over time as technologies and markets changed.

Northern hardwood forest, dominated by sugar and red maple, American beech, and yellow and paper birch, cloak the mountains of the Basin rim and the larger

hills of the Basin interior. Notably absent in the Basin are oaks, another indicator of the more northern character of the forest. Spruce-fir forest covers large areas of the Basin bottom. Red and Black spruce and Balsam fir are the principal trees in these forests, which cover both wetlands on shallow to deep peat soil deposits, and adjacent glacial kame and till soils of the shallow valleys, flats, and low hills. Another northern forest conifer, white spruce, occurs sparingly in flood plains and certain swamps. In upland situations, successional stages of these spruce-fir forests can be dominated by quaking and bigtooth aspen, red maple and paper birch. Tamarack, northern white cedar, and black ash occur commonly in the basin, although restricted to wetlands more heavily influenced by groundwater.

State rare plants found in the division include white-fringed orchid, bog sedge, shining rose, drooping bluegrass, ligonberry, and the State-endangered auricled twayblade. Most of these plants are associated with bogs and other peatlands common in the division, and are more common to the north of the Basin. Peat mosses of the genus *Sphagnum* are a predominant groundcover in the numerous swamps and bogs of the refuge. No plant species are currently known to occur on the division that are federally listed as endangered or threatened, or are proposed for Federal listing.



Bill Buchanan

Raccoon

The division provides habitat for a wide diversity of vertebrate and invertebrate fauna. Some notable species that inhabit the refuge are black bear, moose, marten, snowshoe hare, Eastern wild turkey, ruffed grouse, spruce grouse, coyote, red squirrel, fisher, bobcat, porcupine, raptors, amphibians and reptiles, many migratory and resident song birds, and fish including Eastern brook trout and Atlantic salmon. Specifically, the division provides nesting and migratory habitat for numerous forest-dependent migratory bird species, waterfowl, and raptors. In addition, the Basin contains the largest deer wintering area in the state, about 10,000 acres, the majority of which is located on the Division. White-tailed deer are at the northern end of their range on the Division and are limited by harsh winter conditions. Deer survival depends on adequate shelter and food. Deer wintering areas provide critical winter cover for deer; a core area of softwoods with high crown closure and patches of mixed hardwood or softwood providing accessible browse within or near the core of the area. Our management of spruce-fir habitat will provide a diverse canopy structure which will ensure adequate snow interception and regenerating intolerant hardwoods (e.g. white birch and red maple) associated with spruce-fir landscapes will provide important winter browse. The division was also designated part of the State's largest IBA by the Vermont chapter of The Audubon Society in 2001.

The following biological studies and inventories have occurred on the Nulhegan Basin Division:

- A 2000 to 2001 inventory of fish, macroinvertebrates, marsh birds, waterfowl broods (resurveyed in 2008), and small mammals.
- A 2000 to 2005 survey of owls.
- A 2000 to 2005 survey of breeding amphibians and vernal pools.
- A 2000 to 2006 breeding landbird survey. From 2003 and 2012, additional landbird data was collected at a Monitoring Avian Productivity and Survivorship (MAPS) banding station. Also, Canada warblers were monitored as part of a larger study effort, to obtain and model habitat-specific estimates of productivity, survivorship, dispersal, and site fidelity for northeast Vermont.

- A 2001 inventory and mapping of natural communities and rare plants. The mapping was updated in 2012 to include new refuge land acquisitions.
- A 2007 habitat inventory, including information on species composition, forest stand structure, fuel load, size class, height class, and amount of crown closure.
- A 2012 bat acoustic survey.
- From 2009 to the present, surveys of refuge aquatic habitats, including assessing fish passage and in-stream features.
- A 2012 snow tracking survey for Canada lynx distribution at the division and surrounding lands. A remote camera station was set-up in 2013 in an area that was being heavily used by lynx.
- A recent inventory for invasive species.

There are also several ongoing surveys on the refuge:

- American woodcock surveys, including spring singing ground surveys and summer roosting surveys.
- Spruce grouse breeding surveys in partnership with the State.

Results of these studies and inventories can be obtained from refuge headquarters.

Socioeconomics
Vermont's Essex County, in which the division is located, had an estimated 6,306 residents in 2010 according to USCB data. This represents one percent of Vermont's population occupying seven percent of the state's land area. Of all the counties in the Connecticut River watershed, Essex County has the lowest population density. The Connecticut River watershed of Vermont and New Hampshire experienced low population growth in the recent past compared to the remainder of those states.

In Essex County, Vermont, four towns contain division lands. These towns are Bloomfield, Brunswick, Ferdinand, and Lewis. Based on 2010 USCB, the total population of the towns that contain refuge lands in Essex County is 365 residents (221 in Bloomfield, 112 in Brunswick, 32 in Ferdinand, and 0 in Lewis) (USCB Factfinder 2013). Lewis and Ferdinand are unincorporated towns; a Board of Governors acts as the government for these towns. Bloomfield and Brunswick have Boards of Selectmen that serve as the governing bodies.

For Essex County, employment is reported as follows: manufacturing 15.4 percent (450 jobs), retail trade 14.1 percent (413 jobs), services 5 percent, construction 8.7 percent (256 jobs) transportation and utilities 5.3 percent (154 jobs) agriculture, forestry and fishing 5.2 percent (151 jobs), finance, insurance and real estate 4.0 percent (116 jobs), education, health, social services 24.7 percent (725 jobs), professional, scientific, management, administrative, waste management 4.9 percent (145 jobs), and information 0.9 percent (25 jobs). A total of 61.4 percent of the county's population (16 years and over) are employed. The median household income for Essex County according to 2010 U.S. Census is $37,679. Essex County has the lowest per capita personal income of the Connecticut River watershed counties and in the state, a result of the low number of wage-earners relative to the total county population. The 2010 unemployment in Essex County in 2010 was 5.7 percent.

Nulhegan Basin Division

USFWS

Refuge Public Use
The division is a popular area for hunting, fishing, wildlife observation, snowmobiling, and wildlife photography. These uses were allowed under the previous ownership. Much of the hunting on the division, particularly deer hunting, is based out of leased cabins located within the refuge boundary. Day use is frequent on a year-round basis, particularly for hunting, fishing, dog-training, wildlife observation, and photography. Major wildlife species of interest to the public for observation or harvest include white-tailed deer, black bear, moose, snowshoe hare, ruffed grouse, neotropical songbirds, furbearers, and Eastern brook trout. The division's "boreal" bird species, including spruce grouse, black-backed woodpecker, gray jay, and boreal chickadee are an important attraction for serious birdwatchers.

Snowmobiling on designated trails is currently allowed on the division to facilitate winter access in support of priority public use activities. Snowmobiling is confined to designated State trails, which are generally open the third week of December to about mid-April every year.

To prevent excessive damage to the division's 40-mile road network, public travel by motor vehicle is prohibited during the spring mud season. During this period, which generally is from snow breakup to late May, roads on the division (and adjacent West Mountain Wildlife Management Area (WMA) and Plum Creek Timber lands) are closed to vehicular access. After mud season, people may drive on the designated refuge road network.

Cultural Resources and Historic Preservation
The Nulhegan Basin Division was included in a 2001 cultural resource study assessment and management plan of 48,000 acres of the former Champion International forestlands in the Northeast Kingdom of Vermont (Scharoun et al. 2001). The study was conducted by the University of Maine-Farmington for the Vermont Land Trust and included 26,000 acres of Federal land (the Nulhegan

Basin Division). The study identified no known Native American archaeological sites within the division. However, eight Native American sites are known within a 4-mile radius of the division, providing evidence of settlement that occurred during the pre-Contact period. Regarding historical sites, the study considered sites that were identified in the field during the study, sites referenced on historical maps and/or the archival record, and sites that were referred to anecdotally. Five historical resources, consisting of the remnants of log dams, were confirmed on division lands. The 2001 study also included a preliminary architectural assessment of all standing structures within the former Champion Paper Company forestlands, which included 59 former lumber camps and/or recreational camps dating to the late 19th century through the late 20th century.

The 2011 cultural resources overview for the refuge evaluated the archaeological sensitivity of the Nulhegan Basin Division (Waller and Cherau 2011). The study referred to the previous cultural resource study assessment and management plan (Scharoun et al. 2001) and assessed the likelihood for additional unrecorded Native American and Euro-American archaeological sites. Sensitivity for Native American sites is variable. Sensitivity for post-contact Euro-American sites also varies, according to local topography and landscape features.

Individual Refuge Units

Dead Man's Swamp Unit, Connecticut (31 acres)

Natural Resources
This 31-acre unit consists of a freshwater wetland and sand spit adjacent to the Connecticut River (table 3.19, see appendix A for map). It is 45 miles upriver from the Long Island Sound, and therefore, not directly influenced by tides. River bulrush, tuckahoe or arrow arum, cattail, and water horsetail dominate the wetland. The water depth is mostly over one meter, and it has a quaking surface that cannot be negotiated on foot. Freshwater wading birds and secretive marsh birds use the swamp. The riverine sand spit along the Connecticut River main stem supports the federally listed Puritan tiger puritan beetle (CTDEEP 1999). The refuge has worked in partnership with CTDEEP to monitor Puritan tiger beetles and create suitable larval habitat by removing plants that are encroaching onto the spit.

Table 3.19. Percentage of Dead Man's Swamp Unit by Habitat Type.

General Habitat Type	Percent of Unit
Hardwood forest	27%
Hardwood swamp	50%
Freshwater marsh	7%
Open water	17%

** Based on a GIS analysis; actual percentages may vary slightly*

Public Use
The Dead Man's Swamp Unit is closed to public access to protect habitat for the federally threatened Puritan tiger beetle.

Cultural Resources and Historic Preservation
There are no recorded archaeological sites within the existing Dead Man's Swamp Unit and within the unit's current, approved acquisition boundary. However, the Connecticut site files indicate that several Native American sites are known within a 1-mile radius of the unit, offering evidence of settlement during the Middle Archaic period (7,500 to 5,000 years before present) and Early Woodland period (3,000 to 2,000 years before present). No historical archaeological sites have been identified within the unit to date, and there are no historic structures.

The 2011 cultural resources overview for the refuge evaluated the archaeological sensitivity of the Dead Man's Swamp Unit (Waller and Cherau 2011). The study assessed the likelihood for additional unrecorded Native American and Euro-American archaeological sites. Sensitivity for Native American sites ranges from high to low depending on the location within the unit (with the eastern portion having higher sensitivity). Sensitivity for post-contact Euro-American sites is considered low throughout the unit.

Roger Tory Peterson Unit, Connecticut (56 acres)

Natural Resources

This unit, located in Old Lyme, Connecticut, was once part of the estate of the famous author and naturalist, Roger Tory Peterson (see appendix A for map). The property extends from Route 156 to the Lieutenant River. The predominant habitat is hardwood forest, with fluvial wetlands along the river (table 3.20). This unit is an important component of migratory bird stopover habitat because the forest is intact and it is in close proximity to the Connecticut River flyway corridor.

Table 3.20. Percentage of Roger Tory Peterson Unit by Habitat Type.

General Habitat Type	Percent of Unit
Hardwood forest	89%
Salt marsh	4%
Developed	7%

** Based on a GIS analysis; actual percentages may vary slightly*

In 2012, an inventory for invasive plant species was conducted on this unit similar to other parcels within the refuge. Several invasive plants were identified, including common reed, multiflora rose, burning bush, and Japanese barberry. Although Japanese stiltgrass was not discovered within the boundaries of the unit, it's likely that new populations will arise given a known population's proximity to the parcel. In the southeast section of the parcel, common reed (commonly known as *Phragmites*), has severely invaded the brackish marsh outcompeting native *Juncus spp.* and *Spartina spp.* The eastern uplands of the unit are less invaded.

Public Use

The Roger Tory Peterson Unit was acquired 2012 and does not have any existing public use facilities, such as designated trails or interpretive kiosks and panels. This unit is not currently open to public use, including hunting. The unit also does not have any suitable areas for fishing.

Cultural Resources and Historic Preservation

The Roger Tory Peterson Unit was not covered by the cultural resources overview that was completed for the refuge in 2011 (Waller and Cherau 2011) and no background research concerning known cultural resources has been conducted. The unit is located in Old Lyme and contains multiple historic landscape features (stone fences, historic road traces), as well as a small house (York House) that served as Roger Tory Peterson's office and an adjacent small garage. Peterson was a renowned naturalist, ornithologist, artist, and educator, best known for his series of successful nature field guides (Houghton Mifflin 2009). In 1934, his first book, "A Field Guide to the Birds," was published. The book's clear and simple bird identification system helped introduce many people to bird watching and nature observation (Roger Tory Peterson Institute 2008). By the time of his death in 1996, he had authored and illustrated dozens of books on birds, other wildlife, and plants and had received numerous awards for his

work as a naturalist and conservationist, including the Presidential Medal of Freedom (Houghton Mifflin 2009).

Honeypot Road Wetlands Unit, Massachusetts (21 acres)

Natural Resources

Honey Pot Road Wetlands near Westfield, Massachusetts, is one of the original SFAs identified in the 1995 Conte Refuge FEIS (USFWS 1995); identified for three rare vertebrates and two rare invertebrates. The SFA identified 960 acres needing protection consisting of a complex of vernal pools and scrub/shrub wetlands along with associated forests and fields (table 3.21). In 1999, the Service purchased a 20-acre upland and wetland parcel adjacent to a unit of the Honey Pot WMA. Wetlands in the vicinity host some of the world's few known populations of the American clam shrimp recorded in Massachusetts, Florida, South Carolina, Georgia, and Europe (MassWildlife, NHESP 2008, see appendix A for map).

Table 3.21. Percentage of Honeypot Road Wetlands Unit by Habitat Type.

General Habitat Type	Percent of Unit
Hardwood forest	71%
Hardwood swamp	24%
Pasture/hay/grassland	5%

** Based on a GIS analysis; actual percentages may vary slightly*

Public Use

Honeypot Road Wetlands Unit is open to wildlife observation and photography, environmental education, and interpretation. Hunting under State regulations will be considered in this CCP as the unit lies adjacent to the state-owned, 137-acre Honey Pot Natural Heritage Area and across Honey Pot Road from the 227-acre Westfield WMA. Both these state areas are managed by the Massachusetts Division of Fisheries and Wildlife and are open to hunting, fishing, and passive recreation such as wildlife observation, photography, and hiking.

Cultural Resources and Historic Preservation

There are no recorded archaeological sites within the existing Honeypot Road Wetlands or within the unit's current, approved acquisition boundary. However, the Massachusetts State site files indicate that one Native American site is known within a 1-mile radius of the unit.

The 2011 cultural resources overview for the refuge evaluated the archaeological sensitivity of the Honeypot Road Wetlands Unit (Waller and Cherau 2011). The study assessed the likelihood for additional unrecorded Native American and Euro-American archaeological sites. Sensitivity for Native American sites is considered moderate throughout the unit, while sensitivity for post-contact Euro-American sites is low.

Mount Toby Unit, Massachusetts (30 acres)

Natural Resources

Similar to Mount Tom, Mount Toby is a high (1,269-foot), traprock, heavily forested ridge containing small wetland areas including fens, seeps, and wooded swamps (table 3.22, see appendix A for map). Mount Toby Unit is one of the original SFAs identified in the 1995 Conte Refuge FEIS (USFWS 1995) known for its value to breeding and migrating neotropical and resident birds and a rare assemblage of plants and animals. In 2003, the refuge acquired 30 acres near the base of Mount Toby off Gunn Road in Sunderland, Massachusetts, helping to protect this traprock habitat along with the Massachusetts DCR which owns and manages portions of Mount Toby as part of the Connecticut River Greenways State Park (MDCR n.d.). The nearby 755-acre Mount Toby Demonstration Forest

is owned by the University of Massachusetts and managed by the Massachusetts DCR Recreation (Caputo and D'Amato 2006).

Table 3.22. Percentage of Mount Toby Unit by Habitat Type.

General Habitat Type	Percent of Unit
Hardwood forest	97%
Pasture/hay/grassland	3%

** Based on a GIS analysis; actual percentages may vary slightly*

Public Use
The Mount Toby Unit is part of a partnership conservation effort with the University of Massachusetts, Massachusetts DCR, TNC, and The Trustees of Reservations. The Mount Toby Unit is open to wildlife observation and photography, environmental education, and interpretation. There are no fishing opportunities and the unit is not currently open to hunting.

Cultural Resources and Historic Preservation
There are no recorded archaeological sites within the existing Mount Toby Unit or within the unit's current, approved acquisition boundary. However, the Massachusetts State site files indicate that several Native American sites are known within a 1-mile radius of the unit.

The 2011 cultural resources overview for the refuge evaluated the archaeological sensitivity of the Mount Toby Unit (Waller and Cherau 2011). The study assessed the likelihood for additional unrecorded Native American and Euro-American archaeological sites. Sensitivity for Native American sites is considered high in areas where exposed bedrock outcrops may have been used for rockshelters, and is moderate elsewhere. Sensitivity for post-contact Euro-American sites is considered low throughout the unit.

Mount Tom Unit, Massachusetts (141 acres)

Natural Resources
Mount Tom is a 1,800-acre area adjacent to the Connecticut River near Easthampton, Massachusetts, and was identified as an SFA in the original 1995 Conte Refuge FEIS (USFWS 1995, see appendix A for map). Mount Tom is part of the Metacomet Range, formed over 200 million years ago due to volcanic activity and subsequent geologic and erosive pressures (Stinton et al. 2007). The predominantly basalt or traprock mount offers unique habitat for State-listed rare and endangered species, and is recognized as one of the premier fall hawk watch locations in the eastern U.S. (Ortiz et al. 2003).

Gary Kramer/USFWS

Bobcat

In 2002, the Service acquired 141 acres on Mount Tom in Holyoke, Massachusetts, part of a coordinated conservation purchase with the Massachusetts DRC (who purchased adjacent land to the north and owns a majority of the remainder of the mountain), The Trustees of

Reservations (who bought the adjacent Little Mount Tom), and the Holyoke Boys and Girls Club (who bought the former ski lodge buildings at the base of the mountain). The portion owned by the Service holds former ski slopes, forests, streams, and vernal pools (table 3.23). Mount Tom provides habitat for 13 State-listed plants, several State-listed reptiles, and amphibians, and is used heavily by raptors and other birds during migration.

Table 3.23. Percentage of Mount Tom Unit by Habitat Type.

General Habitat Type	Percent of Unit
Hardwood forest	86%
Pasture/hay/grassland	11%
Open water	3%

** Based on a GIS analysis; actual percentages may vary slightly*

A concerted effort to control invasive plants, especially pale swallowwort, was undertaken by the refuge and abutting partnering landowners for several years. Unfortunately, control of the swallowwort was not successful on Service land. More recently, control efforts have focused on a collaborative effort with the Massachusetts Natural Heritage Program to control pale swallowwort where it threatens State-listed plants and other priority habitat. Other invasive species present include spotted knapweed, Oriental bittersweet, multiflora rose, purple loosestrife, and exotic bush honeysuckles, among others. We have conducted some control of all of these species over the years.

Studies on this unit include natural community mapping, plant and invertebrate inventories, an initial breeding bird inventory, vernal pool and wetland delineations, and amphibian and reptile habitat use and home range studies.

Public Use

The Mount Tom Unit is not currently open to visitors because the partnership did not want to encourage public use with the nearby rock quarry (active until 2012) and the threat of vandalism to the former ski lodge facilities owned by the Holyoke Boys and Girls Club. There are no developed trails on the unit, however, the Metacomet-Monadnock Trail runs along the ridge at the top of the mountain. This trail is a 114-mile long hiking trail that runs from central Massachusetts to Mount Monadnock in southern New Hampshire. Hunting is not allowed on the unit and there are no fishing opportunities. There is also a right-of-way easement for access through the unit to the cellphone, radio, and television towers on Mount Tom. The intention of the partners is to open the property for compatible public uses, with an emphasis on environmental education and interpretation, particularly for adjacent cities such as Holyoke, once it is safe to do so.

Cultural Resources and Historic Preservation

There are no recorded archaeological sites within the existing Mount Tom Unit or within the unit's current, approved acquisition boundary. However, the Massachusetts State site files indicate that several Native American sites are known within a 1-mile radius of the unit, although these are on the valley floor and not the mountaintop area. Several Native American sites have been recorded in the mountaintop zone, but these are approximately 2 miles north of the Mount Tom Unit itself. Historical archaeological resources located on Mount Tom more than 1 mile from the Mount Tom Unit provide evidence of quarries, sawmills, inns from the 18th and 19th centuries, and 20th-century Civilian Conservation

Corps (CCC) activities. In 1946, a World War II B-17 aircraft crashed into Mount Tom in what is now the southwest corner of the unit. The crash site is commemorated by a granite monument erected in 1996 by the town of Holyoke, before the property was acquired by Service. A makeshift shrine contains debris from the crash site collected over the years by visitors. This vicinity also contains a bronze plaque in memory of a local Vietnam veteran who died in 1995.

The 2011 cultural resources overview for the refuge evaluated the archaeological sensitivity of the Mount Tom Unit (Waller and Cherau 2011). The study assessed the likelihood for additional unrecorded Native American and Euro-American archaeological sites. Sensitivity for Native American sites is considered high in areas where exposed bedrock outcrops may have been used for rockshelters, and is moderate elsewhere. Sensitivity for post-contact Euro-American sites is considered low throughout the unit.

Third Island Unit, Massachusetts (4 acres)

Natural Resources

Third Island is a 4-acre island in the Connecticut River in Deerfield, Massachusetts. The island, 4.3 miles upriver from the Sunderland Bridge at Route 116, is contained within one of the original SFAs (#29A) known as the "Connecticut River Main stem–Turners Falls Dam to Highway 116 at Sunderland Bridge" (see appendix A for map). The refuge was established when this island was donated to the Service from the Connecticut River Watershed Council in 1997. It is upriver from First Island and Second Island, which are owned and managed by the Massachusetts Division of Fisheries and Wildlife. The island is mostly hardwood forest, with some shallow water habitats (table 3.24). The island is used as a nesting site by bald eagles, and, as such, is off-limits during the first half of the year until young eagles have fledged. Along with the other two islands, Third Island provides valuable shallow water habitats for spawning Atlantic sturgeon and both American shad and blueback herring (USFWS 1995). Mussels are common on the river bottom near Third Island. Invasive plants including Japanese knotweed, Oriental bittersweet, and purple loosestrife are well established and some management has taken place. The bittersweet is of particular concern to the health of the trees supporting the eagle nest.

Table 3.24. Percentage of Third Island Unit by Habitat Type.

General Habitat Type	Percent of Unit
Hardwood forest	50%
Open water	50%

** Based on a GIS analysis; actual percentages may vary slightly*

Public Use

The Third Island Unit is closed each year to public use during the bald eagle nesting season (January 1 through July 31). From August 1 to December 31 the refuge is open to wildlife observation and photography, environmental education, and interpretation. Because of the unit's location in the Connecticut River, it is also a popular stop for canoeists and kayakers. It is not currently open to fishing or hunting.

Cultural Resources and Historic Preservation

There are no recorded archaeological sites within the existing Third Island Unit or within the unit's current, approved acquisition boundary. However, the Massachusetts State site files indicate that three Native American sites are known within a 1-mile radius of the unit, providing evidence of settlement that

occurred during the Late Archaic period (5,000 to 3,000 years before present) and the greater Woodland period (3,000 to 450 years before present).

The 2011 cultural resources overview for the refuge evaluated the archaeological sensitivity of the Third Island Unit (Waller and Cherau 2011). The study assessed the likelihood for additional unrecorded Native American and Euro-American archaeological sites. Sensitivity for Native American sites is considered moderate in the Third Island Unit elsewhere, while sensitivity for post-contact Euro-American sites is considered low.

Wissatinnewag Unit, Massachusetts (21 acres)

Natural Resources

The 21-acre Wissatinnewag Unit was acquired by the Service in 2001. It, like Third Island above, is contained within SFA 29a "Connecticut River Main stem–Turners Falls Dam to Highway 116 at Sunderland Bridge" (see appendix A for map). The site lies opposite the Great Falls Discovery Center on the upper slope above the Connecticut River in Greenfield, Massachusetts.

The predominant habitat is hardwood forest on a steep, southeast facing slope (table 3.25). The forest serves as important migratory bird stopover habitat during the spring, and supports a variety of nesting songbirds. No biological inventories have been initiated on this unit.

Table 3.25. Percentage of Wissatinnewag Unit by Habitat Type.

General Habitat Type	Percentage of Unit
Hardwood forest	50%
Woodlands (natural)	14%
Developed	6%

** Based on a GIS analysis; actual percentages may vary slightly*

Public Use

The Wissatinnewag Unit is closed to the public to protect sensitive archaeological resources.

Cultural Resources and Historic Preservation

The 2011 cultural resources overview for the refuge compiled information about known archaeological resources within the Wissatinnewag Unit and evaluated its archaeological sensitivity (Waller and Cherau 2011). The unit is within a locality that witnessed Native American settlement over a span of thousands of years. The State site files indicate that at least 30 Native American archaeological sites have been recorded within 1 mile of the unit. More than half of these are contained within the Riverside Archaeological District, which is listed on the NRHP. Nearly all of this unit and its corresponding approved acquisition boundary are within this Archaeological District.

The Wissatinnewag Unit contains portions of the extensive, complex Mackin Sand Bank Site, which has produced burials and evidence of Native American settlement starting at least by the Middle Archaic period (7,500 to 5,000 years before present), more than 7,000 years ago. The site has been damaged by looters, and has also been investigated by professional archaeologists. It is the subject of great interest and concern for the Narragansett Indian Tribe. It is very likely that additional, significant resources await discovery in undisturbed portions of the unit. The sensitivity for post-contact Euro-American sites is considered moderate.

Putney Mountain Unit, Vermont (285 acres)

Natural Resources

The refuge acquired 285 acres at Putney Mountain in 1999 (see appendix A for map). This unit was acquired to protect a population of Northeastern bulrush, a federally endangered species. The population of bulrush is periodically visited by refuge staff and State of Vermont botanists. The population was sampled as part of a large-scale genetics study by researchers at Wilmington College and Wright State University. Their results have not been published yet.

Putney Mountain Unit is a forested mountain summit in Windham County, Vermont, with a height of 1,657 feet (table 3.26). It lies about 20 miles north of the Massachusetts border and 5 miles west of the Connecticut River. The Putney Mountain Hawkwatch is the most important survey point for monitoring migrating hawks in Vermont and also one of the most important along the east coast of the United States (*http://www.putneyvt.org/hawks/index.php*; accessed December 2014).

Table 3.26. Percentage of Putney Mountain Unit by Habitat Type.

General Habitat Type	Percentage of Unit
Hardwood forest	99%
Developed	1%

** Based on a GIS analysis; actual percentages may vary slightly*

In 2012, sections of the Putney Mountain Unit were inventoried for invasive plant species in a similar manner as the 2011 pilot inventory project. A variety of invasive species were identified, although glossy buckthorn was the most prominent. Glossy buckthorn is widespread along forest edges along roads adjacent to the parcel and is highly threatening forest interior and the wetlands in the eastern and northern parts of the parcel. Some plants are relatively small and may be easier to control. Other invasive plant species include Japanese barberry, multiflora rose, and reed canary grass.

Public Use

The Putney Mountain Unit is open to wildlife observation and photography, environmental education, and interpretation. It is also open to hunting under State regulations, with the following stipulations: retrieving, flusing, pointing, and pursuit dogs must be under voice command at all times and nighttime raccoon hunting with dogs requires a special use permit (78 FR 58771). The unit does not have any suitable fishing sites.

Cultural Resources and Historic Preservation

There are no recorded archaeological sites within the existing Putney Mountain Unit or within the unit's current, approved acquisition boundary. However, numerous large Native American settlement areas are known to have existed in the nearby lowlands adjacent to the Connecticut River. The 2011 cultural resources overview for the refuge evaluated the archaeological sensitivity of the Putney Mountain Unit (Waller and Cherau 2011). The study assessed the likelihood for additional unrecorded Native American and Euro-American archaeological sites. Sensitivity for Native American sites is variable. It is considered generally high on level natural terraces, hilltops, wetland margins, and areas adjacent to watercourses, while sensitivity is considered low in poorly drained or steeply sloping areas. Sensitivity for post-contact Euro-American sites also varies. It is considered high in locations of documented historic land use, moderate in proximity to historic road corridors, moderate near historic roads, and low elsewhere.