Chapter 3

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Shrubland habitat on a University of New Hampshire property

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Introduction

Chapter 3 describes the physical, biological, and socio-economic resources that could be impacted by the alternatives described in chapter 2. In the first section of the chapter, we describe the resources that pertain to the entire AOI. Despite being spread across six states, the AOI has many features that are common across the landscape. For the second section, we group RAFAs into smaller sub-regions and describe particular resources for those smaller sub-regions and how those resources differ from the other sub-regions.

Resources of the Area of Interest

Cultural Resources and Historic Preservation

Coastal New England

Prior to European arrival, coastal southern New England likely supported a "shifting mosaic" of open land habitat within a mostly forested landscape. The open lands were a result of native heathlands, grasslands and shrublands, extensive beaver meadows, periodic fires, shifting agriculture by Native Americans, and occasional hurricanes (Cronin 1983, DeGraaf and Yamasaki 2001). DeGraaf and Yamasaki (2001) and Askins (2000) reported broad evidence for the presence of extensive grasslands along the coast and major rivers in pre-European New England.

Native Americans in southern New England depended on fishing and shellfishing for much of their food. They also hunted birds and trapped and hunted small game. When colonists landed on Massachusetts shores in the early 1600s, they saw large clearings and open woodlands. Waterfowl, deer, ruffed grouse, wild turkey, and wild pigeons were abundant (Marchand 1987, Foss 1992, DeGraaf and Yamasaki 2001). Colonists found old growth forests not far inland, including old stands of mixed hardwoods, white pine, and hemlock at low elevations, and spruce and fir in the mountains (Marchand 1987).

European contact (e.g., explorers and traders) with native people began during the 16th century in New England. Foster and Motzkin (2003) suggested that European arrival prompted such rapid and profound changes to the lifestyle and land use practices of indigenous people that by the time colonists began to settle here, the landscape was already altered.

European colonists brought new land use concepts such as permanent settlements and political boundaries. They shifted land use from primarily subsistence farming and gathering to harvesting and export of natural resources (Foss 1992). Just 100 years after the colonists arrived, the forests were rapidly being logged. By 1830, central New England was 80 percent cleared (Marchand 1987).

However, shortly after this, many people began leaving the rough, rocky New England landscape for other opportunities. The abandonment was due to a variety of factors, including the California Gold Rush, the Industrial Revolution, new railroads, richer midwestern soils, and the Civil War. Abandoned farm fields began reverting back to forest. White pine seeded into the fields and pastures and by 1900 was ready for harvest. An understory of hardwoods, released from the shade of white pine, emerged as the new dominant vegetation. This is a legacy that remains today (Marchand 1987, DeGraaf and Yamasaki 2001).

Housatonic River Basin

The Housatonic River Basin is located primarily in western Massachusetts and western Connecticut. However the western headwaters of the basin lie within a small portion of easternmost New York State, where the majority of our Northern Housatonic RAFA is located. The Ten Mile River, Green River, and Williams River are the primary Housatonic tributaries that make up the New York portion of the basin. While the entire Housatonic Basin covers about 1,950 square miles before emptying into Long Island Sound, within New York State

the Housatonic tributaries drain only about 219 square miles in the Taconic and southern Berkshire Mountains. The basin includes small portions of Dutchess and Columbia counties. The following summary about the river's cultural and historic resources comes directly from the U.S. National Park Service's 2002 Upper Housatonic Valley National Heritage Area: Feasibility Study and Environmental Assessment:

The upper Housatonic River and its tributaries have played a prominent role in the growth and development of the valley land around them. The earliest settlers, the Native Americans, arrived in the area some 10,000 years ago. They settled along the river's banks, farmed the river's nutrient-rich floodplains, and fished the river. The Mohicans were the local tribe when the English arrived in the 1720s and 1730s. The English settlers made agriculture the major activity throughout the valley for much of the next century. It is still evident today in the wide, fertile floodplain of southwestern Massachusetts and northwestern Connecticut.

Bill Thompson

Monarch butterfly

During the 18th and 19th centuries, waterpower played an important role in the development of industry throughout the valley. Remnants of dams and mill races can still be seen. In the northwest hills of Connecticut, high quality iron ore was abundant. The ore was smelted with limestone in blast furnaces, molded into finished iron utensils, tools, and armaments, and then cooled with river water. Many forests were cleared to make the charcoal used as fuel in the furnaces. The iron industry began in Salisbury in 1734, and more than 40 blast furnaces were in operation from Lanesboro, Massachusetts, to Kent, Connecticut, during the 1800s. The last furnaces ceased operation in 1923. The 1800s also witnessed extensive quarrying of marble and limestone in the "Marble Valley" of northwest Connecticut. Sheffield quarries provided marble for the Washington Monument, New York City Hall, and the Boston Custom House. The Pittsfield region was the first area in the nation to make paper for markets other than its own. By the end of the Civil War there were at least 28 paper mills in Berkshire County alone. By 1850, most towns had small factories along the upper Housatonic's banks, using the river as both a source of water for their manufacturing or milling processes and a dumping ground for their waste products. While these industries provided economic stimulus to the region they also dumped tons of pollutants into the Housatonic River. The Federal Water Pollution Control Act Amendments (1972) and the Clean Water Act (1977) established a system for controlling river pollutants by mandating removal of chemicals from wastewater discharges.

Physical Environment

Geomorphology

The physical landscape of the AOI is the result of several concurrent and successional events: the combination of complex bedrock and surficial geology and recent glacial history; historical mountain-building and regional land uplifting forces; and the dynamic processes of erosion, sedimentation, and chemical and physical weathering acting differentially on rock types of various hardnesses. Such extraordinary physiographic diversity and geological complexity, along with climate and historical events, have contributed directly to the region's remarkable biological diversity and the current distribution patterns of its fauna and flora. One of the most interesting and significant factors to shape the modern landscape of much of North America has been the work of glaciers and the continental ice sheet during the most recent glacial period, the Pleistocene Epoch.

During the height of glaciation, portions of the region were covered by an ice sheet up to 1.6 kilometers (1.0 mile) thick, though its thickness was considerably less along its margins and eastern portions. Over the entire glaciated area, a layer of unsorted and unconsolidated glacial debris, glacial till, ranging from clay particles to huge boulders, was directly deposited on the landscape by the advancing glacier. Following the retreat of the ice sheet, the post-Pleistocene

landscape, with its rock-strewn surface and polished bedrock surfaces, was devoid of higher plants and animals, leaving a clean slate for the migration and colonization of modern plant and animal communities in the region.

The weight of the Wisconsin ice sheet caused the crust of the continent to sag, depressing the land. During the maximum period and extent of glaciation during the Wisconsin stage, much of the surface water was locked up as frozen ice in the ice sheet and sea level was some 107 to 122 meters (350 to 400 feet) lower than at present, exposing hundreds of miles of the continental shelf. With the warming of the climate and the retreat of the ice sheet, the depressed land rebounded and sea level rose to its present level and continues to rise.

The New England Province is essentially a northward extension of the larger Appalachian Mountains or Highlands region. It is a plateau-like upland that rises gradually inland from the coast and is surmounted by mountain ranges or individual peaks. The topography of the New England Uplands section is that of a maturely dissected plateau with narrow valleys, and the entire area is greatly modified by glaciation. It is the most widespread of the geomorphic sections in the New England Province, extending from Canada through New England down to the Seaboard section and extending southwestward through New York and New Jersey as two narrow upland projections. Glaciation has resulted in the erosion and rounding off of the bedrock topography and numerous rock basin lakes. Glacial drift is thin, patchy, and stony, and ice-contact features such as kames, kame terraces, and eskers are abundant. The surface of the New England uplands slopes southeast from maximum inland altitudes around 670 meters (2,200 feet), excluding the other mountainous sections of the province, to about 122 to 152 meters (400 to 500 feet) along its seaward edge at the narrow coastal seaboard section, which goes down to sea level.

Most of the region is underlain by igneous and metamorphic rocks that are 136 to over 570 million years old. This bedrock is typically seen in natural exposures along the coast, where glaciers and waves have exposed the underlying rocks.

Water Quality

Both point and nonpoint source pollution affect water quality. Point source pollution originates from a single discharge point; nonpoint pollution sources can originate from numerous sources in the watershed, typically as runoff from the land. Point source pollution includes sewer overflows, sewage pipes leading directly to the water, and industrial discharges from paper mills and other manufacturers. Nonpoint source pollution includes nutrients, bacteria, sediment, oil, and heavy metals that are transported to water bodies from different sources by runoff from storms. Nonpoint source pollution is more difficult to manage and control, and is exacerbated by development and increased impervious and polluted surfaces. Faster water carries more sediment and pollutants, and erodes topsoil. Sediments cover aquatic plants, block sunlight from reaching the bottom, and clog the filtering and respiratory organs of aquatic animals. Run-off from uplands carries excess nutrients that can destroy that fragile ecosystem and, eventually, deplete the oxygen in backwaters and coastal ponds. Increased run-off may also cause changes in plant communities along upland edges.

Soils

Heavily influenced by glacial history, the majority of the AOI's soil types are derived from glacial till and glaciofluvial deposits. Sandy loam is a dominant soil type. The sandy loam soils are distributed on hills, drumlins, terraces, and outwash plains. These soils are moderately well-drained to well-drained and contain varying percentages of rock and stone that create an assortment of "very stony," "gravelly," or "extremely stony" characterizations. Silt loams are another abundant soil type, followed by complexes of soil in which two soil types are intermixed or found in close proximity. The sandy and silt loams form the basis for many of the region's farmlands. Mucks, which are very poorly drained soils commonly associated with wetlands, are primarily derived from organic material. Shrublands tend to be ephemeral, occurring in areas that have been periodically

disturbed (fire, storms, or cutting). For those areas that are dominated by shrubs for longer periods of time, there is evidence that soil type has an influence. These areas tend to be on the extremes of being either very wet, organic peat or very sandy, well drained soils (Latham 2003).

Climate, including 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 climate's 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. There is a growing body of evidence, however, to support the theory that the recent historically unprecedented high levels of greenhouse gases being released through human activities (e.g., carbon dioxide, or CO_2, released from fossil fuel combustion and biomass decomposition via extensive global deforestation) greatly exacerbate 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 (Intergovernmental Panel on Climate Change, IPCC 2007, Mithen 2003, and USEPA 2013).

The climate of the AOI is characterized by warm, moist summers and cold, snowy winters. Annual temperatures have risen an average of 0.14 Fahrenheit degrees per decade since 1900, but have also risen by 0.5 Fahrenheit degrees per decade since 1970 (Union of Concerned Scientists, UCS 2006). Winters have been warming even faster, by 1.3 Fahrenheit degrees per decade since 1970. If we remain reliant on current sources of energy, annual temperatures are projected to increase a total of 6.5 to12.5 Fahrenheit degrees by 2100 (UCS 2006).

Because maritime air masses have year-round access to the eastern seaboard, precipitation is evenly distributed throughout the year. Average precipitation in the region is approximately 40 to 43 inches annually (Garabedian 1998). January is the coldest month of the year (mean temperature of 29 Fahrenheit degrees) and July the warmest month (mean temperature of 70 Fahrenheit degrees). This annual variation creates distinct seasons that affect or influence migratory use of the area's land and waterscapes by a variety of fish and wildlife. Precipitation is more uniform than temperature through the four seasons, with summer (June through August) slightly drier than the other three seasons. Overall, the region's weather is known for its frequent and dramatic changes, with temperatures capable of shifting 50 degrees in one week (Gibbs et al. 1995). Blizzards and hurricanes occasionally affect the area, as do tornadoes, ice storms, and flash floods.

Climate changes are expected to alter current precipitation patterns in the AOI (UCS 2006). Winter precipitation is projected to increase, with more falling as rain 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 (UCS 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 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).

Northeast Climate Impacts Assessment (NECIA) is a collaboration between UCS and a team of more than 50 independent experts to develop and communicate 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 or the Mid-Atlantic states with losses of Bicknell's thrush (*Catharus bicknelli*), snowshoe hare (*Lepus americanus*), and Canada lynx (*Lynx canadensis*). Northern hardwoods (e.g., 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).

Kelly Boland/USFWS

Young forest in Durham, New Hampshire

Analysis of breeding bird survey data over a 26-year period shows a significant 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). Eastern brook trout (*Salvelinus fontinalis*) habitat may shrink 50 to 100 percent by the next century. Hemlock woolly adelgid (*Adelges tsugae*) will steadily move north thereby removing hemlocks and reducing shade that moderates stream temperatures, among other impacts. 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 the same biome by 2100 (Inkley 2008, UCS 2006, Frumhoff et al. 2007).

Streamflow could be altered, as greater winter rainfall and earlier snow melt leads to earlier high flows and flooding during the spring (Inkley et al. 2004, UCS 2006). In contrast, summer low-flow periods may become more extended, therefore impacting riparian habitats and instream fish, wildlife, and invertebrates (Koch 2009). Aquatic and riparian life forms will need to adjust rapidly or experience population declines. Replacement of some species by more southerly species is predicted.

Air Quality

Local air quality can affect our daily lives, and like the weather, it changes from day to day. Polluted air also injures wildlife and vegetation, causes acidification of water, degrades habitats, accelerates weathering of buildings and other facilities, and impairs visibility (USEPA 2012, USFWS 2013). Ground-level ozone and

airborne particles are the 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 (NOx) and volatile organic compounds, components of smog. The southern portion of the AOI 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.

Socio-Economic Environment

This section presents an overview of the socio-economic characteristics of the AOI. In addition to providing a brief baseline summary of the area's socio-economic conditions, we discuss in this section and in chapter 4 how the presence of a national wildlife refuge may affect the social and economic vitality of the communities where we propose to conduct additional land acquisition.

For the purposes of reviewing the socio-economic information, we divided the AOI into the following three geographic regions: (1) Coastal New England; (2) Interior New Hampshire; and (3) Eastern New York. Within these three geographic areas, we gathered socio-economic information only on the 11 counties that are encompassed by the 10 RAFAs. Table 3 shows the relationship between the geographic regions and the affected counties. Because socio-economic data is generally collected and reported at the county level by such agencies as the U.S. Census Bureau and the Bureau of Labor Statistics, this draft LPP/EA will predominately use county profiles to characterize regions.

Table 3: Counties Associated with Geographic Regions and Refuge Acquisition Focus Areas

Geographic Regions	Refuge Acquisition Focus Areas	Counties
Coastal New England	Cape Elizabeth-Scarborough, ME	Cumberland County, ME
	Berwick-York, ME	York County, ME
	Rollinsford, NH	Strafford County, NH
	Oyster-Dover-Bellamy, NH	Strafford County, NH
	Plymouth, MA	Plymouth County, MA
	Mashpee, MA	Barnstable County, MA
	RI East-West	Washington County, RI
	Pachaug-Ledyard, CT	New London County, CT
Interior New Hampshire	Merrimack Valley North, NH	Rockingham County, NH Hillsborough County, NH
Eastern New York	Northern Housatonic	Dutchess County, NY
		Litchfield County, CT

Population

There are nearly 3 million people living in the 11 affected counties. This represents 8.7 percent of the total population of the six states (see Table 4). The Coastal New England region contains nearly 60 percent of the affected population, with Interior New Hampshire accounting for about 25 percent and Eastern New York over 15 percent. The exact breakdown of population by region is presented in Table 5.

Table 4: Populations of Affected Counties and States (2014)

	2014 Population
All Counties (11)	2,923,753
Six states (CT, ME, MA, NH, NY, RI)	33,800,387
Percent of Total	8.7%

Source: U.S. Census Bureau, Population Division.

Table 5: Population by Geographic Region (2014)

	2014 Population	Percent of Total
Coastal New England	1,736,376	59.4%
Interior NH	705,805	24.1%
Eastern NY	481,572	16.5%
Total	2,923,753	100.0%

Source: U.S. Census Bureau, Population Division.

Between the 2000 and 2010 U.S. Census, the population of the 11 affected counties has increased at a faster overall rate than their corresponding six states. Populations are predicted to continue to grow. Collectively, the population is predicted to increase by 3.3 percent between the years 2015 and 2025. Leading this growth is the Eastern New York region, which is expected to grow by 6.4 percent, followed by Interior New Hampshire (4.6 percent). The most populous region, Coastal New England, is predicted to grow by only 2 percent between 2015 and 2025. Table 6 shows these estimates.

Table 6: Population Projections

	Population	Population	Population	Percent Change
	2015	2020	2025	2015 - 2025
Coastal New England	1,749,293	1,767,547	1,784,259	2.0%
Interior NH	704,657	721,223	736,736	4.6%
Eastern NY	500,089	517,120	531,922	6.4%
Total	2,954,039	3,005,890	3,052,917	3.3%

Sources: Various State and County Agencies.

Employment

This section provides a general overview of the labor forces in each geographic region. The largest portion of jobs across all three geographic regions is in the fields of education, health care, and social services. Approximately one-quarter of all workers in the affected counties works in these fields. Other popular employment fields include retail trade, manufacturing, and professional services. In contrast, workers in the agriculture, forestry, fishing and hunting, and mining industries comprise the fewest number of workers in the region. Table 7 shows the most current estimated number of jobs by industry sector and Table 8 shows the percentage breakdown.

Table 7: Occupation by Industry, 2009 to 2013

	Coastal New England	Interior New Hampshire	Eastern New York	Total Number of Jobs
	Estimate	*Estimate*	*Estimate*	*Estimate*
Total:	860,111	373,421	241,617	1,475,149
Agriculture, forestry, fishing and hunting, and mining	6,689	2,018	2,494	11,201
Construction	56,894	24,945	17,400	99,239
Manufacturing	78,164	52,616	23,362	154,142
Wholesale trade	20,343	11,950	5,290	37,583
Retail trade	108,849	48,249	28,026	185,124
Transportation and warehousing, and utilities	34,227	16,469	9,732	60,428
Information	16,845	8,939	5,588	31,372
Finance and insurance, and real estate and rental and leasing	64,236	25,869	15,133	105,238
Professional, scientific, and management, and administrative and waste management services	87,409	43,412	25,124	155,945
Educational services, and health care and social assistance	218,923	82,088	69,282	370,293
Arts, entertainment, and recreation, and accommodation and food services	93,632	27,859	19,015	140,506
Other services, except public administration	36,483	15,919	10,227	62,629
Public administration	37,417	13,088	10,944	61,449

Source: U.S. Census Bureau 2009-2013 Five-Year American Community Survey

Table 8: Relative Occupation by Industry, 2009 to 2013

	Coastal New England	Interior New Hampshire	Eastern New York	Total
	Estimate	*Estimate*	*Estimate*	*Estimate*
Agriculture, forestry, fishing and hunting, and mining	0.8%	0.5%	1.0%	0.8%
Construction	6.6%	6.7%	7.2%	6.7%
Manufacturing	9.1%	14.1%	9.7%	10.4%
Wholesale trade	2.4%	3.2%	2.2%	2.5%
Retail trade	12.7%	12.9%	11.6%	12.5%
Transportation and warehousing, and utilities	4.0%	4.4%	4.0%	4.1%
Information	2.0%	2.4%	2.3%	2.1%
Finance and insurance, and real estate and rental and leasing	7.5%	6.9%	6.3%	7.1%
Professional, scientific, and management, and administrative and waste management services	10.2%	11.6%	10.4%	10.6%
Educational services, and health care and social assistance	25.5%	22.0%	28.7%	25.1%

Table 8: Relative Occupation by Industry, 2009 to 2013 (cont.)

	Coastal New England	Interior New Hampshire	Eastern New York	Total
Arts, entertainment, and recreation, and accommodation and food services	10.9%	7.5%	7.9%	9.5%
Other services, except public administration	4.2%	4.3%	4.2%	4.2%
Public administration	4.4%	3.5%	4.5%	4.2%

Table 9: Changes in Occupations by Industry: 2005 to 2013

	Coastal New England	Interior New Hampshire	Eastern New York	Total
Total:	-0.3%	0.3%	-0.3%	-0.2%
Agriculture, forestry, fishing and hunting, and mining	13.9%	-15.6%	-47.0%	-13.6%
Construction	-15.6%	-18.1%	-19.1%	-16.9%
Manufacturing	-6.1%	-8.4%	-16.9%	-8.7%
Wholesale trade	-29.2%	-22.9%	-26.1%	-26.9%
Retail trade	-3.4%	-5.4%	2.7%	-3.1%
Transportation and warehousing, and utilities	10.1%	7.5%	11.7%	9.6%
Information	-16.4%	-3.6%	-17.2%	-13.3%
Finance and insurance, and real estate and rental and leasing	-6.5%	6.7%	-6.2%	-3.5%
Professional, scientific, and management, and administrative and waste management services	7.4%	8.7%	7.4%	7.8%
Educational services, and health care and social assistance	10.7%	20.9%	14.6%	13.5%
Arts, entertainment, and recreation, and accommodation and food services	4.5%	4.2%	15.0%	5.8%
Other services, except public administration	-7.2%	-11.5%	9.0%	-6.1%
Public administration	0.9%	-7.5%	-9.9%	-3.0%

Source: U.S. Census Bureau, American Community Surveys 2005 and 2013, Table C24050

Construction

Since 2004, new housing permits have declined significantly for all three geographic regions. In 2004, Coastal New England counties reported nearly 8,300 new single family home construction permits, which hit a low of 2,430 in 2011 before rebounding to approximately 3,500 in 2013. A similar pattern is repeated for both Interior New Hampshire as well as Eastern New York. Overall, between the years 2004 and 2013, permits for Coastal New England counties declined by 135 percent, for Interior New Hampshire communities by 155 percent, and for Eastern New York communities by 260 percent.

Refuge Management Activities

Refuge management activities that may affect local economies include:

- Refuge purchases of goods and services within the local communities.
- Refuge personnel salary spending.

- Spending in the local communities by refuge visitors.
- Revenues generated from refuge economic management activities (such as timber harvesting or haying on the refuge).
- Refuge land purchases and changes in local tax revenue.

Additionally, it is important to note that the economic value of a refuge encompasses more than just the direct impacts to the regional economy. Refuges also provide substantial nonmarket values (i.e., values for items not exchanged in established markets) such as maintaining endangered species, preserving wetlands, educating future generations, and adding stability to the ecosystem (Caudill and Henderson 2003). The natural "services" provided by the conserved landscape can be extremely valuable to a community's well-being and to society in a more traditional economic sense. For instance, vegetated landscapes naturally filter and regulate water that drains into the public water supply. This natural process can minimize the economic burden on municipalities to treat water in accordance with national water quality standards. Such was the case with New York City, which in the 1990's notably invested between $1 billion and $1.5 billion in conserving and preserving landscapes in the Catskill watershed. This investment was calculated to produce cost savings of $6 billion to $8 billion over 10 years, when compared to the alternative of building and maintaining a new treatment facility (Chichilnisky and Heal 1998). A 2008 study done by Ingraham and Foster attempts to value the bundle of ecosystem services provided by the Refuge System in the contiguous United States. The authors determined the various habitats within the Refuge System were providing services valued at $32.3 billion (2011 dollars) per year, or an average of $2,900 per acre per year (Ingraham and Foster 2008). As the New York City example and this study indicate, these ecosystem service values can be substantial, and should be recognized when evaluating this proposal. However, quantifying individual ecosystem service values is beyond the scope of this EA.

Local economies benefit directly from public use activities offered on many refuges. At the request of state fish and wildlife agencies, the Service has been sponsoring the National Survey of Fishing, Hunting, and Wildlife-Associated Recreation every 5 years since 1955. It is viewed as one of the nation's most important wildlife-related recreation databases and the definitive source of information concerning participation and purchases associated with hunting, fishing, and other forms of wildlife-related recreation nationwide. The U.S. Census Bureau conducted the latest survey in 2011. The results of the survey show that residents and visitors spend significant amounts on wildlife-dependent recreational activities: More than 90 million U.S. residents (16 years old and older) participated in some form of wildlife-related recreation in 2011, up 3 percent from 5 years earlier (USFWS 2015b). These wildlife recreationists spent $144.7 billion in 2011 on their activities, which equated to 1 percent of the Gross Domestic Product. Of the total amount spent, $49.5 billion was trip-related, $70.4 billion was spent on equipment, and $24.8 billion was spent on other items such as licenses and land leasing and ownership.

Refuge Revenue Sharing

The Service makes revenue sharing payments to counties (or towns and cities) for the lands that we administer. When the Act of June 15, 1935 was passed (now commonly referred to as the Refuge Revenue Sharing Act, or 16 U.S.C. 715s), 25 percent of the net receipts collected from the sale of various products or privileges from refuge lands were paid to the counties in which they were located. However, if no revenue was generated from the refuge lands, the county received no payment. The Refuge Revenue Sharing (RRS) Act was amended in 1964 to provide a payment of either 25 percent of the net receipts, or three-quarters of 1 percent of the adjusted purchase price of refuge land, whichever was greater. The lands that were reserved from the public domain for national wildlife refuge

purposes continued to receive 25 percent of the net receipts. The revenue sharing payments during these early years could only be used for roads and schools, but all counties with refuge lands received a payment as a result of the 1964 amendments.

Beginning in 1976 the refuge receipts were not sufficient to make the county payments, and the payments were reduced accordingly. It was partly because of this that the RRS Act was again amended in 1978. The following changes were made as a result of the 1978 amendments:

1. Congress can appropriate funds to make up any shortfall in the revenue sharing fund.

2. All lands administered solely or primarily by the Service (not just the Refuge System) qualify for revenue sharing payments.

3. The payments to units of local government can be used for any governmental purpose.

The last year in which local units of government received 100 percent of the full amount that could be paid by law was 1981. Since 1991, the percentage of what would constitute full payments has declined each year. In 2014, the payments to localities represented approximately 24 percent of the full payment amount.

Biological Environment

Habitat Types

The following descriptions are general characteristics of the broad habitat types that exist within the area in the vicinity of the RAFAs. The habitat types are from Ecological Systems products developed by the University of Massachusetts (Designing Sustainable Landscapes project, *http://www.umass.edu/landeco/research/dsl/dsl.html*), based upon The Nature Conservancy's Northeastern Terrestrial Habitat Classification System. In this draft LPP/EA we focus primarily on shrubland and young forest habitats since that is the habitat type that will be most affected by our proposed actions. For a list of the scientific names of plants mentioned in this section and elsewhere in this draft LPP/EA, refer to the Glossary in the back of this document.

Woodchuck in shrubland, Rhode Island

USFWS

Grassland and Shrubland
Native grasslands dominated by little bluestem occur throughout the region in various sizes and configurations. The effects of tropical storms, salt spray, and coastal winds delay succession of some of these habitat types to shrubland, woodland, and forest. A few large grasslands located on airports and military bases in the region support grassland-dependent birds, such as upland sandpiper (*Bartramia longicauda*) and grasshopper sparrow (*Ammodramus savannarum)*, and serve as important habitats for grassland-dependent insects, including monarch butterflies and other pollinators.

Shrublands are dominated by low woody vegetation (generally less than 3 meters tall) with varying amounts of herbaceous vegetation and sparse tree cover, including regenerating forests and abandoned field sites. Tree cover is less than 25 percent. Early successional shrublands and forests may be either seasonally flooded or non-flooded.

Shrublands include abandoned field sites and power line corridors that would ultimately revert to forest, absent some human or natural disturbance (e.g., mowing or burning), and abandoned beaver flowages along forested stream courses, which typically succeed from wet meadow to drier herb/shrub habitat, and eventually revert to forest in the decades following abandonment. Enduring shrubland habitats also occur, and include both pitch pine-scrub oak communities on relatively dry upland sites, as well as shrub-dominated wetland communities, such as shrub swamps. Shrub swamps are wetlands dominated by woody shrubs. They occur throughout the region and are highly variable depending on a variety of influences such as 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). Our land cover type maps and associated tables for each RAFA combine several upland and wetland shrubland types under the broad category "Grassland and Shrubland."

Coastal Scrub-Herb

The coastal scrub-herb habitat types encompass three sub-types that are important for shrubland wildlife species. These coastal habitats are found within the RAFAs that are located in southeastern Massachusetts and in the Rhode Island and Connecticut coastal areas. While the upland shrub habitats described above tend to be more ephemeral in nature, the influence of storms, salt, and poor quality sandy soils can allow the coastal habitats to persist.

North Atlantic Coastal Plain Heathland and Grassland

This habitat type consists of a heathland/grassland complex of acidic, nutrient-poor and very well-drained soils in coastal areas of southern New England. The vegetation is maintained by extreme conditions and periodic fire or other disturbance. The system has a variable structure and may occur as heathlands, grasslands, or support a patchwork of grass and shrub vegetation. Characteristic species include huckleberry, bearberry, broom crowberry, Nantucket shadbush, golden heather, blueberry, little bluestem, and Pennsylvania sedge.

North Atlantic Coastal Plain Pitch Pine Barrens

Pitch pine barrens are a dry, fire-adapted forest with a variable canopy of pitch pine, a tall shrub layer dominated by scrub oak, and a low shrub layer characterized by blueberry and other heaths. Other oaks (scarlet, black, chestnut, and white) are also sometimes present. Composition and structure vary with fire frequency. In general, oaks are more prevalent in those stands having a longer fire-return interval, while fire frequencies of 8 to 10 years foster the growth of dwarf pine stands, also known as pine plains. The field layer of these pine plains are typified by dwarf-shrubs such as lowbush blueberry, bearberry, and golden heather. Scrub oak stands may occur without pine cover, particularly in low-lying areas where cold air drainage inhibits pine growth.

North Atlantic Coastal Plain Maritime Forest

This forest-shrubland type is a mosaic encompassing a range of woody vegetation on barrier islands, near-coastal strands, and bluffs at the outer edge of the coastal plain. Defined by its proximity to maritime environments, and usually species-poor, the vegetation includes narrow bands of forests or woodlands, often featuring stunted trees with contorted branches and dense vine layers. A range of trees may be present depending on location and degrees of protection from most extreme influences. They may include some combination of pines (e.g., pitch and Virginia) and oaks (e.g., scarlet, black, scrub, post) as well as eastern red cedar, black cherry, American holly, sassafras, and red maple. The shrub layer may be dense and the herb layer is often sparse.

Peatland
Peatlands found in the region containing the RAFAs consist mainly of northern bogs and interior acidic peatlands. In general, these habitats refer to nutrient poor, acidic areas in which peat mosses, shrubs, and sedges play a prominent role. 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 S.C. 2008, Thompson and Sorenson 2000). Conifers such as black spruce and white pine are often present. These bogs are often associated with former kettlehole ponds and lakes that have filled and now contain early forest or shrubland habitat with moss carpeting.

Northeastern Upland Forest
Upland forests are dominated by tree cover where soils are not saturated by water for extensive portions of the growing season. They are characterized by deciduous trees, evergreen trees, or mixed evergreen-deciduous trees with overlapping crowns forming between 60 and 100 percent canopy cover. We consider early successional forest (less than 25 years old) to be important ephemeral shrub habitat as the tree species are of a size and density that fulfills habitat niche requirements for shrubland wildlife species.

Deciduous Forest
Deciduous forests consist of large stands of deciduous trees with overlapping crowns forming between 60 to 100 percent canopy cover. Some combination of sugar maple, American beech, and yellow birch characterize most hardwood forests. Generally, these forests contain five layers: a tree stratum, 60 to 100 feet high, dominated regionally by various combinations of the genera listed above; a small tree or sapling layer with younger specimens of the tall trees and other shorter height species such as shadbush, dogwood, and redbud; a shrub layer often with members of the heath family such as rhododendron, azaleas, and mountain laurel; an herb layer of perennial forbs that bloom primarily in early spring; and a ground layer of lichens, clubmosses, and true mosses. Lichens and mosses also grow on the trunks of trees. Lianas such as wild grape, poison ivy, and Virginia creeper climb the trees to flower and fruit high in the forest canopy.

Evergreen Forest
Evergreen forest stands contain a diverse assemblage of coniferous trees. Found throughout the area on a variety of soil types, either as pure or mixed stands. Eastern hemlock is most prevalent, but has recently declined especially in the southern portion of the region due to hemlock wooly adelgid infestation. Evergreen forests include species such as white and red pine, and spruce and fir trees.

Mixed Forest
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. A mixed forest is closely related to a northern or central hardwood forest, but typically sustains a composition that can be evenly distributed. These forests mainly consist of red maple, red oak, eastern hemlock, and white pine.

Northeastern Wetland Forest
Northeastern wetland forests, or forested swamps, are wetlands where trees dominate the vegetation and there is generally little buildup of peat. Soils are saturated for much of the growing season, often with standing water in the spring. Forested swamps are the most abundant types of all wetlands in the Northeastern United States. They usually occur as patches within the

Forested swamp habitat

USFWS

surrounding upland matrix forest. They follow patterns of differences similar to the upland forests. For example, in evergreen forest areas, forested swamps are cold and often conifer-dominated. In the warmer southern and eastern parts of the region and in deciduous forested areas, forested swamps are dominated by red maple or Atlantic white cedar. They occur in stream headwaters, behind floodplain forests, and in poorly drained basins. Forested swamps develop in poorly drained areas throughout the region. Depending on the physical setting, forested swamps receive water through surface runoff, groundwater inputs, or stream and lake overflow.

Agriculture

For the purposes of this section, lands classified as agriculture include managed grasslands, herbaceous areas, or pastures. These lands can also consist of actively cultivated croplands. When not actively tilled, these areas generally consist of herbaceous plants such as grasses, herbs, and ferns that form 25 percent or more of the ground cover. This includes grasslands managed on public lands for wildlife and other managed grasslands consisting primarily of naturalized European species, such as timothy, red clover, and red fescue, as well as other herbaceous or broad-leaved plants and flowers. If this land type is actively managed for wildlife, these habitats are routinely mowed or burned prior to or after the conclusion of the avian breeding season. These areas include wet meadows and a variety of temporarily flooded grasslands. The flooding may be controlled as part of a management plan for the habitat. Vegetation typically includes a variety of herbaceous plants, including forbs, grasses, flowers, sedges, and rushes (e.g., reed canarygrass, common reed, big bluestem, bluebell bellflower, bluejoint, tussock sedge).

Active pastures have usually been planted with non-native, cool-season forage grasses and are maintained by grazing livestock or mowing. Abandoned pastures are extremely ephemeral and show a rapid increase in woody vegetation. These serve as habitat for a succession of animal communities that parallels the stage of the vegetation communities.

Freshwater Marsh
Also known as emergent herbaceous wetlands, these areas are typically adjacent to rivers and streams, and periodically flooded and influenced by run-off from adjacent upland areas. Basin freshwater marshes also are found in glacial kettles. Typical plants include cattail, buttonbush, highbush blueberry, water willow, and swamp loosestrife. This habitat type includes deep and shallow emergent marshes, wet meadows, kettlehole wet meadows, coastal interdunal marshes/swales, calcareous sloping fens, calcareous seepage marshes, calcareous basin fens, and acidic graminoid fens. Shallow emergent marshes occur in broad, flat areas bordering low-energy rivers and streams, often in backwater sloughs, or along pond and lake margins. Shallow marshes also commonly occur in abandoned beaver flowages, and in some states this type of natural community is named "abandoned beaver meadows" or "beaver flowage communities." The soils are a mixture of organic and mineral components. There is typically a layer of well-decomposed organic muck at the surface overlying mineral soil. There is standing or running water during the growing season and throughout much of the year, but water depth averages less than 6 inches.

Marshes are dominated by emergent herbaceous vegetation and have a water table that is generally at or above the surface throughout the year, but can fluctuate seasonally. Examples of marsh natural communities include cattail marshes and deep-emergent marsh-aquatic beds.

Emergent wetlands are characterized by erect, rooted, herbaceous hydrophytes occurring in all water regimes except sub-tidal and irregularly exposed. This vegetation is present for most of the growing season (Cowardin et al. 1979). Most communities are dominated by perennial plants. Freshwater emergent wetlands are dominated by non-persistent and persistent grasses, sedges, rushes, forbs, and other grass-like plants, with minimal representation by woody trees or shrubs. These communities are primarily non-tidal, freshwater habitats known as marshes, wet meadows, and pond shores.

Estuarine
This category includes intertidal salt and brackish marshes, and mud and sand flats. Marsh in this category is dominated by emergent herbaceous vegetation and has a water table that is generally at or above the surface throughout the year, but can fluctuate seasonally. However, these lands are influenced by tidal fluctuations and some level of saltwater intrusion. Higher levels of salinity change the vegetation composition. These estuarine wetland ecosystems are characterized by erect, rooted, herbaceous hydrophytes, excluding mosses and lichens that are present for most growing season in most years. These plants may be temporarily to permanently flooded at the base, but do not tolerate prolonged inundation of the entire plant. A salt marsh profile features a low regularly flooded marsh dominated by salt marsh cordgrass; a higher irregularly flooded marsh dominated by saltmeadow cordgrass and saltgrass; low hypersaline pannes characterized by saltwort; and a salt scrub ecotone characterized by marsh elder, groundsel-tree, and switchgrass. Brackish areas support salt marsh cordgrass, narrowleaf cattail, bulrush, and other emergent species. The estuarine category also includes coastal waters protected from high wave energy by barrier beaches or located in sheltered channels and bays, that have lower salinities at times due to freshwater runoff from the land.

Wildlife

The variety of habitats described above provides some of the lifecycle needs for a large number of animal and plant species. Since our actions are focused on shrub-scrub and early successional forest habitat maintenance and restoration, this section describes those species that are adapted to and use those habitat types. Early successional habitats are vitally important to a number of animal species. Table 10 provides information about species of national conservation priority, including Federal-listed species such as the bog turtle.

Table 10: Regional Conservation Plans and Priority Species for Shrublands and Young Forest Habitats

Species common name (Federal T&E status)	Scientific name	Associated step-down plans	Comments
American Burying Beetle (E)	*Nicrophorus americanus*	NALCC*	State-endangered in MA and RI; species of special concern in CT
American Woodcock	*Scolopax minor*	NALCC*#, BCR14‡, BCR28‡, BCR30‡, BCR13†, PIF27§, PIF09§, American Woodcock Conservation Plan	
Blue-winged Warbler	*Vermivora pinus*	NALCC*#, BCR30‡, BCR13†, BCR14†, BCR28†, PIF09§	
Bog Turtle (T)	*Clemmys muhlenbergii*	NALCC*#	State-endangered in MA, CT, NY
Indiana Bat (E)	*Myotis sodalis*	NALCC*	State-endangered in MA, CT, NY
Northern Long-Eared Bat (E)	*Myotis septentrionalis*		State-endangered MA, CT; State-threatened NY, NH
Karner Blue Butterfly (E)	*Lycaeides melissa samuelis*	NALCC*	State-endangered in NH, NY
New England Cottontail	*Sylvilagus transitionalis*	NALCC*#	State-endangered in ME, NH; species of special concern in NY
Northeastern Bulrush (E)	*Scirpus ancistrochaetus*	NALCC*	
Northern Red-Bellied Cooter (E)	*Pseudemys rubriventris*	NALCC*	State-endangered in MA
Prairie Warbler	*Dendroica discolor*	NALCC*#, BCR30‡, BCR28†, PIF09§	
Brown Thrasher	*Toxostoma rufum*	NALCC#, BCR13†, BCR28†, BCR30†	Species of special concern in CT
Eastern Towhee	*Pipilo erythrophthalmus*	NALCC#, BCR28‡, BCR30†	
Field Sparrow	*Spizella pusilla*	NALCC#, BCR28‡, BCR13†, BCR30†	
Northern Bobwhite	*Colinus virginianus*	BCR30†	
Whip-poor-will	*Caprimulgus vociferus*	BCR30†	Species of special concern in CT, NY
Willow Flycatcher	*Empidonax traillii*	BCR28†, BCR30†	
Chestnut-sided Warbler	*Setophaga pensylvanica*	NALCC#, BCR14†, PIF27§	
Olive-sided Flycatcher	*Contopus cooperi*	BCR14†	
Rusty Blackbird	*Euphagus carolinus*	BCR14†	
Golden-winged Warbler	*Vermivora chrysoptera*	BCR13‡, BCR28‡, PIF09§	State-endangered in MA, CT; species of special concern in NY
Canada Warbler	*Cardellina canadensis*	BCR14‡	
Black Racer	*Coluber constrictor*		State-endangered in ME, State-threatened in NH
Eastern Hognose Snake	*Heterodon platirhinos*	NALCC#	State-endangered in NH; species of special concern in CT, NY

* *NALCC–Highest priority species for North Atlantic Landscape Conservation Cooperative Development and Operations Plan*

† *High and ‡highest priority species for Bird Conservation Region Plans (BCR30 = New England/Mid-Atlantic Coast Bird Conservation Region; BCR14 = Atlantic Northern Forest; BCR13 = Lower Great Lakes/St. Lawrence; BCR28 = Appalachian Mountains)*

§ *Priority species for Partners in Flight Landbird Conservation Plans (PIF27 = Northern New England; PIF09 = Southern New England)*

#NALCC-designated surrogate species

Birds

Shrublands and thickets provide vital breeding and foraging habitat for numerous avian species which are considered priorities by bird conservation initiatives. Several species have been identified as priorities for the bird component for assessing land acquisition priorities for the Refuge System. The priority species for the Refuge System's recently adopted Targeted Resource Acquisition Comparison Tool (TRACT) are the birds that are identified on the National Birds of Conservation Concern (BCC) list. The shrubland species that are included on this list are American woodcock, blue-winged warbler, golden-winged warbler, chestnut-sided warbler, prairie warbler, field sparrow, olive-sided flycatcher (*Contopus cooperi*), and loggerhead shrike (*Lanius ludovicianus*). Birds dependent on early successional shrublands and pine barrens have shown steep population declines in the Northeast over the last few decades (Dettmers and Rosenberg 2000). Ten percent of the breeding population of blue-winged warblers is estimated to breed in the last remaining remnant patches of early successional habitats in bird conservation region BCR 30.

Whip-poor-will

William Majoros

Within BCR 30, there are a total of eight "highest" and "high" priority species dependent on scrub-shrub and early successional habitats for breeding. The highest priority species for these habitats include American woodcock, prairie warbler, and blue-winged warbler. The high priority species are brown thrasher, eastern towhee, field sparrow, whip-poor-will (*Caprimulgus vociferous)*, and willow flycatcher (*Empidonax traillii)*. Gray catbird (*Dumetella carolinensis*), another shrubland-dependent species, is a moderate priority species. In addition to their priority status in BCR 30, blue-winged warbler, prairie warbler, and willow flycatcher have been identified by the NALCC as representative species for shrubland/early successional habitats in the southern New England region, as well as chestnut-sided warbler. In addition, early successional habitats provide important landbird migration habitat for species such as the Bicknell's thrush, which uses coastal shrubland communities during fall migration.

Priority species that have been identified under the PIF 9 Southern New England physiographic area for shrubland/young forest habitat are as follows, with focal species in boldface: **blue-winged warbler,** prairie warbler, **American woodcock, eastern towhee,** and whip-poor-will. Many species of shrubland birds have been experiencing steep population declines in the Northeast over the last several decades. In addition to the significant decreases in the high priority species listed under this habitat type, brown thrasher, eastern towhee, and indigo bunting (*Passerina cyanea*) have also undergone significant long-term population declines, as monitored through the Breeding Bird Survey (Dettmers and Rosenberg 2000, Sauer et al. 1999).

For selected shrubland-dependent birds identified as priorities in BCR 30 or as representative species for shrubland habitats within the southern New England region, we have estimated the current combined total amount of potentially suitable habitat within all RAFAs for this project and the associated number of breeding birds currently supported by that habitat (see Table 11). We also compare these habitat and population estimates with the habitat and population objectives that have been identified for each species in BCR 30, as reported in the

BCR 30 Bird Conservation Plan (ACJV 2014), the PIF North American Landbird Conservation Plan (Rich et al. 2004) in conjunction with the PIF Population Estimates Database (PIF 2013), or the American Woodcock Conservation Plan (WMI 2008).

Table 11: Current Breeding Bird and Habitat Estimates for all RAFAs Combined

Context:

Current suitable habitat for shrubland-dependent birds in all RAFAs combined = 21,120 acres.

Species	% of BCR 30 habitat objective based on 21,120 acres	# of breeding birds (% of BCR 30 population objective)
Blue-winged warbler	7.8%	6,380 (10.6%)
Prairie warbler	10.1%	12,480 (13.4%)
Brown thrasher	17.1%	3,950 (7.2%)
Eastern towhee	2.0%	14,720 (3.2%)
Chestnut-sided warbler	14.9%	16,460 (16.5%)
Field sparrow	14.8%	5,510 (3.3%)
Willow flycatcher	53.3%	13,900 (69.5%)
Gray catbird	1.5%	13,400 (1.7%)
American woodcock	0.01%	772 (0.01%)

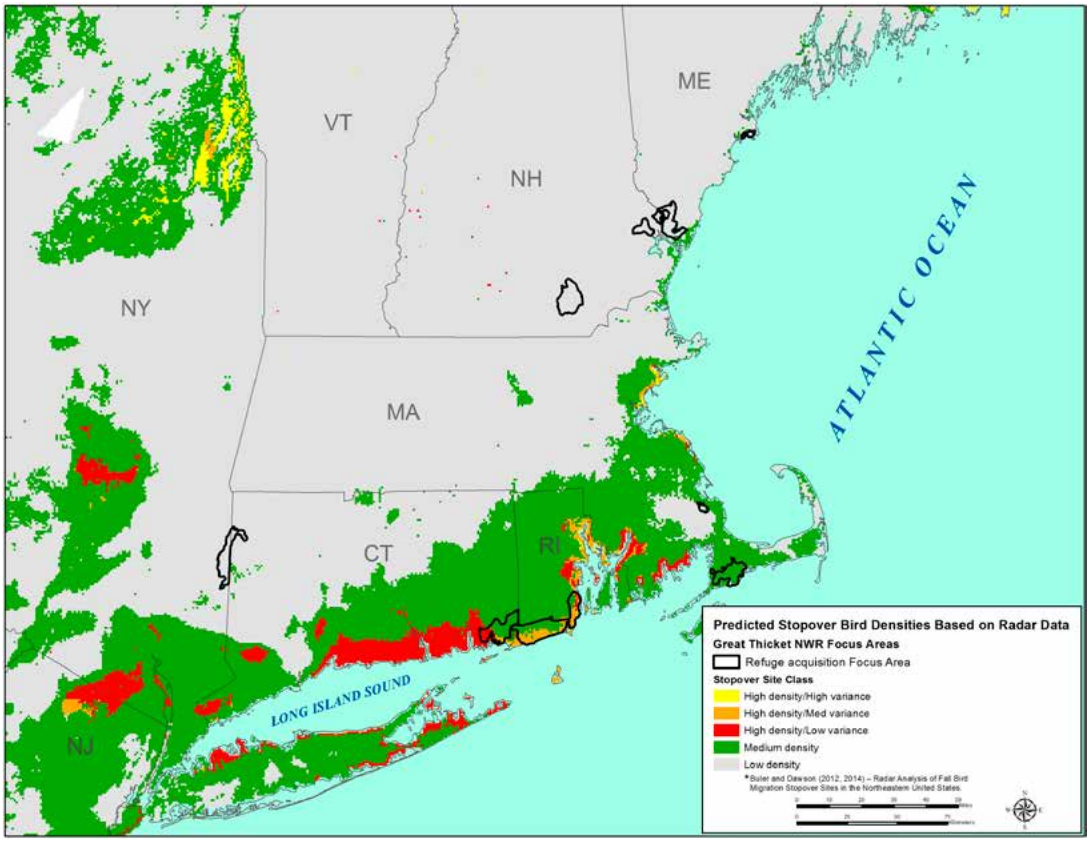
The amount of existing suitable shrubland habitat within focus areas was estimated from appropriate shrubland and forest classes, as described above, within the modified ecological systems model developed for the Designing Sustainable Landscapes project (NALCC 2015). Acres of upland and wetland shrub habitats were estimated directly from the amount of those habitat classes within RAFAs. Acres of early successional forest were estimated by calculating the county-level proportion of young forest based on Forest Inventory Analysis data (USDA 2014) and then multiplying that proportion by the total acres of upland and wetland forest within the RAFAs. Bird population estimates were derived by applying published breeding density estimates for each species (see Emlen 1977, Inman et al. 2002, Chandler et al. 2009, King et al. 2009a, King et al. 2009b, Schlossberg et al. 2010) to the acres of upland and wetland shrub habitat types occurring within the RAFAs. We typically used numbers at the lower end of the range of published density estimates because high densities usually reflect the most suitable habitat but we are trying to estimate populations across the landscape, which will include a range of habitat quality. We also acknowledge that the published bird population objectives typically reflect relatively low densities at landscape scales, and we wanted our estimates to be as comparable with those objectives as possible.

In addition to contributions to breeding bird populations, the shrubland habitat within the RAFAs provides critical habitat during post-breeding and migratory periods for landbirds, and is also important for many forest-interior breeding birds (Marshall et al. 2003, Vitz and Rodewald 2006). Shrublands are considered to be some of the most important stopover habitat for migrant landbirds because they provide quality food resources in the form of fruits and berries that are not as abundant in other habitats during the fall migration. The dense vegetation of shrublands also provides high quality cover for resting and recovery by birds that

have completed migratory flights. An analysis of radar data from the National Weather Service (Buler and Dawson 2012, 2014) has indicated that the Southern New England coastal area is among a small number of areas in the Northeast that supports the highest density of migrating birds during the fall migration.

Figure 1, adapted and modified from that analysis, shows that both the Rhode Island East-West and the Pachaug-Ledyard RAFAs overlap with areas of high bird density of migrating birds. Several of the other RAFAs overlap with areas of at least moderate migrant bird density. Thus, current conditions within the RAFAs support not only significant populations of breeding shrubland birds, but they also provide critical migratory stopover habitat in areas that support moderate to high densities of migrating birds. Observations along the southern Rhode Island coast confirm the presence of high priority forest interior birds in addition to the shrubland species, and often a disproportionate number of young of the year making their first migration such that availability of this habitat may contribute to increasing survival and recruitment of young into the breeding populations of these species.

Figure 1: Predicted Stopover Bird Densities Based on Radar Data



Mammals

The majority of the 60 native terrestrial mammal species that occur in the Northeastern United States utilize resources from several habitats on a seasonal basis. As many as 20 of these mammals demonstrate some preference for young forests, shrublands, or old-field habitats (Fuller and DeStefano 2003, DeGraff and Yamasaki 2001). Three mammal species are considered obligate users, including the NEC, the non-native eastern cottontail (*Sylvilagus floridanus*) and the bobcat (*Lynx rufus*), which preys upon both rabbit species as well as on other species (Litvaitis 2001). Examples of part-time or opportunistic users of these types of habitats in this area include the black bear (*Ursus*

americanus), the little brown bat (*Myotic lucifugus*), and the white-tailed deer (*Odocoileus virginianus*). Additional examples include white-footed and deer mice (*Peromyscus leucopus, P. maniculatus*), red and grey fox (*Vulpes vulpes, Urocyon cinereoargenteus*), raccoon *(Procyon lotor*), Opossum (*Didelphis virginiana*), striped skunk (*Mephitis mephitis*), and semi-aquatic mammals like the beaver (*Castor canadensis*) and mink (*Mustela vison*).

Although the Service decided in 2015 that the NEC does not need Federal protection, much work still needs to be done to stabilize NEC populations throughout its historic range. Shrubland habitat and NEC population goals have been established within a SHC framework to help guide our efforts. The NEC has been described as a barometer for the health of other shrubland-dependent wildlife species that occur throughout the Northeast because the NEC is: (1) an extreme habitat specialist; (2) is highly sensitive to habitat area size; (3) is dispersal limited; and (4) lives in these habitats through all seasons. NEC live in dense areas of shrubs and young forests where trees are growing back following disturbances caused by factors such as logging, fire, flooding, mortality from disease or insects, and high winds. NECs are "habitat specialists," which means they depend on a specific kind of habitat. In this case, it is early successional or "thicket" habitat (Litvaitis 2001).

Eastern hognosed snake

Ohio DNR

Additionally, research has indicated the importance of early successional habitat to many other mammals, including hoary (*Lasiurus cinereus*), red (*L. borealis*), and big brown bats (*Eptesicus fuscus*).

Reptiles and Amphibians

Several state-listed endangered reptile species, such as the eastern hognose snake, northern black racer (*Coluber constrictor*) and Blanding's turtle, are found along forest edges and other shrubland habitats that are the focus of this land protection plan.

Invertebrates

Shrublands are some of the most important natural communities for rare and endangered Lepidoptera across much of the Northeastern United States, and considered most important in both Connecticut and Massachusetts. This is especially evident in Massachusetts, where 41 percent of State-listed moths and butterflies are associated with shrublands. In Connecticut, species of shrub-dominated habitats account for 23 percent of that State's listed Lepidoptera. In both states, pitch pine-scrub oak barrens, ridgetop pitch pine-scrub oak barrens, and heathlands are the most important shrubland habitats for rare moths and butterflies. Shrubland species also account for high percentages of Lepidoptera ranked as rare in other Northeastern states (Wagner et al. 2003). Many species of pollinators, including butterflies and bees, have experienced severe declines in the past two decades.

Monarch butterflies use early successional habitats that contain milkweed during the spring and summer breeding period. Natural and managed early successional and shrub-dominated lands generally support a mix of native flowers with different bloom times, which ensure a stable food source for butterflies and milkweed to feed monarch caterpillars. The monarch population has recently declined to a fraction of its previous size. NatureServe and the Xerces Society recently report that estimates of up to 1 billion monarchs made the flight each fall from portions of the United States and Canada to sites in Mexico in the 1990s, and more than 1 million overwintered along the California coast. In the

winter of 2013/2014, estimates from overwintering sites in Mexico suggest only about 33 million monarchs overwintered, representing a 90 percent drop from the 20-year average (Jepsen et al. 2015). These declines are so severe that the Service has been petitioned to consider listing the North American monarch as threatened under the ESA.

The subspecies occurring in North America and the two North American populations are considered in jeopardy, and the rapid decline and widespread threats to the eastern population qualify it as critically imperiled. While the report explains that the species as a whole is apparently secure, these two major populations at the heart of its range and the associated subspecies now face potential extinction. North American monarchs are said to probably represent the majority of the total global population. One of several major factors appearing to be most important in the decline of the eastern monarch is the loss of early successional milkweed breeding habitat due to herbicides, land conversion, and reforestation.

Federally Threatened and Endangered Species

The federally listed cooter is found in early successional habitats, especially in the Plymouth RAFA. The cooter is a large, freshwater basking turtle with a carapace (i.e., shell) length of 10 to 12 inches when mature. The cooter subsists primarily on submergent vegetation, and requires good water quality and suitable basking, nesting, and overwintering sites free from disturbance. The population of this species is restricted to approximately 22 sites in Plymouth County, centered within the Plymouth RAFA. The cooters spend most of their lives in these freshwater coastal ponds in Plymouth and Carver counties, coming on land to bask in the sun and breed in sandy soils. The cooter, like other turtles, are active only during the warmer months (March to October) and hibernate through the winter months buried in the mud on the bottom of these coastal ponds (USFWS 1994).

In addition, federally listed bog turtles occur in the Northern Housatonic RAFA. The northern population of the bog turtle is a federally threatened species and listed as endangered in the states of Connecticut and New York. Among the contributing factors to the decline of bog turtles is habitat destruction due to development; illegal collection; wetland ditching, flooding, and filling; water quality degradation; and forest succession or invasive species encroachment (Beans and Niles 2003). Bog turtles require open wetlands, generally with a scrub-shrub component, with perennial groundwater seepage and typically at least several inches of mucky substrate.

Parcels in the Cape Elizabeth-Scarborough and Pachaug-Ledyard RAFAs are associated with coastal beach and marsh habitats that are important to the federally threatened piping plover. Finally, the federally endangered Karner blue butterfly (*Lycaeides melissa samuelis*) uses early successional pine and oak barren habitat that is an important component of this land protection proposal.

Invasive Species

Invasive species have been introduced, purposefully or accidentally, into the AOI from other countries or other regions of this country. Often these exotic species establish in natural ecosystems, becoming naturalized, but without noticeably affecting natives animals 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, parasitism) in their new location. In many cases, species have been introduced specifically because they were easy to establish, hardy, and resistant to disease. In addition to the initial introductions, human activities that result in disturbed soils, excessive nutrients, and native plant removal can favor the spread of exotics. In general, introduced species that multiply in large numbers, displace native species, and

cause ecological damage (e.g., 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 (*Dreissena polymorpha*)], or impact human health (e.g., giant hogweed) are called invasive species.

Some invasive species that occur within the AOI and specifically within the RAFAs include Asiatic bittersweet, common reed, autumn olive, Japanese knotweed, glossy buckthorn, garlic mustard, Japanese barberry, and tree-of-heaven. Control of these species would be integrated into the management regime for maintaining shrubland habitats within RAFAs.

Description of Sub-Regions Containing Refuge Acquisition Focus Areas

For the second section of this chapter, we grouped the RAFAs into the following five sub-regions:

- Maine/New Hampshire Coast
- Merrimack Valley-New Hampshire
- Southeastern Massachusetts
- Southeastern Connecticut/Rhode Island Coast
- Northern Housatonic

Below, we list the RAFAs that fall under each sub-region and describe the particular resources that can be found in each sub-region. We also provide maps illustrating the specific locations of each RAFA and the habitat types that can be found within each RAFA.

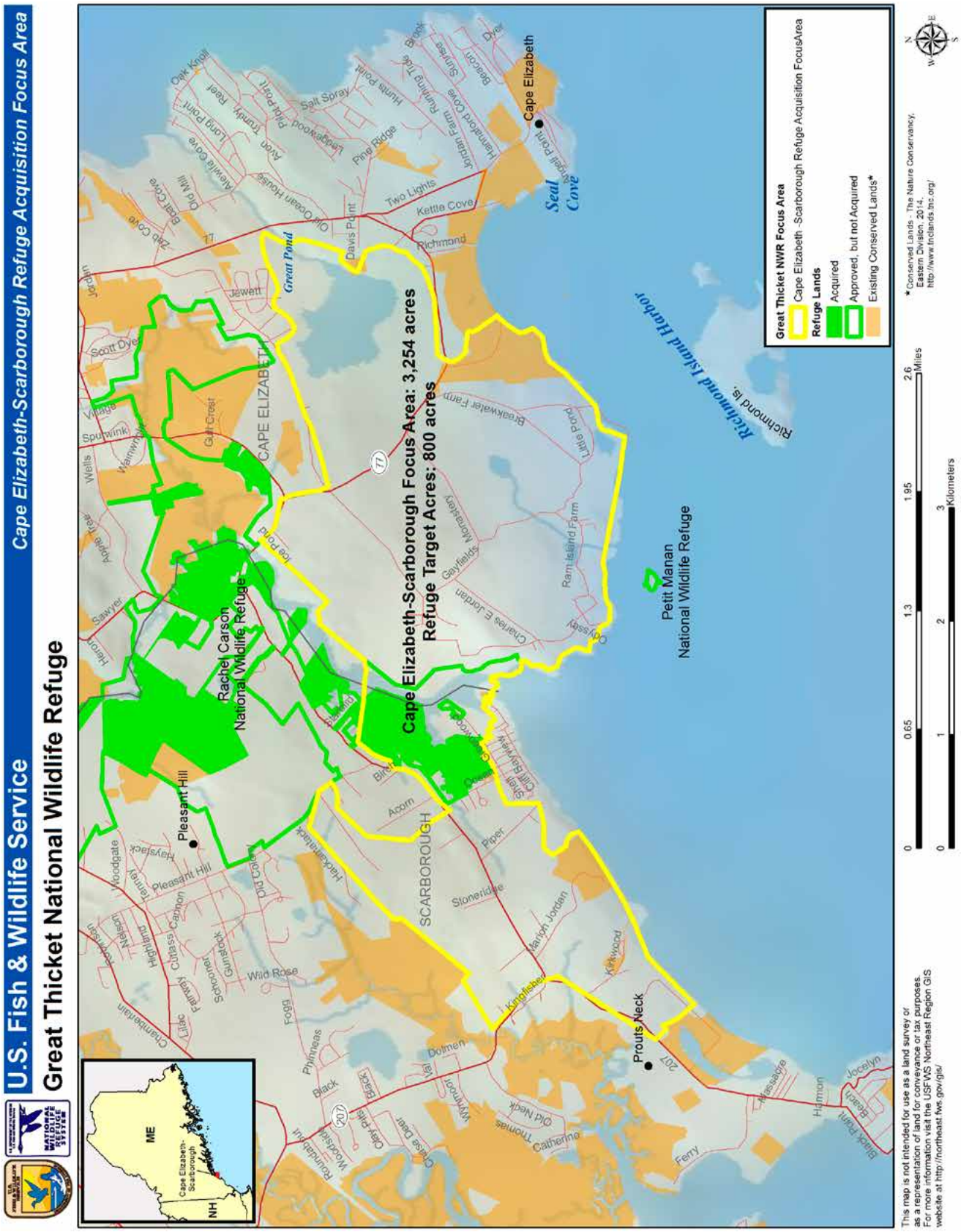
Maine/New Hampshire Coast Sub-Region

The Maine/New Hampshire Coast sub-region includes the following four RAFAs: Cape Elizabeth-Scarborough, Berwick-York, Rollinsford, and Oyster-Dover-Bellamy. In general, these areas are within 20 miles of the coast and contain a mix of forest, marsh, and shrubland habitats, with northern upland forest habitats making up nearly half of the area. Approximately 16.3 percent of the area is in some stage of development and 14.5 percent of the total acreage of this sub-region is currently classified as agriculture. This area also contains almost 4,500 acres of land that is currently protected. This includes more than 2,000 acres of private land that is protected by conservation easements and 952 acres of local conservation land. Lands identified for protection within these sub-regions under the proposed Great Thicket NWR often link already existing conservation areas and add to the overall wildlife and water quality benefits.

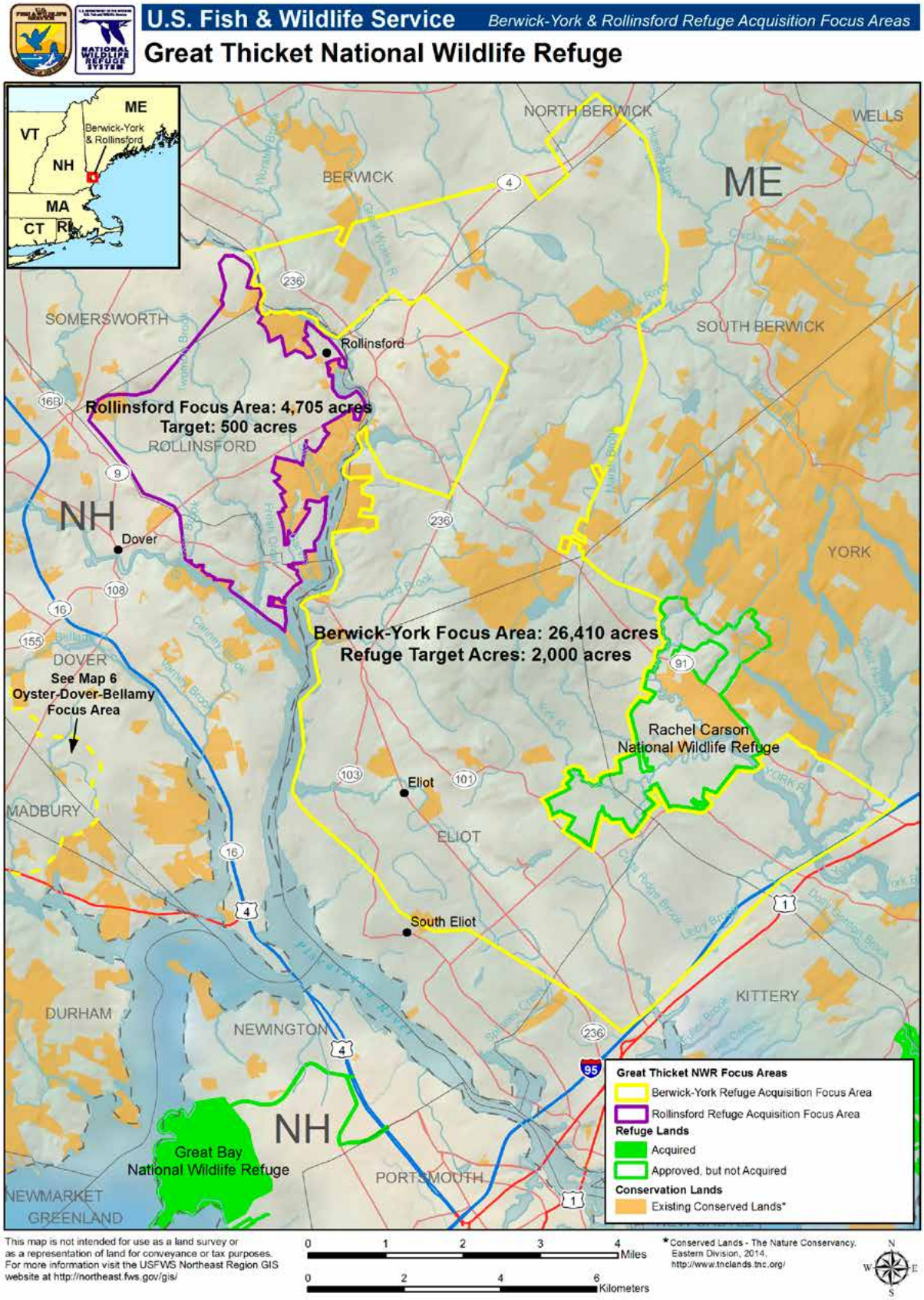
Table 12: Maine/New Hampshire Coast Sub-Region Conserved Lands

	Cape Elizabeth-Scarborough RAFA Acres	Berwick -York RAFA Acres	Rollinsford RAFA Acres	Oyster-Dover-Bellamy RAFA Acres	Total
Federal	128	0	0	42	170
State	3	384	0	363	750
Local	1	286	72	593	952
Non-government conservation organization	8	604	0	2	614
Private landowner conservation easement	42	650	92	1,228	2,012
Total	**182**	**1,924**	**164**	**2,228**	**4,498**

Map 4: Cape Elizabeth-Scarborough Refuge Acquisition Focus Area



Map 5: Berwick-York and Rollinsford Refuge Acquisition Focus Areas



Map 6: Oyster-Dover-Bellamy Refuge Acquisition Focus Area

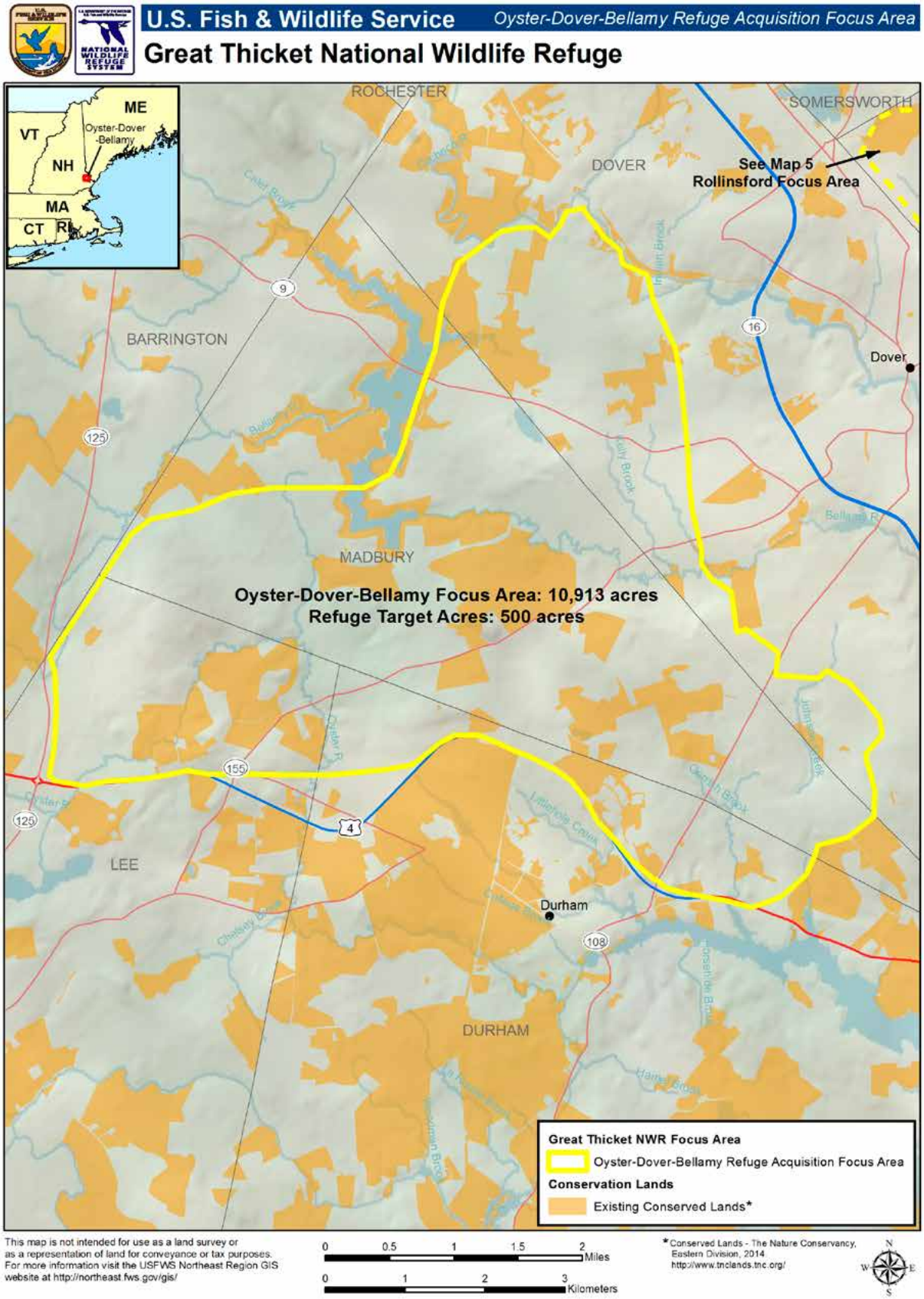


Table 13: Maine/New Hampshire Coast Sub-Region Land Cover Types*

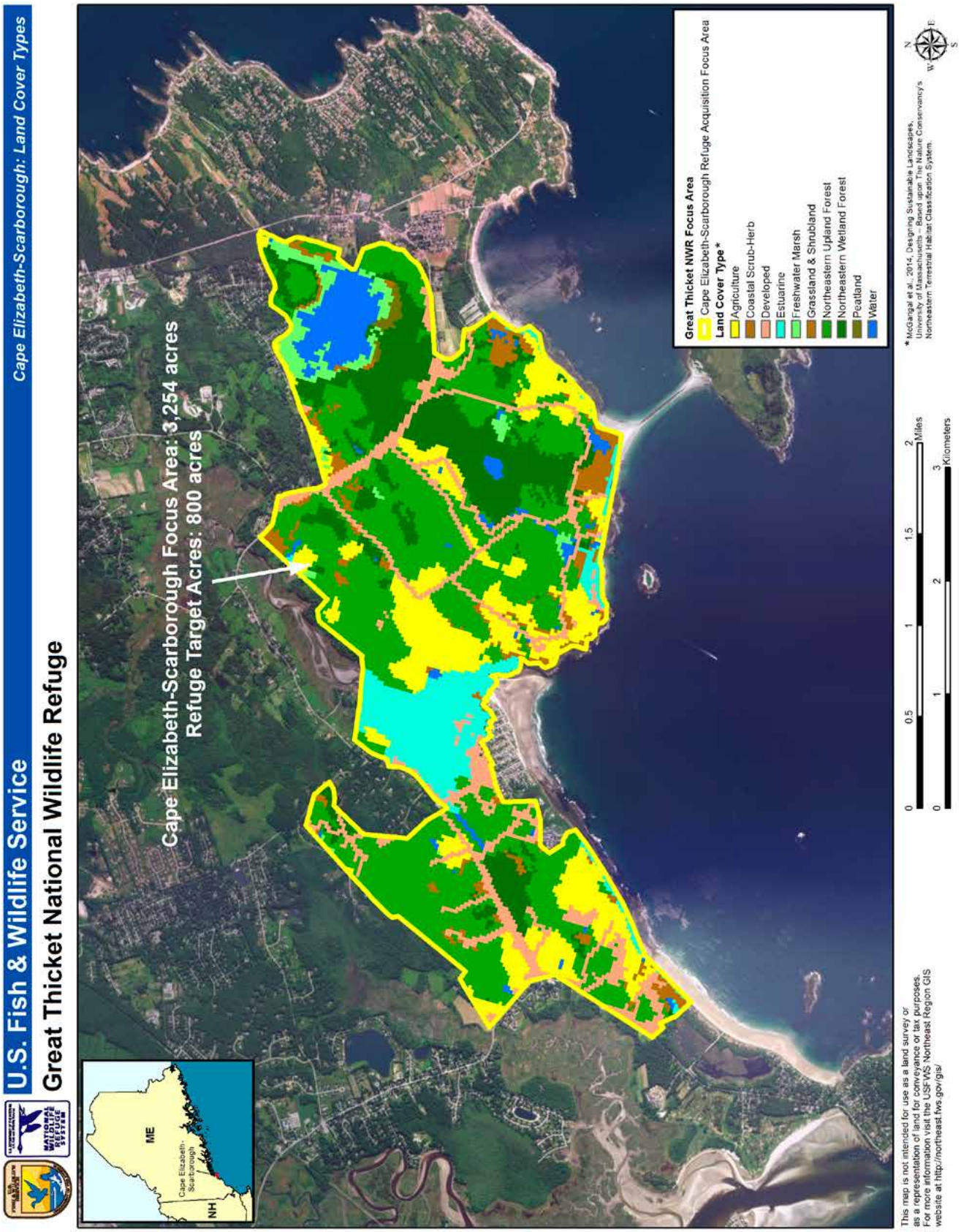
	Cape Elizabeth-Scarborough RAFA Acres	Berwick-York RAFA Acres	Rollinsford RAFA Acres	Oyster-Dover-Bellamy RAFA Acres	Total
Grassland and Shrubland	120	1,746	158	394	2,418
Coastal Shrub-herb	42	0	0	0	42
Peatland	12	53	0	14	79
Northeastern Upland Forest	1,244	12,775	1,653	5,643	21,315
Northeastern Wetland Forest	493	2,990	191	740	4,414
Agriculture	484	3,607	1,039	1,444	6,574
Freshwater Marsh	153	645	54	82	934
Estuarine Intertidal	185	379	20	20	604
Open water	206	754	159	388	1,507
Developed	361	3,434	1,415	2,189	7,399
Total	**3,300**	**26,383**	**4,689**	**10,914**	**45,286**

**Note: Total acres for each RAFA may not exactly match those in Table 1 due to different GIS data types used in acreage calculations.*

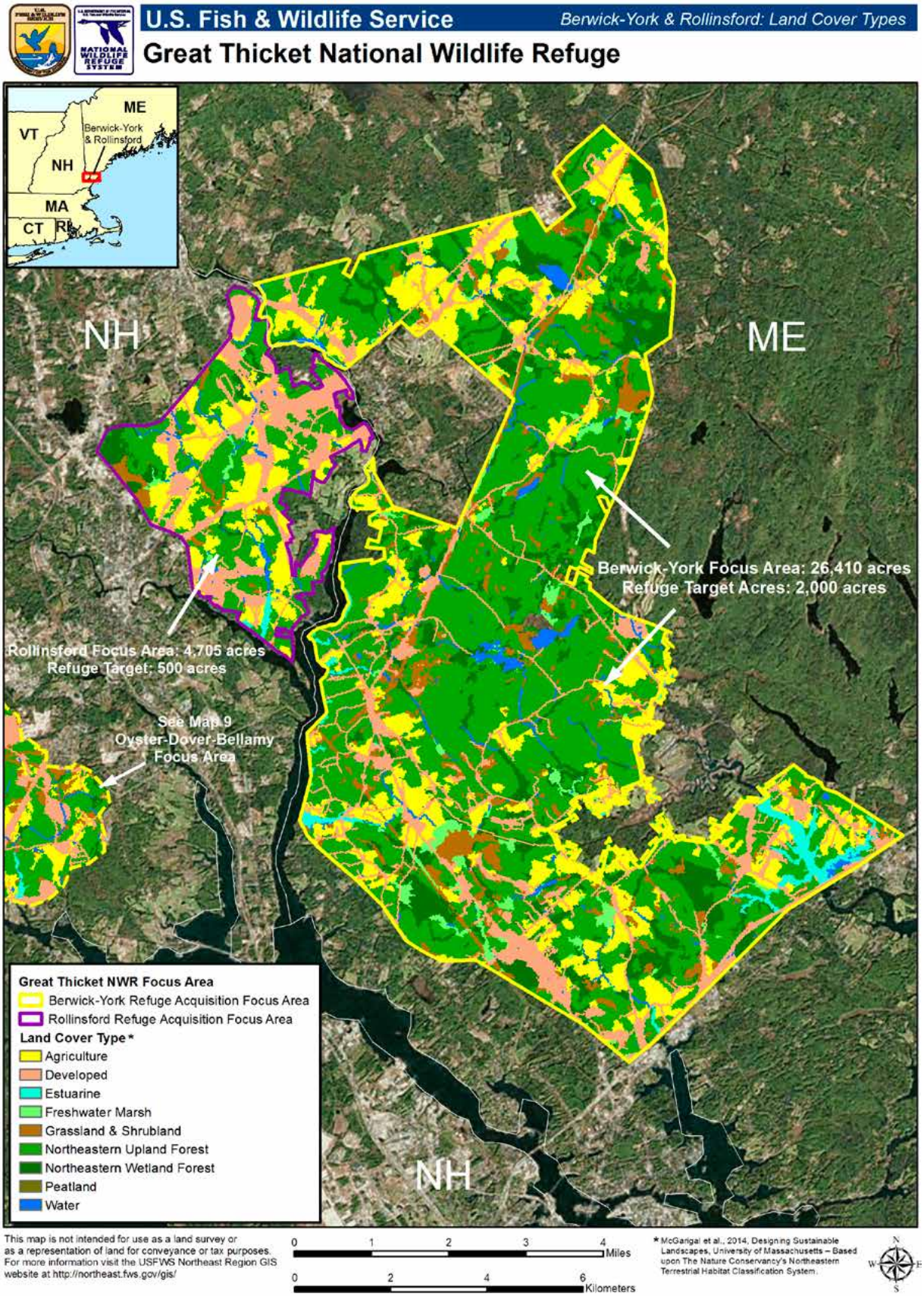
Habitat restoration in the Lee Five Corner Preserve in New Hampshire

Ted Kendziora/USFWS

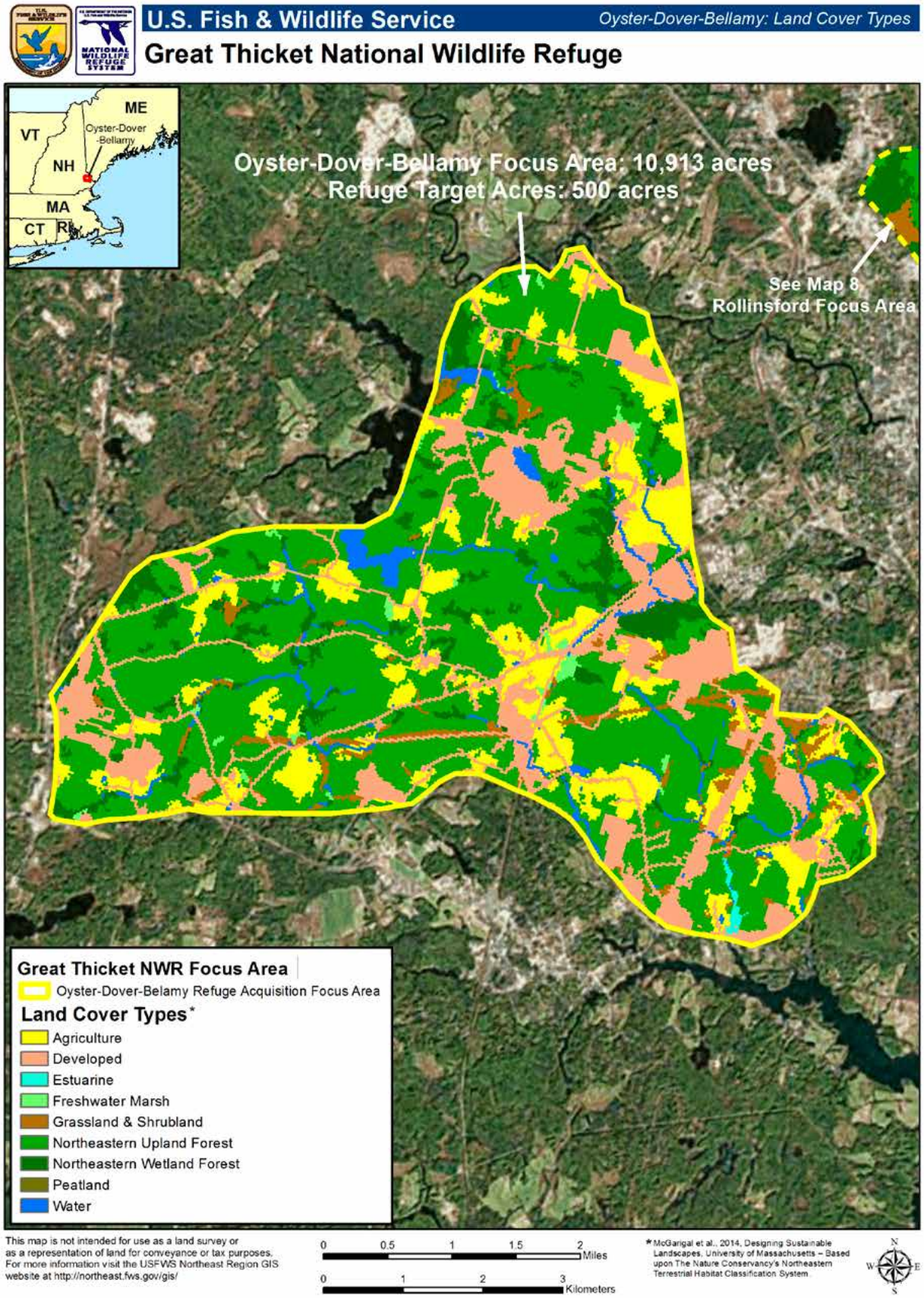
Map 7: Cape Elizabeth-Scarborough Refuge Acquisition Focus Area: Land Cover Types



Map 8: Berwick-York and Rollinsford Refuge Acquisition Focus Areas: Land Cover Types



Map 9: Oyster-Dover-Bellamy Refuge Acquisition Focus Area: Land Cover Types



Aspen stand regeneration

Ted Kendziora/USFWS

The Maine/New Hampshire Coast sub-region has an archaeological record that offers evidence of thousands of years of Native American occupation. Euro-American settlement has shaped the ecology of the sub-region as well.

The four RAFAs in this sub-region feature ponds, streams, and wetlands in proximity to the Atlantic coastline. Native American settlement was oriented around these freshwater resource areas during the pre-European contact period. Consequently, undeveloped areas in settings such as wetland margins and riparian zones have high sensitivity for Native American archaeological sites, including seasonal camps and large and small settlements. At the time of European contact, Native American communities in this sub-region apparently occupied large villages surrounded by palisades and planting fields, with smaller villages or hamlets distributed along the shoreline. Some groups may have dispersed upriver or inland periodically for hunting, fishing, and access to other seasonal resources.

Historical Euro-American settlement in the vicinity of this sub-region began in the early 17th century, resulting in the founding of the communities of York and Scarborough in Maine (settled in 1624 and 1635, respectively), and Dover and Rollinsford in New Hampshire (settled in 1623 and 1630). Euro-American land use featured the establishment of villages, farms, and early industries such as grist mills, sawmills, and shipyards. Today, undeveloped locations that feature favorable agricultural soils in the four RAFAs, and are found near water sources, thoroughfares, or centers of early colonial occupation, are likely to contain archaeological evidence of agrarian land use and settlement over the last three and a half centuries.

Lands within the Maine/New Hampshire Coast sub-region that may be considered for acquisition are likely to include undeveloped, open spaces and current, or former agricultural areas. Depending on the proximity of such properties to freshwater resources (e.g., wetlands, streams, rivers) and/or to locations that witnessed historic land use (e.g., settlement, agriculture, early industries), expected historic properties in the acquired lands may include Native American and Euro-American archaeological sites, and historic agricultural structures.

Merrimack Valley-New Hampshire Sub-Region

This sub-region contains just one RAFA, Merrimack Valley North. This RAFA stands alone in the interior area of New Hampshire. This area is 48 percent forested and contains a high concentration (35 percent) of developed land. Within this RAFA, there are over 4,300 acres of conservation land. Of that land, most is either protected by the local government or by conservation easements on private lands (2,063 acres and 1,647 acres, respectively).

Table 14: Merrimack Valley North Conserved Lands

Ownership	Merrimack Valley North RAFA Acres
Federal	8
State	677
Local	2,063
Non-government conservation organization	0
Private landowner conservation easement	1,647
Total	**4,395**

Table 15: Merrimack Valley North Land Cover Types*

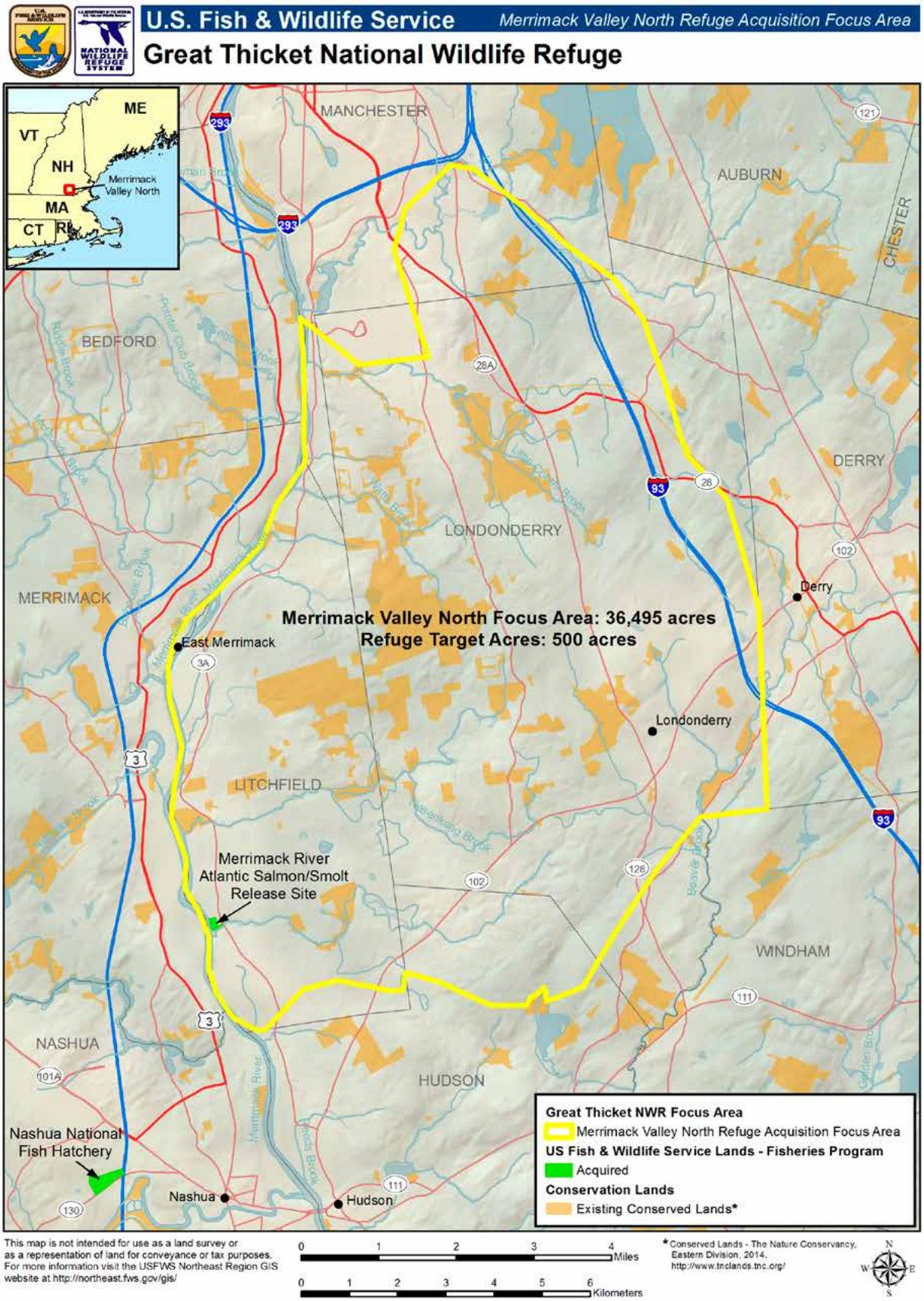
Land Cover Types	Merrimack Valley North RAFA Acres
Grassland and Shrubland	507
Peatland	24
Northeastern Upland Forest	14,407
Northeastern Wetland Forest	3,395
Agriculture	3,220
Freshwater Marsh	1,257
Open Water	1,250
Developed	12,898
Total	**36,958**

**Note: Total acres for each RAFA may not exactly match those in Table 1 due to different GIS data types used in acreage calculations.*

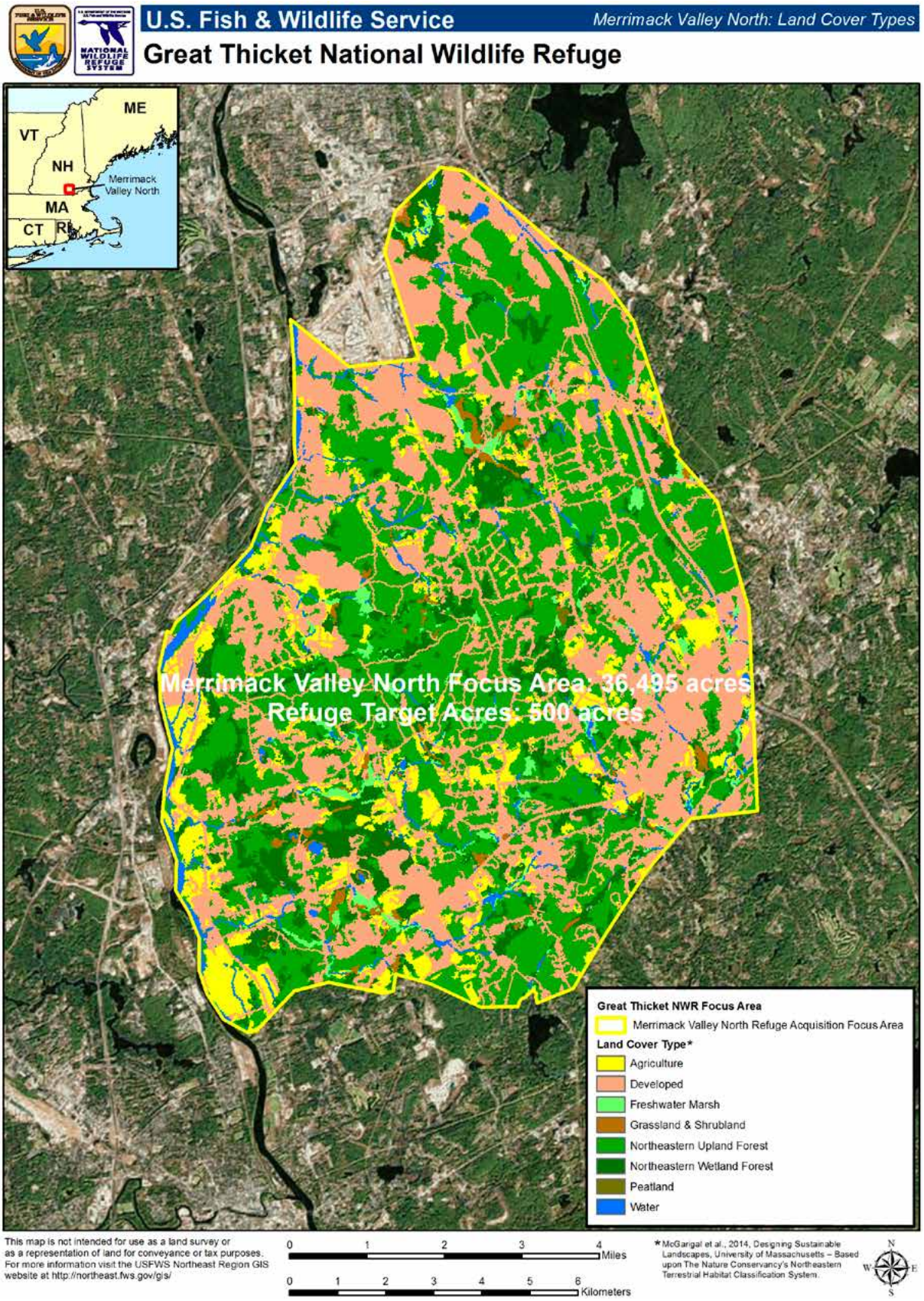
Regenerating young forest (aspen and birch) at Bellamy River Wildlife Management Area in Dover, New Hampshire

Emma Carcagno/UNH Cooperative Extension

Map 10: Merrimack Valley North Refuge Acquisition Focus Area



Map 11: Merimack Valley North Refuge Acquisition Focus Area: Land Cover Types



The archaeological record within this sub-region is complex and diverse. It has provided evidence of Native American settlement that began more than 11,000 years ago. The sub-region also witnessed early Euro-American exploration and colonization, which affected land use and local ecology.

The Merrimack Valley North RAFA is characterized by glaciated landscapes, with streams and wetlands. Although environmental transitions affected the types of plant and animal species that were available to Native Americans for their subsistence, their settlement systems appear to have been oriented around these freshwater resource areas throughout the ancient past. Consequently, undeveloped areas in settings such as wetland margins and zones near the Merrimack River have high sensitivity for Native American archaeological sites, including large and small settlements, and seasonal camps.

Euro-American settlement began in the mid-17th century, resulting in the initial occupation of Nashua (1655), Derry (1719), and Manchester (1722) near the focus area. Euro-American land use featured the establishment of villages and farms, and early industries such as grist mills, sawmills, lumber camps, and tanneries. Today, undeveloped locations that feature favorable agricultural soils in this

Habitat restoration area in Lee Five Corner Preserve in New Hampshire

Ted Kendziora/USFWS

RAFA, and are found near water sources, thoroughfares, or centers of colonial-period occupation, are likely to contain archaeological evidence of agrarian land use and settlement over the last three and a half centuries.

Lands within this sub-region that may be considered for acquisition are likely to include undeveloped, open spaces and current, or former agricultural areas. Depending on the proximity of such properties to freshwater resources (e.g., wetlands, streams, rivers) or to locations that witnessed historic land use (e.g., settlement, agriculture, early industries), expected historic properties in the acquired lands may include Native American and Euro-American archaeological sites, and historic agricultural structures.

Southeastern Massachusetts Sub-Region

This sub-region includes the Plymouth and Mashpee RAFAs. These RAFAs are located in the low elevation area near and on Cape Cod respectively. Shrubland habitats in these areas include pine barrens and scrub-oak shrublands that can be more permanent in nature. Approximately 43% of land within the two RAFAs is forested and 37% is developed. Within these two RAFAs, over 9,500 acres is currently protected. Of that total, State conservation land is 2,287 acres, and local government conservation land is 5,424 acres.

Table 16: Southeastern Massachusetts Sub-Region Conserved Lands

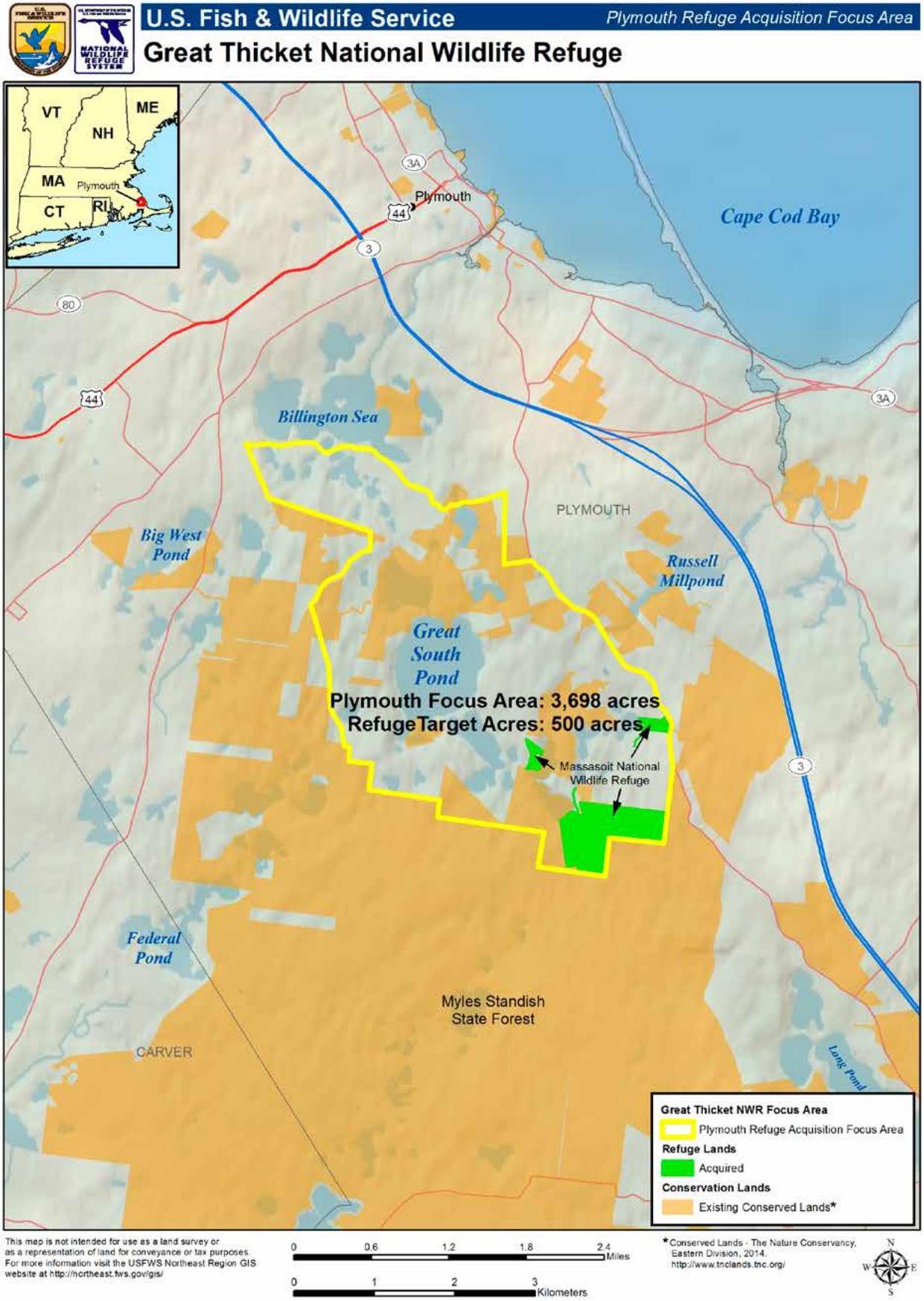
	Plymouth RAFA Acres	Mashpee RAFA Acres	Total
Federal	209	281	490
State	269	2,018	2,287
Local	577	4,847	5,424
Non-government conservation organization	148	726	874
Private landowner conservation easement	18	433	451
Total	**1,221**	**8,305**	**9,526**

Table 17: Southeastern Massachusetts Sub-Region Land Cover Types*

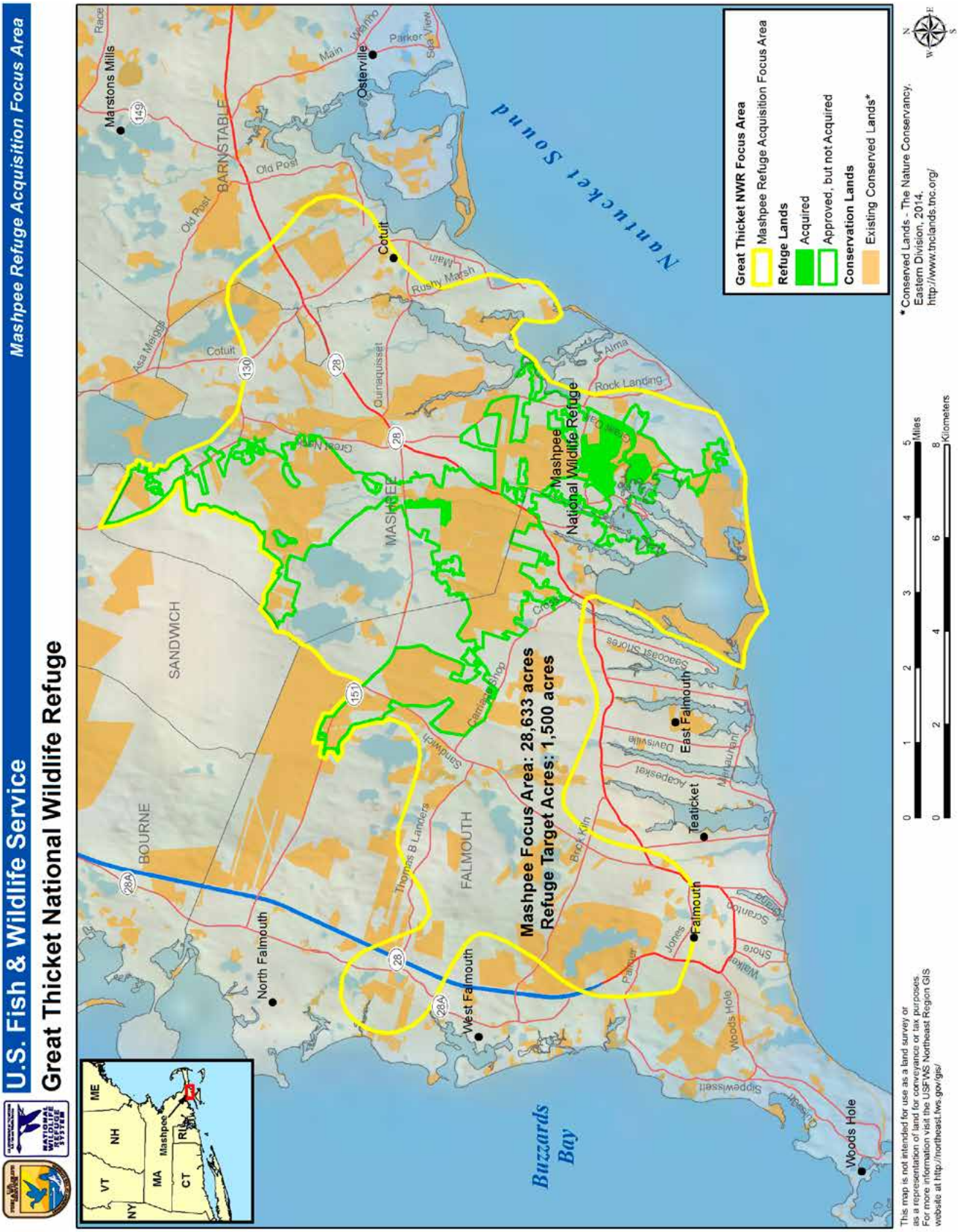
	Plymouth RAFA Acres	Mashpee RAFA Acres	Total
Grassland and Shrubland	62	422	484
Coastal Shrub-herb	0	461	461
Peatland	0	34	34
Northeastern Upland Forest	2,021	11,234	13,255
Northeastern Wetland Forest	0	688	688
Agriculture	431	382	813
Freshwater Marsh	16	292	308
Estuarine Intertidal	0	615	615
Open water	579	3,515	4,094
Developed	590	11,173	11,763
Total	**3,699**	**28,355**	**32,054**

**Note: Total acres for each RAFA may not exactly match those in Table 1 due to different GIS data types used in acreage calculations.*

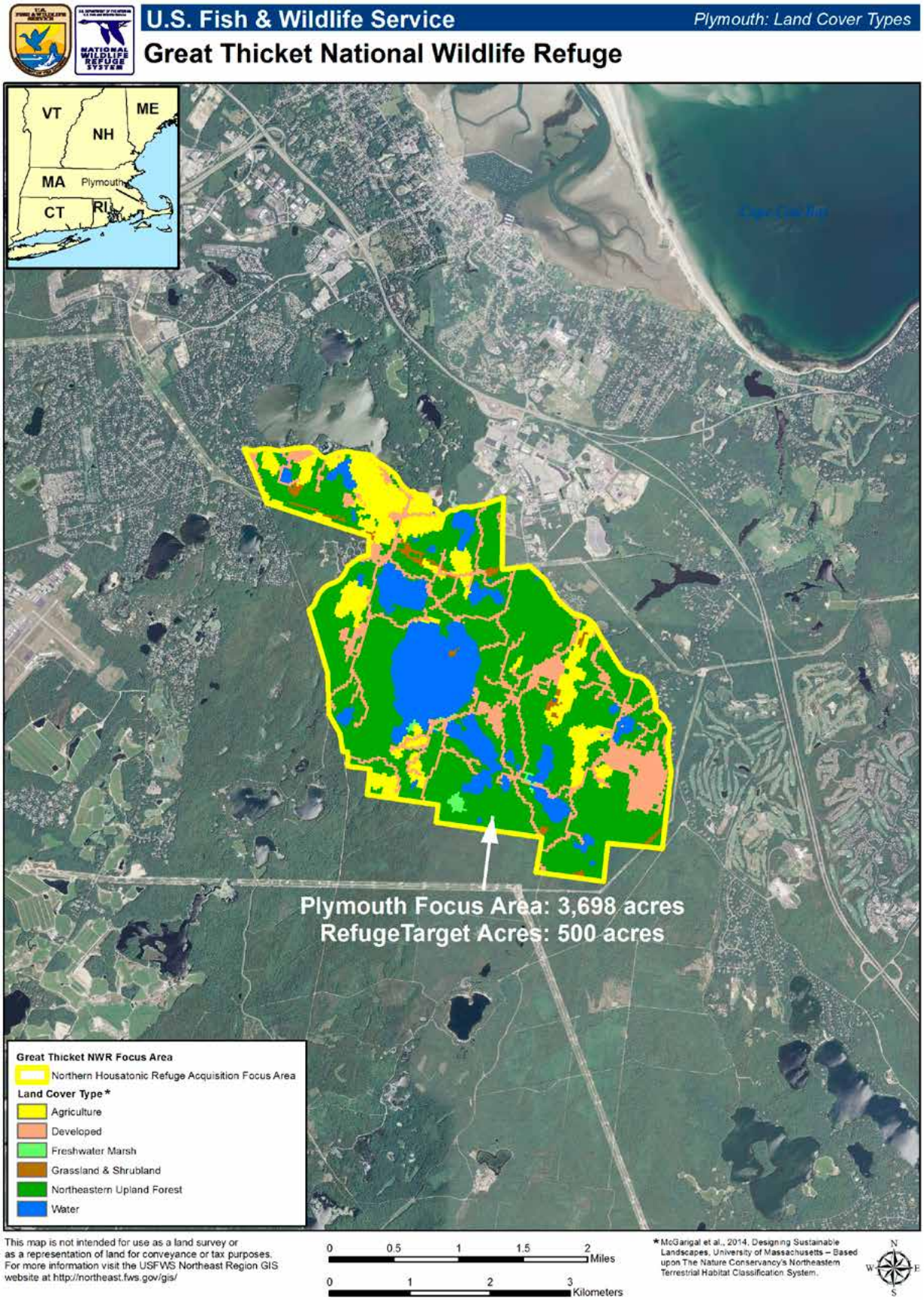
Map 12: Plymouth Refuge Acquisition Focus Area



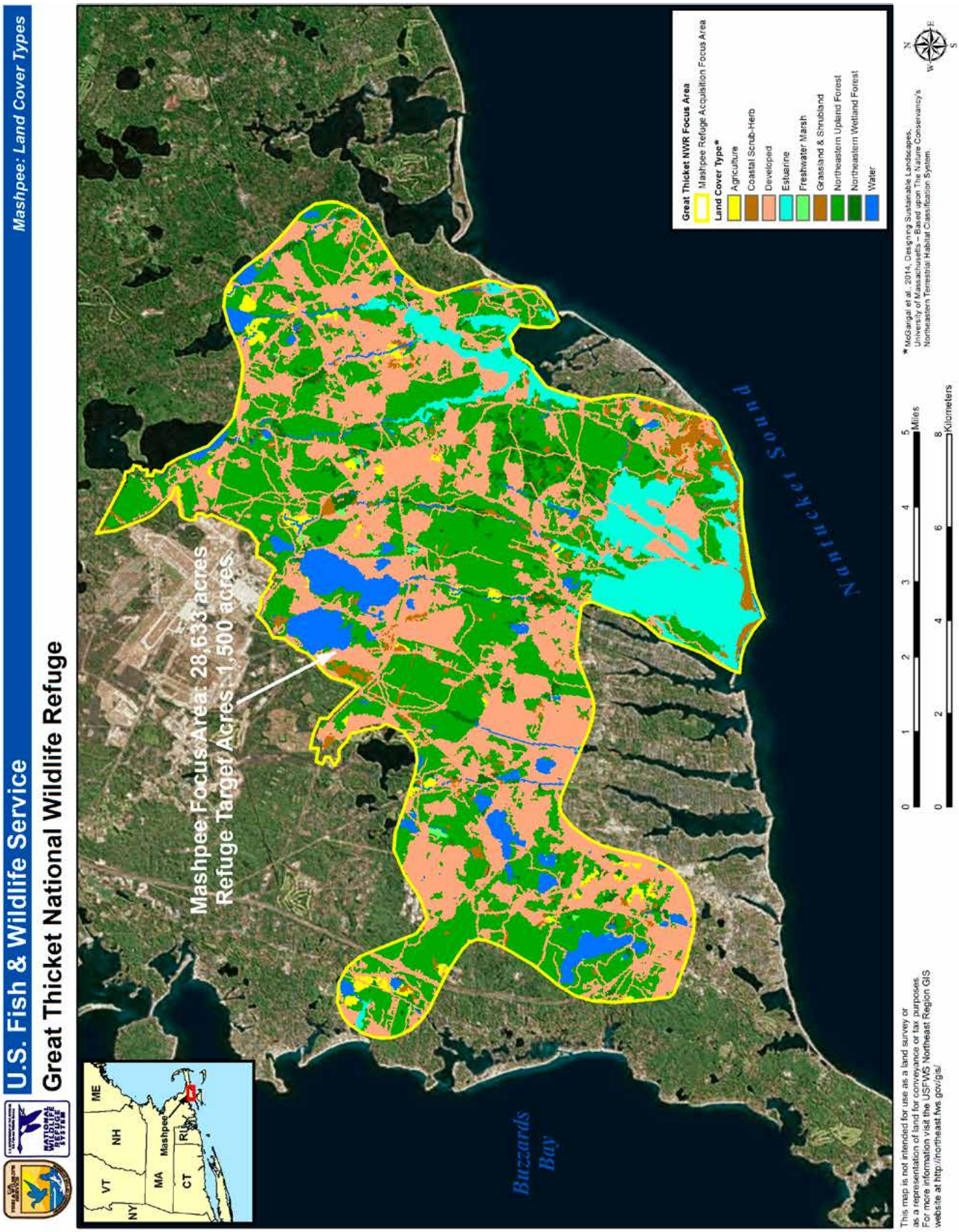
Map 13: Mashpee Refuge Acquisition Focus Area



Map 14: Plymouth Refuge Acquisition Focus Area: Land Cover Types



Map 15: Mashpee Refuge Acquisition Focus Area: Land Cover Types



The archaeological record within this sub-region is complex and diverse. It has provided evidence of Native American settlement that began more than 11,000 years ago. The area was continuously populated by indigenous people, even as profound changes in environmental conditions occurred, and the estuary systems, rivers, and coastline recognized today came into form. The sub-region also witnessed some of the earliest Euro-American exploration and colonization in North America, with consequences for land use and local ecology.

The Plymouth and Mashpee RAFAs are both characterized by glaciated landscapes, with numerous ponds, streams, and wetlands in proximity to the Atlantic coastline. Although environmental transitions affected the types of plant and animal species that were available to Native Americans for their subsistence, their settlement systems appear to have been oriented around these freshwater resource areas throughout the ancient past. Consequently, undeveloped areas in settings such as wetland margins have high sensitivity for Native American archaeological sites, including large and small settlements, seasonal camps, and burial grounds. Native American communities in this sub-region followed a seasonal round, favoring coastal settlements during the summer months and inland settlements during the winter. Today, the descendants of these Native American groups include the members of the two federally recognized Tribes in this sub-region: the Mashpee Wampanoag Tribe, and the Wampanoag Tribe of Gay Head (Aquinnah).

Historical Euro-American settlement began in the early 17th century, resulting in the founding of Plymouth and Mashpee near the two RAFAs. Euro-American land use featured the establishment of villages, farms, fishing and seafaring points, and early industries such as grist mills, sawmills, and tanneries. Today, undeveloped locations that feature favorable agricultural soils in the RAFAs, and are found near water sources, thoroughfares, or centers of early colonial occupation, are likely to contain archaeological evidence of agrarian land use and settlement over the last four centuries.

Management for shrubland wildlife in Connecticut

Bill Zimni/USFWS

Lands within this sub-region that may be considered for acquisition are likely to include undeveloped, open spaces and current, or former, agricultural areas. Depending on the proximity of such properties to freshwater resources (e.g., wetlands, streams, rivers) and to locations that witnessed historic land use (e.g., settlement, agriculture, early industries), expected historic properties in the acquired lands may include Native American and Euro-American archaeological sites, and historic agricultural structures.

Southeastern Connecticut/Rhode Island Coast Sub-Region

This sub-region includes the RI East-West and the Pachaug-Ledyard RAFAs. Similar to the Southeastern Massachusetts sub-region, these areas are relatively heavily developed with over 21 percent of the land within the two RAFAs considered developed. Only 8 percent of the land is in agricultural use and 58 percent is forested. Within these focus areas, there is over 5,400 acres of State conservation land and just over 5,700 acres of non-governmental conservation organization land.

Table 18: Southeastern Connecticut/Rhode Island Coast Sub-Region Conserved Lands

	RI East-West RAFA Acres	Pachaug-Ledyard RAFA Acres	Total
Federal	1,762	0	1,762
State	5,383	63	5,446
Local	3,352	879	4,231
Non-government conservation organization	5,057	732	5,789
Private landowner conservation easement	3,195	182	3,377
Total	**18,749**	**1,856**	**20,605**

Table 19: Southeastern Connecticut/Rhode Island Coast Sub-Region Land Cover Types*

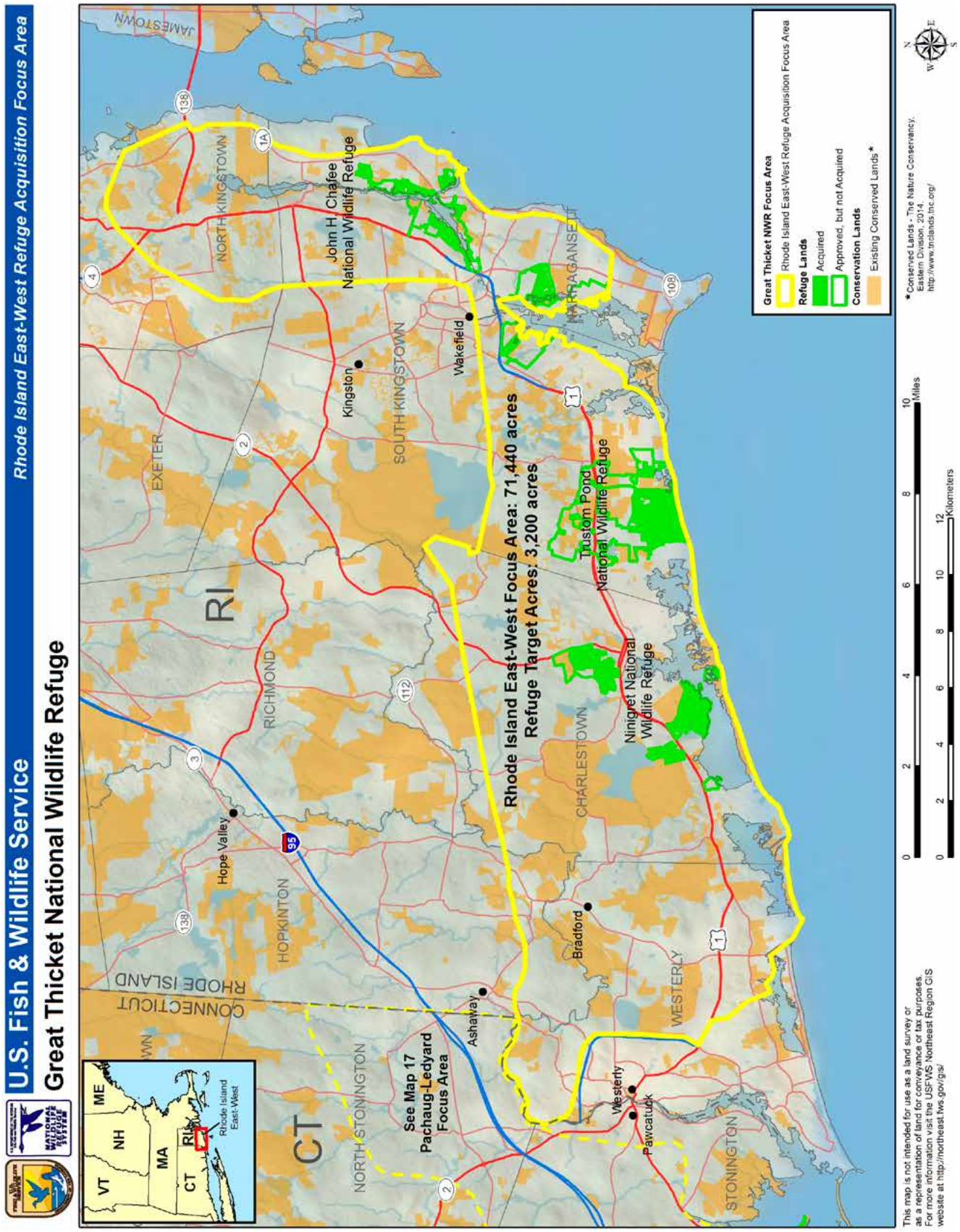
	RI East-West RAFA Acres	Pachaug-Ledyard RAFA Acres	Total
Grassland and Shrubland	2,010	463	2,473
Coastal Shrub-herb	1,292	342	1,634
Peatland	56	6	62
Northeastern Upland Forest	25,964	18,960	44,924
Northeastern Wetland Forest	14,078	4,520	18,598
Agriculture	3,732	5,195	8,927
Freshwater Marsh	324	60	384
Estuarine Intertidal	1,690	129	1,819
Open water	6,462	1,209	7,671
Developed	15,817	7,195	23,012
Total	**71,425**	**38,079**	**109,504**

**Note: Total acres for each RAFA may not exactly match those in Table 1 due to different GIS data types used in acreage calculations.*

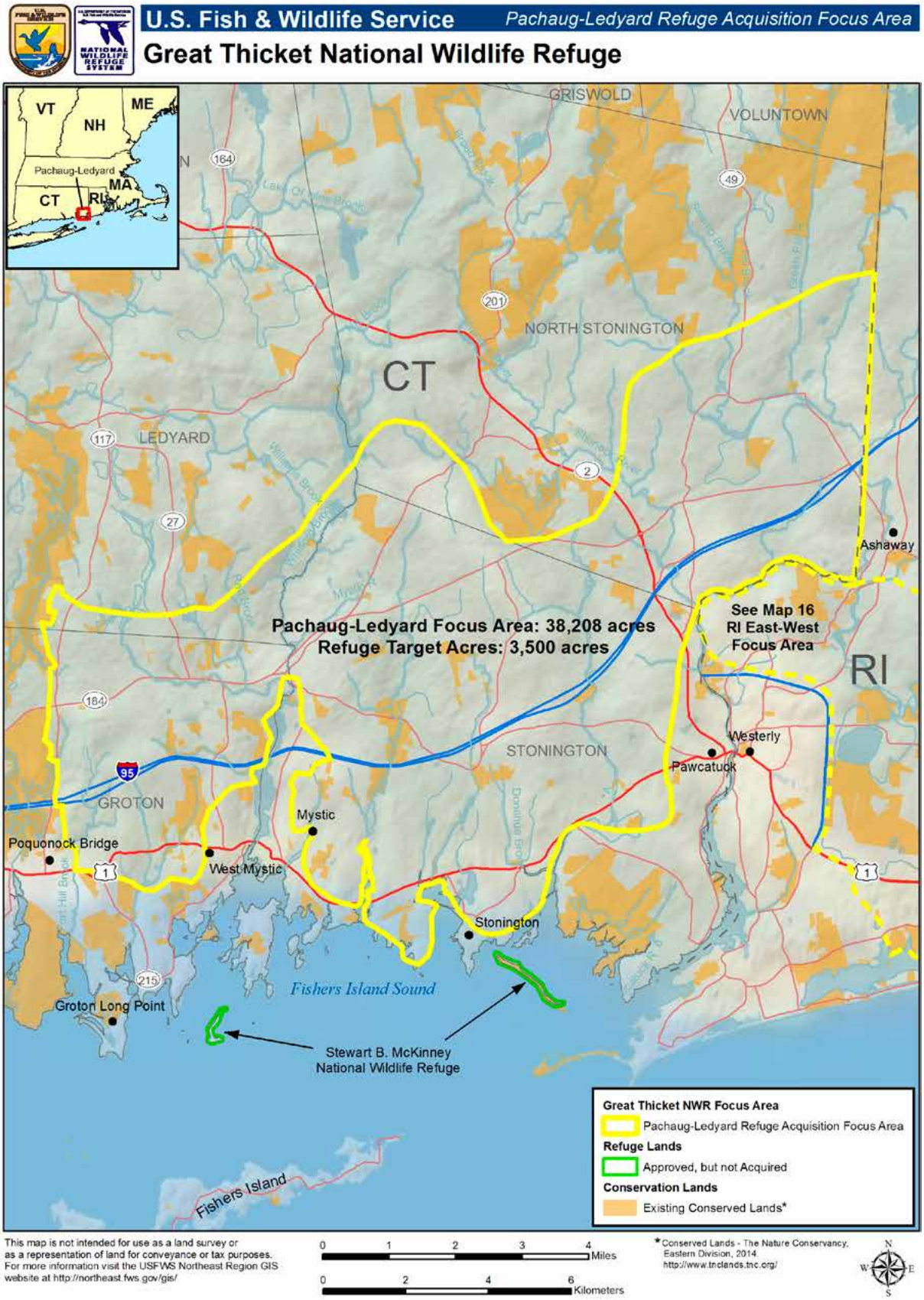
The archaeological record within this sub-region has provided evidence of Native American settlement that began more than 11,000 years ago. Indigenous people adapted to profound changes in environmental conditions, as the estuary systems, rivers, and coastline recognized today came into form. This sub-region also witnessed early Euro-American exploration and colonization, which affected land use and local ecology.

The Rhode Island East-West and Pachaug-Ledyard RAFAs are both characterized by glaciated landscapes, with numerous ponds, streams, rivers, and wetlands, many of which are close to the Atlantic coastline. Although environmental transitions affected the types of plant and animal species that were available to Native Americans for their subsistence, their settlement systems appear to have been oriented around these freshwater resource areas throughout the ancient past. Consequently, undeveloped areas in settings such as wetland margins have high sensitivity for Native American archaeological sites, including large and small settlements, and seasonal camps. Today, the descendants of these Native American groups include the members of the federally recognized Tribes in this sub-region: the Narragansett Indian Tribe, the Mashantucket Pequot Tribal Nation, and the Mohegan Tribe of Indians of Connecticut.

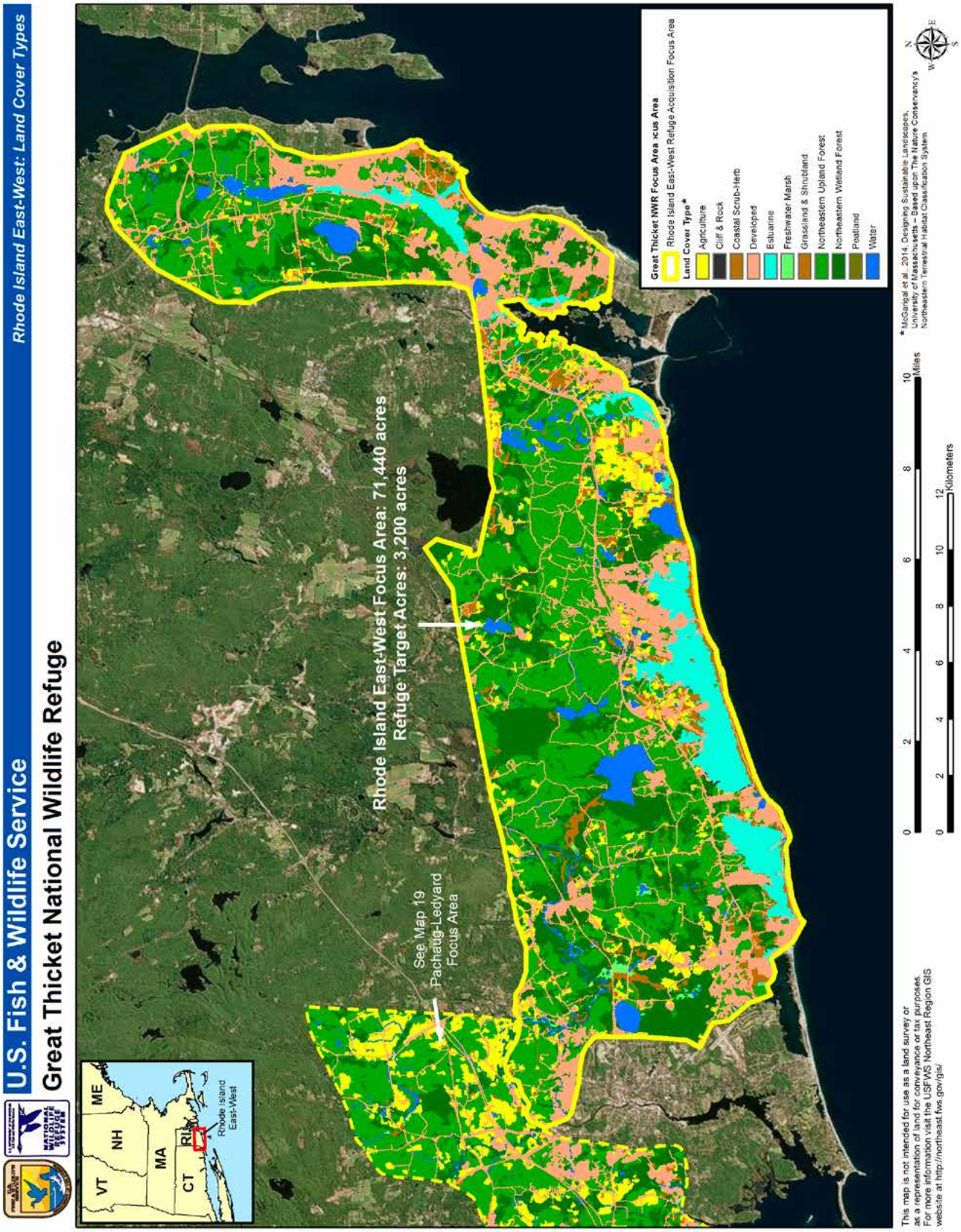
Map 16: Rhode Island East-West Refuge Acquisition Focus Area



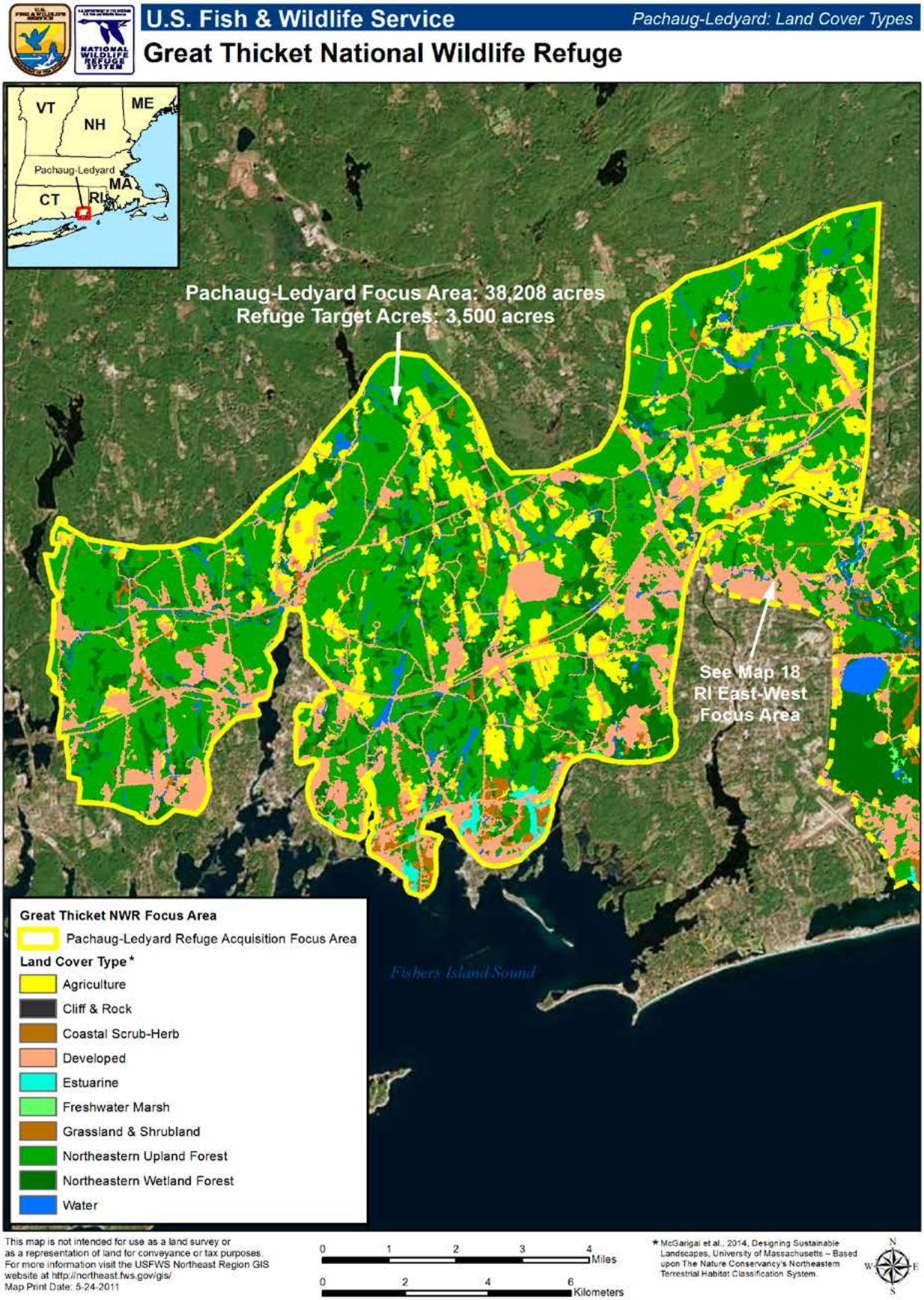
Map 17: Pachaug-Ledyard Refuge Acquisition Focus Area



Map 18: Rhode Island East-West Refuge Acquisition Focus Area: Land Cover Types



Map 19: Pachaug-Ledyard Refuge Acquisition Focus Area: Land Cover Types



Euro-American settlement within the RAFAs began in the early 17th century, resulting in the founding of numerous colonial towns. Euro-American land use featured the establishment of villages, farms, fishing and seafaring points, and early industries such as grist mills, sawmills, and tanneries. Today, undeveloped locations that feature favorable agricultural soils in the RAFAs and are found near water sources, thoroughfares, or centers of early colonial occupation, are likely to contain archaeological evidence of agrarian land use and settlement over the last four centuries.

Lands within this sub-region that may be considered for acquisition are likely to include undeveloped, open spaces and current, or former, agricultural areas. Depending on the proximity of such properties to freshwater resources (e.g., wetlands, streams, rivers) and to locations that witnessed historic land use (e.g., settlement, agriculture, early industries), expected historic properties in the acquired lands may include Native American and Euro-American archaeological sites, and historic agricultural structures.

New York/Connecticut Border Sub-Region

The Northern Housatonic RAFA is the only focus area in this sub-region. This area is less than 10 percent developed and is over 60 percent forested. It also has 23 percent classified as agriculture. Within the Northern Housatonic RAFA, 2,216 acres of land are protected. Of that total, over 800 acres are owned by non-government conservation organizations and over 550 acres is protected as Federal land.

Table 20: New York/Connecticut Border Sub-Region Conserved Lands

Ownership	Northern Housatonic RAFA Acres
Federal	557
State	429
Local	156
Non-government conservation organization	832
Private landowner conservation easement	242
Total	**2,216**

Table 21: New York/Connecticut Border Sub-Region Land Cover Types*

Land Cover Types	Northern Housatonic RAFA Acres
Grassland and Shrubland	447
Northeastern Upland Forest	19,683
Northeastern Wetland Forest	1,199
Agriculture	7,619
Freshwater Marsh	738
Open water	903
Developed	2,895
Cliff and Rock	303
Total	**33,787**

**Note: Total acres for each RAFA may not exactly match those in Table 1 due to different GIS data types used in acreage calculations.*

New England cottontails use thick shrubs and young trees to hide from predators.

Emily Reuber/SUNY-ESF

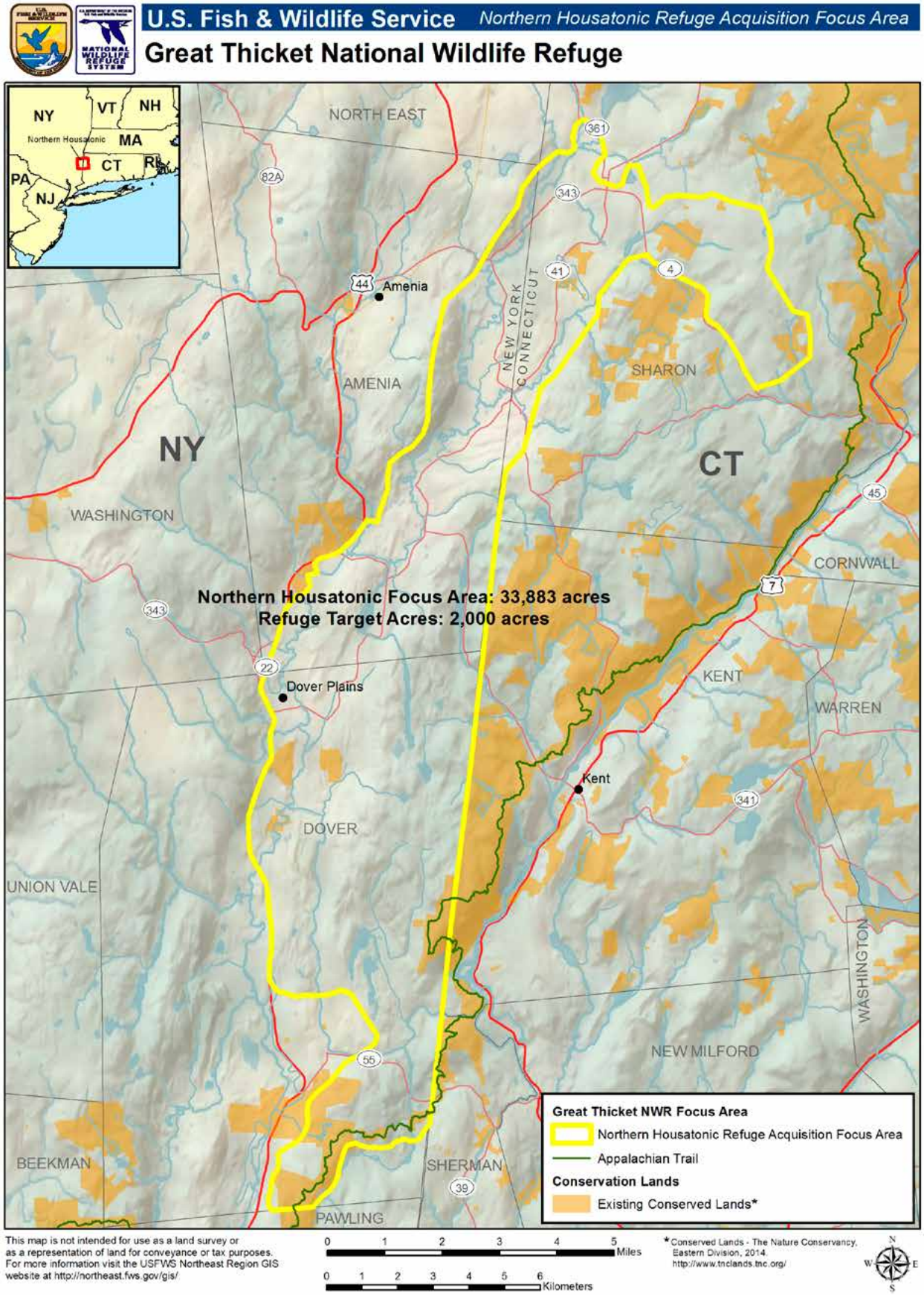
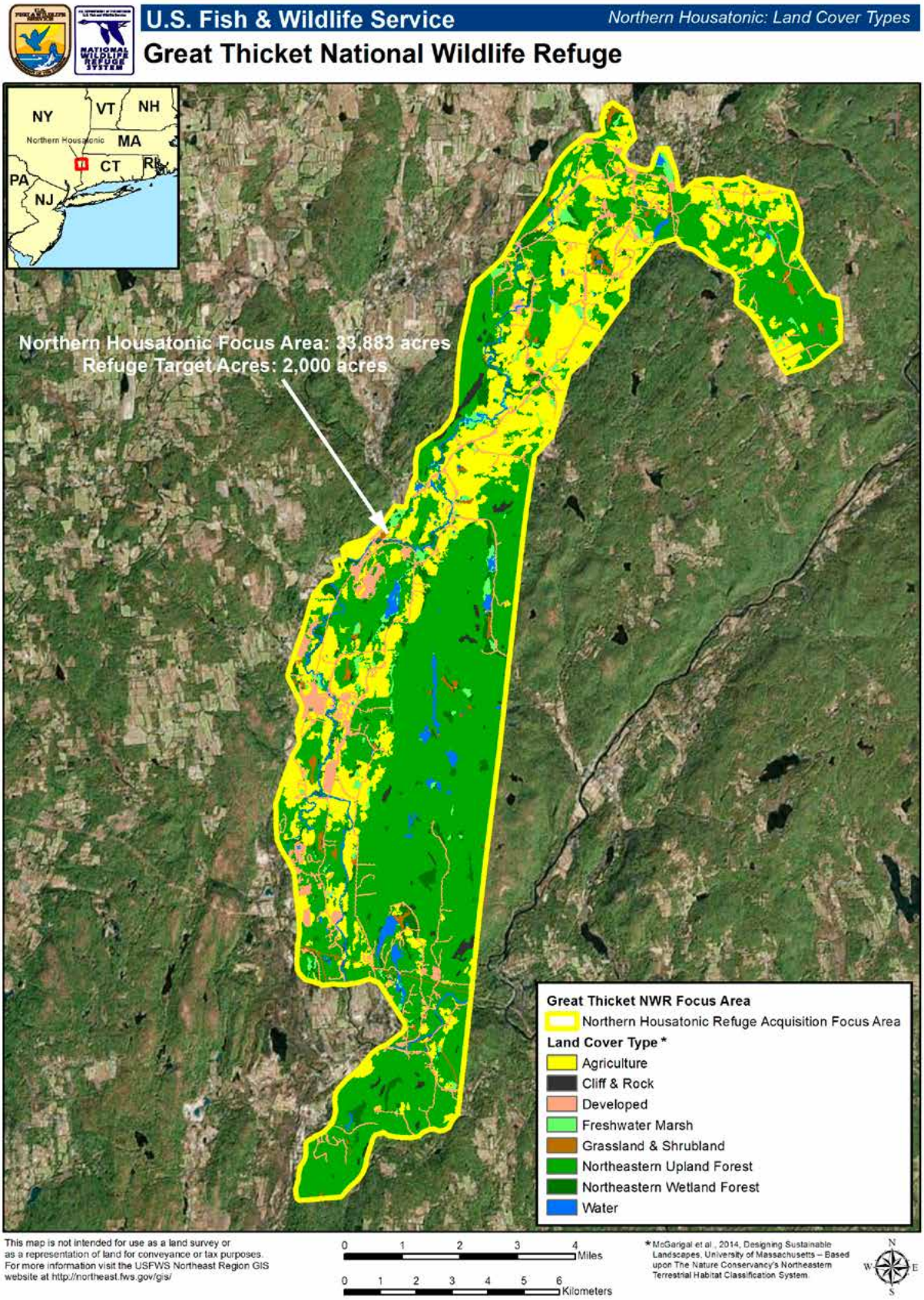
The archaeological record within this sub-region has provided evidence of Native American settlement that began more than 11,000 years ago. There is archaeological evidence of settlement occurring in subsequent periods, up until the time of European contact, although this area was somewhat isolated from more focal areas of Native American settlement within the Hudson River Valley, the lower Housatonic River drainage, and in coastal Connecticut. Even until the early 18th century, the lands within the Northern Housatonic RAFA were not well-known to the colonial authorities of New York and Connecticut.

The Northern Housatonic RAFA is characterized by a glaciated landscape, with multiple ponds, streams, and wetlands distributed among rugged, forested ridges and gently rolling valley floors. Although changing environmental conditions affected the types of plant and animal species that were available to Native Americans for their subsistence, their settlement systems appear to have been oriented around these freshwater resource areas throughout the ancient past. Consequently, undeveloped areas in settings such as wetland margins have high sensitivity for Native American archaeological sites, including long-term settlements and seasonal camps. Today, the descendants of the Native American people of this RAFA include members of the federally recognized Stockbridge-Munsee Band of the Mohican Nation.

Historical Euro-American settlement began in the late 17th and early 18th centuries, resulting in the founding of multiple townships near the Northern Housatonic RAFA. Euro-American land use featured the establishment of villages, farms, and early industries such as grist mills, sawmills, and iron works. Today, undeveloped locations that feature favorable agricultural soils in this sub-region, and are found near water sources, thoroughfares, or centers of colonial occupation, are likely to contain archaeological evidence of agrarian land use and settlement over the last three centuries.

Lands within this sub-region that may be considered for acquisition are likely to include undeveloped, open spaces and current, or former, agricultural areas. Depending on the proximity of such properties to freshwater resources (e.g., wetlands, streams, rivers) and to locations that witnessed historic land use (e.g., settlement, agriculture, early industries), expected historic properties in the acquired lands may include Native American and Euro-American archaeological sites, and historic agricultural structures.

Map 20: Northern Housatonic Refuge Acquisition Focus Area



Map 21: Northern Housatonic Refuge Acquisition Focus Area: Land Cover Types