Chapter 3

Small waterfall on Ted's Trail
Lelaina Marin/USFWS

Affected Environment

- Introduction
- Geology and Land Use Setting
- Regional Demographics and Economic Setting
- Refuge Staffing and Operations
- Habitat Types and Vegetation
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Introduction

This chapter discusses the physical, biological, and human environment of the refuge.

Geology and Land Use Setting

Geology

The bedrock in this region is a type of rock is known as the Littleton Formation: schist and quartzite formed by the metamorphosis of shale and sandstone during the late Devonian period. The dominant subtypes in the Wapack Range are grey micaceous quartzite, grey coarse mica schist and rust-colored sulfidic schist. They provide little buffering of soil pH, resulting in acidic soils. However, over 18 percent of the area from Crotched Mountain to Temple Mountain contains mica schist that is capable of leaching calcium into groundwater seeps and springs, which in turn may enrich the soil. Those enriched areas have the potential to support communities of rare plants (Van de Poll 2006).

The Littleton Formation is very resistant to weathering, resulting in many monadnocks in the region. A monadnock—named for Mount Monadnock—is a resistant mountain rising above an eroded plain. That resistance varies according to the relative concentrations of various minerals in the Littleton Formation. That variation creates the hills and valleys of the Wapack Range (Flanders 2006).

Glaciers started advancing over the region about one million years ago, the last retreating about 10,000 years ago. They scoured the area, removing topsoil and eroding and polishing the bedrock. Groove marks oriented north-south can be seen in the bedrock along parts of the Wapack Trail. As the glacier moved up and over North Pack Monadnock, its rate of movement slowed, and glacial till dropped on the north and west slopes. As it moved down the south slope, it gouged away bedrock, creating steep slopes and cliffs on the south and east slopes. A hill or mountain created by such glacial activity is called a whaleback hill or a *roches moutonnees* (Flanders 2006).

The geology of the refuge has helped form habitat for many species of plants and animals, some of which are either rare or unique in southern New Hampshire. The mountains and valleys also create a setting for the Wapack Trail, which offers diverse woodland settings and ridge-top views.

Water

The Wapack Range is the source of the headwaters of the Contoocook and Souhegan rivers. The north slopes of North Pack Monadnock drain into Otter Brook, while the east slopes drain into Stoney Brook. Those brooks provide riparian habitat, groundwater recharge areas and vertical migration corridors (Van de Poll 2006).

Land Use

Since the retreat of the glaciers, erosion and weathering have worked slowly to create topsoil and influence the landscape of the Monadnock region of today. More recently, human influence has helped shape the landscape. Evidence shows use by Abenaki Indians for hunting before Europeans settled in the area. The Abenaki used burning to facilitate hunting, possibly clearing the forests of understory plants at that time. The first significant influx of Europeans in the late eighteenth and early nineteenth centuries cleared more than 55 percent of the land for farming. Thin soils on steep slopes were subject to water and wind erosion during this time period (Wessels 1997).

In the eighteenth and nineteenth centuries, sheep and cattle were pastured on the hillsides and many stone walls were built to clear fields of rocks and define property boundaries. Raising cattle remained economically viable until the end of the nineteenth century. At that time, fields were abandoned and allowed to grow back into forest. Throughout the 1900s, forests in the area were logged when demand was high.

Since the last period of significant deforestation in the 1940s, timber harvests have been selective, resulting in mixed-aged stands. Coinciding with the decline in agriculture, railroads started bringing visitors to the area for vacations. The mountains became a place for people to hike, relax and get away from the crowded cities. People began to build summer homes in the area, and as mobility and the ability to work from home increased, the year-round population began to climb in the 1970s.

Climate

The climate in this region provides abundant rainfall, potentially heavy snowfall, and a wide range of temperatures that helps to create the habitat types on the refuge. Although the refuge lies about 50 miles from the ocean, it has an inland climate. Its proximity to the ocean exposes it to hurricanes, and nor'easters that form off the coast can cause heavy snowfalls in winter or heavy rains in other seasons. The temperature extremes range from -35° to 90°F, with a summer average around 70˚F. The prevailing summer winds are west to southwest; prevailing winter winds tend west to northwest. The average precipitation for Peterborough, NH, approximately 5 miles from the refuge, is 44.6 inches a year.

Air Quality

The New Hampshire Department of Environmental Services (NH DES) says that air quality for the state is relatively good. Carbon monoxide, sulfur dioxide and particulate matter levels have decreased steadily since the 1980s. Despite emission controls, levels of nitrous oxide have remained constant due to the increased use of gas and diesel engines. An ozone smog forms on one out of every four or five days during the summer; the most affected areas lie in the southeastern part of the state. High ozone levels in New Hampshire are caused primarily by the transport of ozone and its precursors from areas upwind, in the Northeast and industrial Midwest. Acid rain, also known as acid deposition, is also believed to originate in the industrial Midwest, from coal-burning power plants (NH DES 2007).

Global Climate Change

Global climate change is a significant concern for the wildlife conservation community. The Service takes this issue very seriously, and is working with partners to analyze how a rise in global temperatures may affect plants, fish and wildlife across the continent, and how our management practices may have to change. For example, wildlife, and the plants that sustain them, could be greatly affected if they require a minimum temperature to initiate certain biological changes, such as seed germination or hibernation. Some species might face drastic changes or reductions in their distribution and range, and breeding success, thereby affecting their total population. Other species able to adapt quickly might react to those climate changes with population increases and range expansions. We expect that species ranges will shift northward or toward higher elevations as temperatures rise, but those responses likely will vary highly among species.

Climate change is already documented as affecting the timing of migration and reproductive success in birds. Some species have been shown to start migrating earlier in the spring and breeding earlier. Impacts on species ranges are predicted as habitats fluctuate, influencing the availability of food, breeding habitat and the length of the breeding season, and competition with other species for resources. Changes in bird ranges will in turn affect seed dispersal and pollination for plants, nutrient cycling, and natural pest control.

Since amphibians "breathe" through their porous skins during all the stages of their life cycle, they are considered especially sensitive to changes in temperature and precipitation in their environment. Most amphibian activities are triggered by rain and temperature conditions; thus, distribution and population size will change significantly if air and water temperatures change.

Global climate change may also threaten aquatic and semi-aquatic amphibians and reptiles by reducing wetland acreage due to the frequency and severity of storms and sea level rise. Latitudinal shifts in temperature and precipitation patterns also have implications to both the local and regional distribution of amphibians and reptiles, especially those on the edges of their ranges (*http://www.parcplace.org/education.html#threats*).

Global warming's effect on carbon sequestration is something we are considering in our comprehensive conservation planning. The Department of Energy defines carbon sequestration as "the capture and secure storage of carbon that otherwise would be emitted to or remain in the atmosphere" (DOE Office of Fossil Energy and Office of Science 1999). Vegetated land is a tremendous factor in carbon sequestration. Terrestrial biomes of all sorts—grasslands, forests, wetlands, tundra, and deserts—are effective both in preventing carbon emission and in acting as biological "scrubbers" of atmospheric CO_2. The DOE notes that ecosystem protection is important for carbon sequestration, and may reduce or prevent the loss of carbon now stored in the terrestrial biosphere. The actions we propose in this CCP would conserve land and habitat, and thus, would retain the carbon sequestration on the refuge. That, in turn, would contribute positively in mitigating human-induced global climate change.

The forests of New Hampshire are very important resources for ecological and economic reasons; the changes facing them will have profound effects. In response, both state and federal agencies have initiated studies to plan for and anticipate impacts.

Regional Demographics and Economic Setting

Population and Demographics

Southern New Hampshire's proximity to metropolitan areas, like Boston, Massachusetts and Manchester, New Hampshire, exposes it to urban sprawl. As the real estate in those areas becomes scarcer and more expensive, city residents look outward for more affordable housing. In addition, New Hampshire offers outdoor recreation and beautiful landscapes.

An analysis of population data by the New Hampshire Office of Energy and Planning (NH OEP) shows that the state can be divided casually into the slow-growing north and the fast-growing south. Since 1960, New Hampshire's population has increased by about 703,000. More than 60 percent of that growth occurred in Hillsborough and Rockingham counties. The population trend for state counties between 1960 and 2000 shows that Hillsborough County has the greatest share. Projections for 2010–2030 show that the county will maintain the highest share of state population. However, growth is expected to shift away from the county because of the decreasing availability and increasing cost of land, and greater freedom of location in the future (NH OEP 2006). The estimated 2006 population of Hillsborough County is 402,789, an increase of 66,716 since 1990 (US DOC 2006a). Hillsborough County's 876 square miles contained 460 persons per square mile in 2006, compared to 934 square miles of land area and 159 persons per square mile in Merrimack County, which borders Hillsborough County to the north (US DOC 2006b).

The population between the ages of 20 and 54 in 2005 was estimated at 201,157, more than half of the total population in Hillsborough County. The number of people moving into new homes between 2000 and 2005 was estimated at 68,888, compared to 24,643 people between 1995 and 1999. The US DOC estimates that 209,874 workers in Hillsborough County are age 16 and over, of which 195,694 drive, carpool, or take public transportation an average of 25 miles to work (US DOC 2005).

Business and Economic Climate

In Hillsborough County, management, service occupations, sales and office occupations make up 78 percent of the workforce, while the other 22 percent work in farming, construction, and manufacturing. In 2005, the median household income in Hillsborough County was estimated at $60,913, compared to the national average of $46,242 (US DOC 2005). Service industry jobs, including health care, education, and social assistance, are the number one employers in the county.

The Monadnock region of southern New Hampshire attracts visitors from all over New England. The appreciation of the landscape has fostered conservation efforts through which a significant amount of land surrounding the refuge has been preserved. That includes the NH Division of Parks and Recreation Miller

State Park and The Nature Conservancy Joanne Bass Bross Preserve. Both increase the opportunities for outdoor recreation.

Outdoor activities such as skiing, hiking, and observing wildlife are important components of New Hampshire's economy. Tourists spent around $2.2 billion on meals and rental tax in 2004, an increase of 5.4 percent from the previous year (Josten and Picard 2006). In 2004, every county in New Hampshire recorded increases in retail sales of outdoor equipment. Just over half of the $2.7 billion increase in sales was spent in either Hillsborough or Rockingham counties (Josten and Picard 2006).

Refuge Contributions to the Local Economy

A national wildlife refuge provides many benefits to the local economy. Those include the benefits of open space and associated reduced cost of community services and increased property tax values, revenues from the refuge revenue sharing program, and, revenues from refuge visitors who purchase equipment, lodging, or meals.

Refuge Revenue Sharing

Under the Refuge Revenue Sharing Act of June 15, 1935, local taxing authorities receive refuge revenue sharing payments based on the acreage and value of refuge land in their jurisdiction. The payments are calculated in one of three formulas, whichever yields the highest amount: three-quarters of 1 percent of the appraised value of that land, 25 percent of the gross receipts from the sale of refuge products, or 75 cents per acre of land held in fee title. We reappraise the value of refuge land every 5 years. Until we reappraise a newly acquired property, the formula uses the purchase price.

The money for refuge revenue sharing payments comes from the sale of oil and gas leases, timber, grazing, and other Refuge System resources, and from congressional appropriations. Those appropriations are intended to make up the difference between the net receipts in the refuge revenue sharing fund and the total amount due to local taxing authorities. The actual amount paid varies from year to year, because Congress may or may not appropriate funds sufficient for payments at full entitlement. Refuge revenue sharing payments are provided to the Towns of Greenfield and Temple (table 3.1).

Table 3.1. Refuge revenue sharing payments to the towns of Greenfield and Temple, 2000–2006

Years	*Town of Greenfield*	*Town of Temple*
2000	$2,422	$1,018
2001	$2,472	$1,040
2002	$2,309	$971
2003	$2,420	$1,017
2004	$2,140	$900
2005	Not Available	$1,016
2006	$2,237	$940

Revenues from Wildlife Watching

The refuge provides opportunities for wildlife watching enthusiasts, which aligns to local and statewide economic benefits. Those benefits are due to trip-related amenities such as food, lodging, transportation and other costs, such as equipment rental. According to the Service publication "2006 National Survey of Fishing, Hunting, and Wildlife-Associated Recreation" (USFWS & US DOC 2007a), 698,000 people participated in wildlife watching in the State of New Hampshire. A Service study also found that, in New Hampshire, resident and non-resident wildlife watchers respectively spent about $27 and $151 per person, per day (USFWS 2003).

Benefits of Open Space

Forests can bring in a lot of revenue for the surrounding community. In 2001, for example, revenues from forest-related recreation and tourism in New Hampshire totaled $940 million (NEFA 2004). A review of cost of community services studies compared the cost per dollar of revenue generated by residential or commercial development to that of revenue and savings generated by an open space designation. On the one hand, residential development expands the tax base, but the costs of increased infrastructure and public services (e.g., schools, utilities, and emergency and police services) often offset any increases in tax revenue. On the other hand, undeveloped land requires few town services and places little pressure on the local infrastructure. That results of that review show that favoring residential development at the expense of open land does not alleviate the financial problems of communities, but rather, is likely to exacerbate them (Crompton 2004).

Refuges also provide valuable recreational opportunities for local residents, and maintain a rural character important to many people's quality of life. Ecologically, refuges maintained as natural lands perform valuable services in a local community, such as the filtration of pollutants from soil and water that otherwise would have to be provided technologically at great expense.

Refuge Staffing and Operations

We discussed previously in both chapters 1 and 2 that the Service's 2006 Regional Strategic Downsizing Plan includes the decision to de-staff Great Bay refuge, which currently administers Wapack refuge. In 2008, both of those refuges will be administered by Parker River refuge in Newburyport, Massachusetts. Up through fiscal year (FY) 2007, the budgets of Great Bay and Wapack were combined and the refuge manager made decisions about how to spend those funds based on annual priorities. The FY2007 operations and maintenance budget for the combined refuges was $287,512.68. Currently, there are no buildings or other structures located on Wapack refuge.

Habitat Types and Vegetation

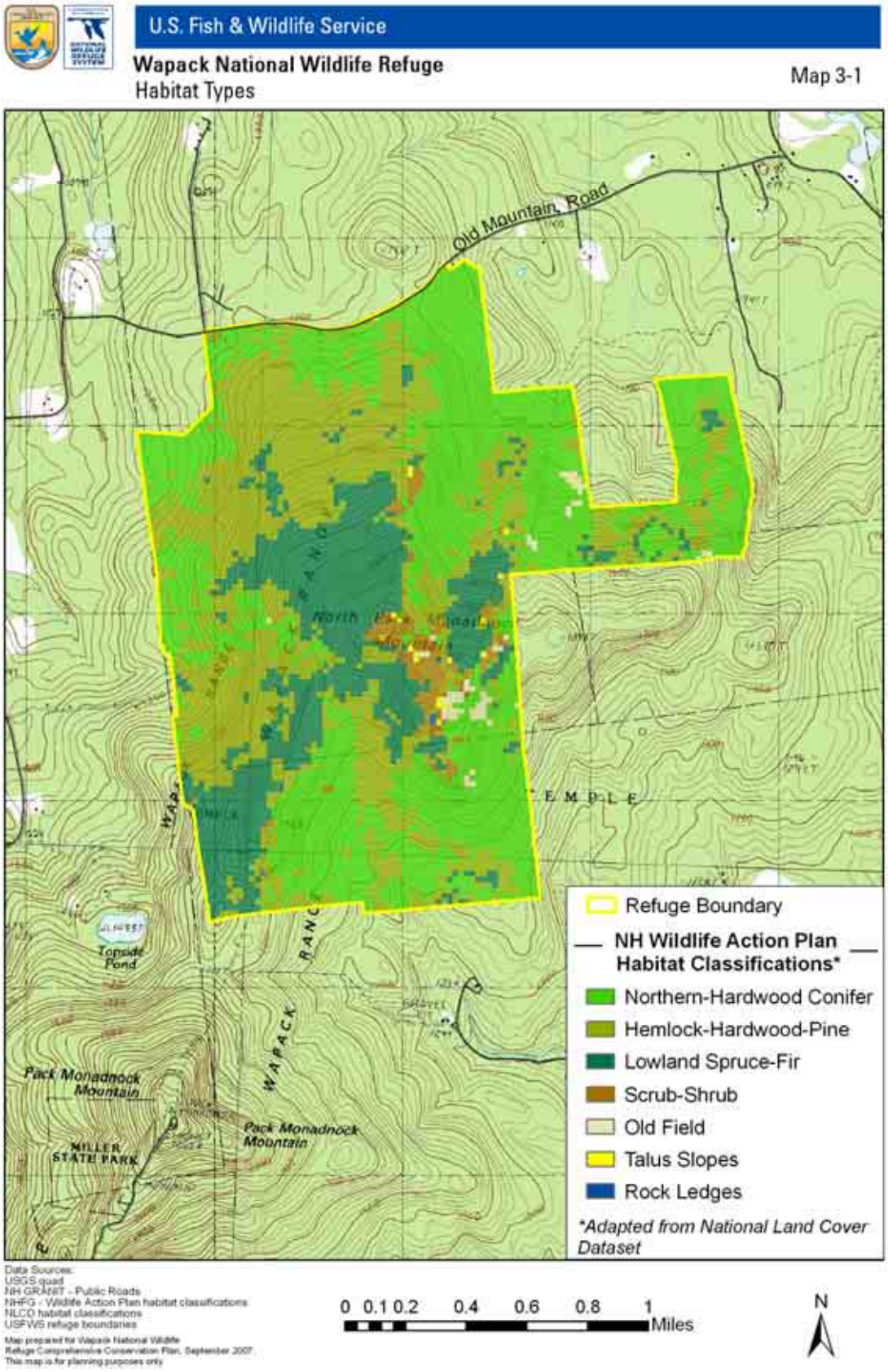
The following table summarizes the major habitat types on the refuge. Map 3-1 shows where they occur on the refuge. We have also included a narrative description of each habitat type.

Table 3.2. Acreage of habitat types at Wapack refuge

Habitat Type	*Acres**
Northern Hardwood-Conifer	710
Hemlock-Hardwood Pine	560
Lowland Spruce-Fir	329
Old Field	38
Scrub-Shrub	14
Talus Slopes	<5
Rock Ledges	<5

Source: National Land Cover Dataset, U.S. Geological Survey

**acres are approximated based on GIS data.*


U.S. Fish & Wildlife Service
Wapack National Wildlife Refuge
Habitat Types
Map 3-1
Old Mountain Road
Topside Pond
Pack Monadnock Mountain
Pack Monadnock Mountain
MILLER STATE PARK
Refuge Boundary
NH Wildlife Action Plan Habitat Classifications*
Northern-Hardwood Conifer
Hemlock-Hardwood-Pine
Lowland Spruce-Fir
Scrub-Shrub
Old Field
Talus Slopes
Rock Ledges
*Adapted from National Land Cover Dataset
Data Sources:
USGS quad
NH GRANIT - Public Roads
NHFG - Wildlife Action Plan habitat classifications
NLCD habitat classifications
USFWS refuge boundaries
Map prepared for Wapack National Wildlife Refuge Comprehensive Conservation Plan, September 2007
This map is for planning purposes only
0 0.1 0.2 0.4 0.6 0.8 1 Miles
N

Northern Hardwood-Conifer Forest

The northern hardwood-conifer forest is found around the refuge in the mid-and upper-elevations, serving as a transition from the lower hemlock-hardwood-pine forest to the high elevation spruce-fir forest. This is the most abundant refuge habitat type. Approximately 710 acres of northern hardwood-conifer forest are present on the refuge (table 3.2, map 3-1). The northern hardwood-conifer forest is characterized by American beech (*Fagus grandifolia*), sugar maple (*Acer saccharum*), and yellow birch (*Betula alleghaniensis*) (NHFG 2005). The northern hardwood-conifer forest supports a large diversity of plant life. The most common tree types are yellow birch (*Betula alleghaniensis*), eastern hemlock (*Tsuga canadensis*), American beech (*Fagus grandifolia*), white pine (*Pinus strobus*) and red oak (*Quercus rubra*). The understory of the northern hardwood-conifer forest is very diverse, including striped maple (*Acer pensylvanicum*), high bush blueberry (*Vaccinium corymbosum*), mountain laurel (*Kalmia latifolia*), and hobblebush (*Viburnum lantanoides*). Ephemeral plants and other woodland wildflowers thrive in this forest type. Trillium (*Trillium spp.*), goldthread (*Coptis trifolia*), wild sarsaparilla (*Aralia nudicaulis*), pink lady's slipper (*Cypripedium acaule*), wood sorrel (*Oxalis violacea*) and several ferns (*Pteridophyta spp.*) are found in the herbaceous layer of this forest type (Sperduto and Nichols 2004).

Hemlock-Hardwood-Pine Forest

Hemlock-hardwood-pine forests are transitional forest regions or "tension zones" in New Hampshire. They occur between hardwood-conifer forest to the north (above 1400 ft) and oak-pine forests to the south (below 900 ft). Hemlock-hardwood-pine forest is the most widely distributed forest type in New Hampshire, covering nearly 50 percent of the state's land area. Approximately 550 acres of hemlock-hardwood-pine forest are present on the refuge (table 3.2, map 3-1).The main matrix forest community that defines this system is hemlock-beech-oak-pine forest. Eastern hemlock (*Tsuga canadensis*) and American beech (*Fagus grandifolia*) are the primary late-successional trees in this community, while red oak (*Quercus rubra*) and white pine (*Pinus strobus*) also are typically abundant. Beech and oak trees are important for providing hard mast for many wildlife species in this ecosystem. Also common in the hemlock-hardwood-pine forest region are numerous herbs, including starflower (*Trientalis borealis*), wild sarsaparilla (*Aralia nudicaulis*), and Canada mayflower (*Maianthemum canadense*). The understory of this forest contains shrub species such as witch hazel (*Hamamelis virginiana*), black birch (*Betula lenta*), black cherry (*Prunus serotina*), ironwood (*Ostrya virginiana*), maple-leaved viburnum (*Viburnum acerifolium*), wintergreen (*Gaultheria procumbens*), and black huckleberry (*Gaylussacia baccata*) (NHFG 2005).

Lowland Spruce-Fir Forest

The spruce-fir forest, which is the dominant forest type in northern latitudes, covers approximately 10 percent of New Hampshire, occurs on the refuge mostly above 1,500 feet in elevation. Approximately 329 acres of spruce-fir forest are present on the refuge (table 3.2, map 3-1). In this latitude, this habitat type occurs primarily on high mountain ridges. Trees such as red spruce (*Picea rubens*) and balsam fir (*Abies balsamea*) dominate, while paper birch (*Betula papyrifera*) and poplar (*Populus spp.*) are common early successional species. The spruce-fir forest lacks the diversity of the northern hardwood forest because the dark shade cast by the canopy and the acidic needle-covered soil make it hard for most species to grow. The most common shrubs include mountain ash (*Sorbus Americana*), sheep laurel (*Kalmia angustifolia*), and low bush blueberry (*Vaccinium angustifolium*). The herbaceous understory contains clintonia (*clintonia* spp.), starflower (*Trientalis americana*), bunchberry (*Cornus canadensis*) as well as lichens (*Parmelia* spp.) and mosses (*Bryophyta* spp.). Another key feature of the spruce-fir forest is that the tree size becomes smaller as the elevation rises toward the summit (Sperduto and Nichols 2004). Upslope, lowland spruce-fir forest systems typically transition to northern hardwood-conifer systems (NHFG 2005).

Old Field

The stone walls which crisscross the land near the refuge show old field boundaries, which are clues to an agricultural history. Natural succession has converted most of the old field habitat to mature forest. The only old field habitat that remains is on the north slope of North Pack Monadnock. Approximately 38 acres of old field habitat are present on the refuge (table 3.2). Large junipers growing in this upland field, typical of old pastures, are now in succession to the spruce-fir forest which surrounds them. High bush blueberry plants (*Vaccinium corymbosum*) can also be seen growing in the understory of the forest, suggesting that they once grew in an open location (Flanders 2006).

Scrub-Shrub

Scrub-shrub habitat refers to shrub-dominated areas with scattered forbs and grasses. These habitats are typically the result of some disturbance and may include dry shrublands, utility rights-of-way, and old agriculture fields in our project area. The majority of this habitat type is transitional, and given time, will become forest. Approximately 14 acres of this habitat type occurs on the refuge (table 3.2, map 3-1).

The New Hampshire WAP describes the decline of this and other woody early-successional habitats in New Hampshire and throughout the Northeast. In our area land use changes including the loss of farmland, the increase in residential development, and the suppression of fire and beaver activity, are the reasons this habitat type is declining. Its decline has implications for many associated wildlife species. For example, nearly half of the 33 shrubland birds covered by Breeding Bird Survey routes in the Northeast have significantly declined in the last 35 years. The American woodcock, eastern towhee, and ruffed grouse are examples of birds documented on the refuge that rely on this habitat type.

Talus Slopes

Only four talus slope natural community systems occur in New Hampshire, and one is on the refuge. Temperate acidic talus slopes are found on the refuge at low elevations below 1800 ft. Fewer than 5 acres of talus slope are present on the refuge (table 3.2, map 3-1). They are characterized by oaks (*Quercus spp.*), black birch (*Betula lenta*), and other temperate species. This system tends to have an open woodland character, with frequent canopy gaps, sporadic large rocks, and occasional lichen-dominated talus barren openings. This system transitions to forested talus areas characterized by hemlock-hardwood-pine forest or oak-pine forest systems (NHFG 2005). This rare forest type provides excellent wildlife den sites for small- and medium-sized mammals (Van de Poll 2006).

Rock Ridges

Rocky ridges occur on outcrops and shallow-to-bedrock ridge and summit settings below those that are classified on alpine habitat (Sperduto and Nichols 2004). There are two major rocky ridge natural community systems in New Hampshire; one of them is on the refuge. The montane rocky ridges on the refuge are dominated by red spruce (*Picea rubens*), red pine (*Pinus resinosa*) and red oak (*Acer rubrum*). Fewer than 5 acres of rock ridge are present on the refuge (table 3.2, map 3-1). Outcrops include cliff slabs, which are steep bedrock exposures of $<65^{\circ}$ slope. These rocky ridges, summits, and slabs have a woodland to sparse woodland canopy structure ranging from completely open patches to thin forest cover $>65\%$, much open bedrock exposure, and one or more of the three primary diagnostic communities that overlap in their elevation ranges (see forest types above) (NHFG 2005). The refuge contains extensive areas of exposed rock. The amount of exposed bedrock increases with elevation. The numerous ledges and cliffs include a dramatic 200-foot vertical cliff facing south. That cliff is a fine example of a glacial whale back, with steep cliffs and talus boulder fields created by physical weathering.

Threatened and Endangered Plants or Rare Plant Communities

We know of no federal- or state-listed threatened or endangered plants or rare plant communities on the refuge.

Invasive Plants

No invasive plant species are known to grow on the refuge. However, we have not done an extensive survey. The areas most susceptible to invasion lie on the edges of the refuge. That is where we would focus our monitoring program in the future.

Wildlife Resources

Birds

The unfragmented upland forest on the refuge provides ideal habitat for many birds. It includes a wide variety of habitat of nesting and foraging substrates. Bird surveys were last completed on the refuge during the breeding season in 2002. Some of the birds observed on the refuge during those surveys include the ovenbird, hermit thrush, red-eyed vireo, Canada warbler, blackpoll warbler, bay-breasted warbler, black-throated blue warbler, black-throated green warbler, blackburnian warbler, golden-crowned kinglet, scarlet tanager, rose-breasted grosbeak and yellow-bellied sapsucker. Several of those species have been identified as species of concern or priority by the New Hampshire Wildlife Action Plan (WAP), the Atlantic Northern Forest Bird Conservation Region (BCR 14) Blueprint, or the Partners in Flight (PIF) Landbird Conservation Plan—Northern New England (Area 27).

The bay-breasted warbler, Canada warbler, and veery are identified by the New Hampshire WAP as species of concern or regional concern (NHFG 2005). The black-throated blue warbler, black-throated green warbler, blackburnian warbler, blackpoll warbler, ovenbird, and yellow bellied sapsucker are identified by the BCR 14 Blueprint as moderate or high priority species (Dettmers 2005). The rose-breasted grosbeak and scarlet tanager are identified by the PIF plan (Area 27) as species of high regional concern (Hodgedon & Rosenberg 2000). The priorities identified in these plans will help us in focusing our research and monitoring efforts. This forest provides ideal breeding grounds for these neotropical migrant birds who migrate to these forests to breed during the warm months. Many more species of neotropical and resident birds exist on the refuge and will be included in Appendix C, Species of Conservation Concern.

Raptors observed on the refuge during our 2002 survey include the red-tailed hawk and the sharp-shinned hawk. Several other species of raptors can be viewed migrating through in the fall and spring seasons. The steep cliff habitat on the south side of North Pack Monadnock may provide nesting habitat for the peregrine falcon. Ruffed grouse, located on the refuge in the wet forested areas is the only upland game bird observed on the refuge.

Mammals

The refuge provides habitat for many mammal species. Due to their daytime activity the species most commonly seen are the red and gray squirrel. The red squirrel occupies the upland spruce/fir forest where it feeds on spruce cones. The gray squirrel builds large nests in the high tree branches of the northern hardwoods. Many other rodents live in the refuge although they are seldom seen. Stone walls that run across the property offer habitat for these small animals. The white-footed mouse and the deer mouse build nests in burrows, hollow trees, and under rocks. The woodland vole is a likely resident of dense shrub areas. Moles and shrews dwell underground and feed on insects. The porcupine, the largest rodent in the refuge, has a healthy population due to the abundance of woodland habitat. The eastern chipmunk uses the deciduous forest for food and shelter (Flanders 2006).

Moose and white-tailed deer are the only hoofed animals on the refuge. The northern hardwood-conifer forest provides abundant understory browse for these animals. Hemlock trees provide ideal bedding habitat for the white-tailed deer. Moose use the refuge as an unfragmented upland corridor between wetland habitats to the east, north and west of the refuge.

The snowshoe hare can be found in thick shrub areas. The steep talus boulder fields offer den sites for bobcat, gray fox, red fox, coyote and black bear. The remnants of old fields provide hunting habitat for bobcat although most of this habitat type has gone through succession to forest cover. Black bear, bobcat and coyote have large home ranges and prefer to use unfragmented mountain ridges for their daily and seasonal movements. Red and gray fox habitat is abundant on the refuge since these species are opportunistic feeders and function well in many different habitat types (Flanders 2006).

Reptiles and Amphibians

The most common amphibian on the refuge is likely the red-backed salamander. The refuge also provides habitat for the red spotted salamander, which finds habitat in the darkness under rocks, humus, and old logs. The red-spotted newt in its larval stage can be seen on moist rocks and leaves after summer showers (Flanders 2006). The American toad, which prefers the lower elevations, is also a resident. The wetter areas may also provide habitat for frog species including the spring peeper, pickerel, and the bull and leopard frog. These areas may also provide habitat for the wood turtle (Flanders 2006).

The sunny ledges, wetlands, and open woodlands provide excellent snake habitat for the milk snake, garter snake, and ribbon snake (Flanders 2006).

Invertebrates

Compared to the wooded areas, the old fields on the refuge play host to a larger diversity of insects. Butterflies, dragonflies, beetles, wasps, bees, ants, and other bugs can be seen throughout the year (Flanders 2006). The insect diversity on the refuge provides an integral food source to many bird species. No invertebrate survey has ever been conducted at the refuge. Thus, we cannot list exact species' names.

Threatened or endangered wildlife

To date, no federal- or state-listed threatened or endangered species have been documented on the refuge.

Wildlife Inventories and Monitoring

Studies within the refuge have been limited to bird surveys completed in 2000-2002. Groups such as New Hampshire Audubon also use the refuge for bird observation and raptor migrations counts. We continue to encourage compatible wildlife studies on the refuge since it offers a unique opportunity to observe wildlife in a natural, undisturbed setting.

Visitor Services

Activities specifically allowed

The refuge is open for the following activities from official sunrise to sunset, seven days a week. Annually, the refuge receives approximately 30,000 visitors.

In 1994, the refuge manager completed compatibility determinations for berry picking, hiking/backpacking, jogging/walking, snowshoeing and cross-country skiing, wildlife observation, photography, and picnicking. All of those were found at that time to be compatible with the mission of the Refuge System and the purpose for which the refuge was established.

Berry picking only for personal use is allowed only in the areas next to the Wapack Trail.

Hiking and through-backpacking are popular on trails in the refuge. Hiking, through-backpacking, jogging and walking areas include the 4-mile section of the Wapack Trail, the 1.1-mile Cliff Trail loop off the Wapack Trail, and the 3 miles of the Ted's and Carolyn's trails that cross the refuge.

Snowshoeing and cross-country skiing are allowed on existing trails during daylight hours when there is sufficient snow cover.

Wildlife observation and photography are allowed along any of the trail systems only during daylight hours. All commercial photography must be approved in advance by special use permit.

Picnicking on the refuge is a secondary use currently allowed in conjunction with observing wildlife and hiking/backpacking. No facilities are provided for picnicking.

Activities specifically not allowed

The refuge was donated to the Service with certain deed restrictions. In addition to the requirement that we manage it in a "wilderness-like" or undeveloped, natural setting, the deed prohibits hunting, fishing, trapping, traveling in or using vehicles, and the cutting of trees except for the maintenance of trails. In adhering to the deed, we do not allow any of those activities on the refuge. Refuge managers in past years have determined the following activities are not compatible: camping, mountain biking, and horseback riding. Dog walking is an activity that occurs on the refuge that has not been formally determined compatible and is therefore technically prohibited. Each of these uses has been reevaluated in light of new policies on appropriate and compatible uses. See appendix A for our current evaluations.

Cultural or Historic Resources

The refuge holds no known archaeological or historic sites or structures, and owns no museum property. However, it is also important to note that we have conducted no archaeological surveys of the refuge. Some evidence indicates hunting by Abenaki Indians before Europeans settled in the area.