

## Chapter 3

Dan Salas, Cardno JFNW



*View of Carlton Pond*

## Existing Environment

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- **Cultural Landscape Setting and Land Use History**
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## Introduction

This chapter describes the current and historic physical, biological, and socioeconomic landscape of Carlton Pond WPA and the three units comprising Sunkhaze Meadows NWR (Sunkhaze Meadows, Benton, and Sandy Stream Units). Included are descriptions of the physical landscape, the regional context and its history, and the refuge environment, including its history, current administration, programs, and specific refuge resources.

The 11,484-acre Sunkhaze Meadows Unit is located in the town of Milford, Penobscot County, approximately 14 miles northeast of Bangor, Maine. The refuge is about 3 miles east of the Penobscot River and roughly bounded on the west by Dudley Brook, on the south and east by County Road, and on the north and east by Stud Mill Road. Sunkhaze Stream bisects the refuge along a northeast to southwest orientation and, along with its six tributaries, creates a diversity of wetland communities. The bogs and stream wetlands, adjacent uplands and associated transition zones, provide important habitat for many wildlife species. The wetland complex consists primarily of wet meadows, shrub thickets, cedar swamps, extensive red and silver maple floodplain forests and open freshwater stream habitats, along with plant communities associated with peatlands, such as shrub heaths and cedar and spruce bogs.

The 334-acre Benton Unit is in the town of Benton, Kennebec County, about 5 miles northeast of Waterville, Maine. This unit is just east of the Sebasticook River and is bounded by Route 139 on the west, Fowler Brook to the east, and Albion Road to the south. The Service acquired this property from the FmHA. This unit includes wetlands and breeding habitat for sedge wrens (*Cistothorus platensis*), a State-listed endangered species, although sedge wrens have not been observed on the unit since then. About one-third of the Benton Division is maintained as grassland and two-thirds is second growth mixed softwood-hardwood forest. Historically, the land was drained to provide pasture for dairy cows. In 1993, the Service installed three dikes to restore some small wetland habitats ranging from one-quarter to 2 acres at the site.

The 58-acre Sandy Stream Unit was acquired along with the Benton property and is located in the town of Unity, Waldo County. This parcel is primarily old pasture with a variety of shrub species. The unit is bounded on the east by Sandy Stream that flows north into Unity Pond, west by Prairie Road, and to the south by town-owned land that abuts Route 139.

The 1,068-acre Carlton Pond WPA is located in the town of Troy, Waldo County, about 7 miles north of Unity, Maine. Waterfowl production areas are wetlands (and surrounding uplands) that provide breeding, resting, and nesting habitat for waterfowl, shorebirds, waterbirds, and other wildlife. The original rock dam at Carlton Pond was built in 1850 to power a local sawmill. The Service reconstructed the dam in 1972 and manipulates water levels using a water control structure. The pond is approximately 295 acres of open water and 489 acres of emergent marsh; the remainder of the WPA is upland forest and peat bog. Carlton Pond WPA provides nesting areas for a population of black terns (*Chlidonias niger*), a State-listed, endangered species.

## Physical Landscape

### Landscape Perspective

Sunkhaze Meadows NWR and Carlton Pond WPA lie within the Gulf of Maine watershed, an immense area extending from eastern Quebec Province in Canada to Cape Cod, Massachusetts. Maine is the only state located entirely within the watershed boundary. The Gulf of Maine watershed encompasses, among others, the great rivers of Maine (St. John, Penobscot, Kennebec, Androscoggin, and Saco) and the coastal drainages of Downeast Maine. The Sunkhaze Meadows Unit is within the Penobscot River watershed. Carlton Pond WPA and the Benton and Sandy Stream Units are in the Kennebec River watershed. These refuge lands lie in the south central region of Maine (see map 1.1 and 1.2).

Regional conservation initiatives in Maine span the State from the “Mount Agamenticus to the Sea” collaboration in southern Maine to the “Mahoosuc Initiative” straddling the western border with New Hampshire, and efforts to protect Cobscook Bay and the Downeast Lakes in Washington County. A partnership between TNC and the Forest Society of Maine is working to conserve 42,000 acres southeast of the Sunkhaze Meadows Unit. In addition to refuge lands, this would augment lands owned by the Maine Department of Conservation (Bradley and Greenfield Units and Nicaous easement) and the U.S. Forest Service (Penobscot Experimental Forest). This partnership known as the Lower Penobscot Forest Project would further buffer the refuge from future development and protect headwaters of several tributaries that flow into Sunkhaze Stream (TNC 2011).

The Sebasticook Regional Land Trust (formerly the Friends of Unity Wetlands) is active in the area around the Benton and Sandy Stream Units (FUW 2006). Their 42,000-acre Unity Wetlands Focus Area is a large expanse of wetlands and uplands centered on Unity Township, extending east to Unity Pond and west to the Sebasticook River, covering about 65 square miles. The Sebasticook River from its mouth upstream several miles is the best habitat in the State for at least two rare mussels, tidewater mucket (*Leptodea ochracea*), and yellow lampmussel (*Lampsyllis cariosa*). These mussel populations extend into some of the tributaries including Sandy Stream. The focus area’s floodplain forests also provide habitat for wood turtles and yellow-throated vireos, which are both State-rare, streamside forest specialists. The Unity Wetlands landscape is characterized by working farms and forests and is known as part of Maine’s Dairy Belt (Friends of Unity Wetlands 2006).

### Climate

Sunkhaze Meadows NWR and Carlton Pond WPA lie within the Central Interior biophysical region of Maine (McMahon 1990). The climate of this region is transitional between the more moderate climate of the coast and more extreme continental conditions (i.e., colder winters, warmer summers) further inland. Summers are warm and the frost-free season of 140 to 160 days is comparable to that of the coastal zone. Mean maximum July temperature is 80 °F. Winter temperatures are relatively mild with a mean minimum January temperature of 10 °F. Snowfall averages 80 inches per year, intermediate between coastal and northern regions. Vegetation associations, which are in part a reflection of climate, in the Central Interior region are transitional from Appalachian forests of oaks, pine, and mixed hardwood in the south to more

boreal spruce-fir and northern hardwood forests in northern and eastern Maine. Similarly, wetland types are transitional in this region, with red maple swamps and vernal pools more common in the southwest part of the region and peatlands more common farther north and east (McMahon 1990).

There is consensus among the scientific community that climate change will lead to significant impacts across the U.S. and the world (Joint Science Academies' Statement 2005). The effect of climate change on wildlife and habitats is expected to be variable and species specific, with a predicted general trend of species' distributions shifting northward. Current global climate change models developed by the U.S. Forest Service Northern Research Station predict that the range of spruce-fir forest cover type will recede substantially north of the Sunkhaze Meadows Unit by the end of the present century (Prasad et al. 2007).

Climate change is expected to affect Maine's ecosystems and biodiversity in several ways, such as shifting species distributions, increasing drought stress for plant communities and aquatic systems, raising air and water temperatures, amplifying pest and disease outbreaks, and increasing plant growth fertilized by higher ambient carbon dioxide levels. In Maine, all groups of native species are predicted to be greatly affected by climate change and the corresponding shift in habitat, food resources, weather, and competition (Whitman et al. 2010). In addition, global climate changes are predicted to affect natural disturbance patterns over time by altering the timing and frequency of events such as flooding, fires, and other severe weather events (Lorimer 2001).

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### **Hydrology and Water Quality**

The lands comprising Sunkhaze Meadows NWR and Carlton Pond WPA are within two distinct watersheds. Sunkhaze Stream, which flows through Sunkhaze Meadows Unit, drains into the Penobscot River. Carlton Pond WPA and Benton and Sandy Stream Units are in the Sebasticook River Watershed, which in turn flows into the Kennebec River. The landscapes of both watersheds impact the water quality of both systems.

#### ***Penobscot River – Sunkhaze Stream***

The Penobscot River, New England's second largest river system, drains into an 8,570-square mile watershed. The West Branch starts near Penobscot Lake in western Maine, on the border between Maine and Quebec Province, Canada. The East Branch begins at East Branch Pond near the headwaters of the Allagash River in north-central Maine. The two branches join in the town of Medway near East Millinocket, more than 60 miles to the north of the Sunkhaze Meadows

Unit. The main stem of the Penobscot River empties into Penobscot Bay, along the Maine coast, near the town of Bucksport.

Sunkhaze Stream is approximately 20 miles long and begins as a series of seeps and springs. The stream and its tributaries flow through three townships (Greenfield, Greenbush, and Milford) before reaching the Penobscot River in Milford. The Sunkhaze Meadows Unit encompasses 5 miles of Sunkhaze Stream and another 16 miles of tributary streams that include Buzzy, Little Buzzy, Baker, Dudley and Johnson Brooks, and Birch and Little Birch Streams. The portion of Sunkhaze Stream within the refuge is generally comprised of three river segments. The lower section contains a deep, wide, channelized stream surrounded by a hardwood canopy, dominated by silver maples, that shades the water. Middle portions of Sunkhaze Stream are bordered by emergent marsh and grassy wet meadow and contain a string of beaver dams and ponds connected by slow-moving runs. Upstream of Johnson Brook, alders and other shrubs and trees form a canopy, then the grade increases creating a series of riffles, runs, and pools below Stud Mill Road (Smithwood and McKeon 1999). Sunkhaze Stream, north of Stud Mill Road and outside refuge lands, has a series of riffles and falls separated by long stretches of slow meandering water. This section supports some of the most important brook trout fisheries in the Bangor area (Rupp 1955, Stockwell and Hunter 1983, Smithwood and McKeon 1999).

Sunkhaze Stream, with a watershed of approximately 100 square miles, flows in a westerly direction to its confluence with the Penobscot River. During spring snowmelt periods, waters from the Penobscot River flow up Sunkhaze Stream and down the Otter Chain Ponds, causing the entire bog area to become a large lake (USFWS 2001).

Sunkhaze Stream and its tributaries are classified as Class AA waters by Maine Department of Environmental Protection (MDEP) (MDEP MRS Title 38 467 7(C)(8)). According to MDEP, “Class AA shall be the highest [water] classification and shall be applied to waters which are outstanding natural resources and which should be preserved because of their ecological, social, scenic or recreational importance” (MDEP MRS Title 38 464 1(A)). Class AA waters must be of such quality that they are suitable for the designated uses of drinking water after disinfection, fishing, agriculture, and recreation in and on the water, navigation, and as habitat for fish and other aquatic life. The habitat must be characterized as free-flowing and natural.” The main stem of the Penobscot River in this region is classified as Class B water, defined as waters of such quality that they are suitable for the designated uses of drinking water supply after treatment; fishing; agriculture; recreation in and on the water; industrial process and cooling water supply; hydroelectric power generation; navigation; and as habitat for fish and other aquatic life (MDEP 2011c).

### ***Kennebec River – Sebasticook River and Tributaries***

The Kennebec River begins at Moosehead Lake in west-central Maine, and flows 150 miles to its outflow into Merrymeeting Bay in the town of Richmond. The Sebasticook River is the largest tributary to the Kennebec River. The Sebasticook River begins in Dexter and flows 50 miles, draining 985 square miles before reaching the Kennebec River, about 16 miles upstream of Merrymeeting Bay (Maine Rivers 2011).

The Benton Unit of Sunkhaze Meadows NWR lies along a portion of Fowler Brook, which flows north directly into the Sebasticook River in the town of Benton. Carlton Pond drains into Carlton Stream, one of three major tributaries that flow into Unity Pond. Sandy Stream flows north into Unity Pond just at its outlet. The outlet of Unity Pond is Twenty-Five Mile Stream, which joins the Sebasticook River in the town of Burnham. Typically, Sandy Stream flows north and into the wetland area southwest of the Unity Pond outlet and then into Twenty-Five Mile Stream. However, during significant rain events and when lake water levels are low Sandy Stream may bypass Twenty-Five Mile Stream and flow directly into Unity Pond, greatly increasing the watershed of the Pond (MDEP 2004).

According to the MDEP Water Classification Program Report (Title 38, Article 4-A), the Sebasticook River main stem, including all impoundments—from the confluence of the East Branch and the West Branch to its confluence with the Kennebec River is classified as Class C water. This is the 4th highest classification in Maine and is defined as suitable for the designated uses of drinking water supply after treatment, fishing, agriculture, recreation in and on the water, industrial process and cooling water supply, hydroelectric power generation, navigation, and as habitat for fish and other aquatic life. Tributaries in the Sebasticook River are classified as Class B water (MDEP 2011c). Unity Pond has a history of supporting excessive amounts of algae in the late summer and early fall, due in large part to the contribution of phosphorus that is prevalent in area soils and that has accumulated in the pond bottom sediments (MDEP 2004).

### **Geology and Soils**

Continental glaciers probably extended across Maine several times during the Pleistocene Epoch, which lasted from about 2.5 million to 10,000 years ago. The slow-moving glacial ice changed the landscape as it scraped across mountains and valleys, eroding and carrying rock debris. The sand, gravel, and other unconsolidated sediments that cover much of Maine are largely the products of that glaciation. Glaciation also changed drainage patterns and helped create the hundreds of modern ponds and lakes scattered across the State (MGS 2005).

The most recent glacial period in Maine began 35,000 years ago, when the Laurentide Ice Sheet spread across southern Quebec and New England. During its peak development, this ice sheet was centered over eastern Canada and flowed east to southeast across Maine. It became several thousand feet thick and covered the highest mountains in the State (MGS 2005). The Laurentide Ice Sheet started to recede as early as 21,000 years ago, soon after it reached its terminal position on Long Island, New York (Sirkin 1986). The ice margin receded to the present position of the Maine coast by 17,000 to 16,000 years ago (Borns et al. 2004).

The land previously underneath the glacier was still depressed by the weight of the ice sheet, causing ocean waters to flood southern Maine as the glacier continued retreating. Ocean waters extended up into the Kennebec and Penobscot valleys, reaching present elevations to at least 420 feet above current mean sea level in central Maine (MGS 2005). Consequently, the lowlands of the lower Kennebec and Penobscot River valleys were filled with glaciomarine clays and silts (McMahon 1990). The last remnants of glacial ice were gone from Maine by about 11,000 years ago (MGS 2005). The modern network of streams became established soon after glaciers receded and organic deposits began to form in peat bogs, marshes, and swamps. Tundra vegetation

bordering the ice sheet was replaced by changing forest communities as the climate warmed (Davis and Jacobson 1985).

Most of the soils (more than 70 percent) on the Sunkhaze Meadows Unit are poorly or very poorly drained; the dominant soil types include peat and muck, Monarda and Burnham, Biddeford, Buxton-Scantic-Biddeford, and Scantic. The primary well-drained soils at Sunkhaze Meadows Unit include Howland, Plaisted, and Thorndike (USDA 2011).

The dominant soil types on the Benton Unit are poorly drained Scantic silt loam and Ridgebury very stony fine sandy loam. These soils underlie much of the fields including the entire field area around the small diked wetlands. Well-drained soils at this unit include Scio, Woodbridge, and Paxton-Charlton soil types, which are primarily in the eastern half of the unit (USDA 2011).

The soils at the Sandy Stream Unit include the poorly drained Limerick and Rumney soils, and moderately well-drained Podunk fine sandy loam. The poorly drained soils underlie much of the shrub habitat (USDA 2011).

Approximately 90 percent of the soils on Carlton Pond WPA are poorly drained. Besides a large area of open water, the dominant soil type is the very poorly drained Borosapristis (ponded). The primary well-drained soil is the Thorndike-Winnecook complex (USDA 2011).

### Air Quality

The Penobscot Indian Nation monitoring station, located in Penobscot County on the Penobscot Indian Nation Reservation and adjacent to the Sunkhaze Meadows Unit, is the only air quality monitoring station near any Sunkhaze Meadows NWR and Carlton Pond WPA properties. The Penobscot Indian Nation monitoring station monitors ozone levels hourly.

Ozone levels are low in the winter and peak in the summer months. The current National Ambient Air Quality Standard for ozone is 0.075 parts per million (ppm). A monitoring station experiences an ozone exceedance when the 8-hour ozone average exceeds the current standard. Table 3.1 presents the ozone exceedance incidents for the Penobscot Indian Nation station from 2006 to 2011.

Table 3.1. Ozone exceedance days, Penobscot Indian Nation Monitoring Station, Penobscot County, 2006 through 2011 (MDEP 2011).

Year	Number of Exceedance Days, State of Maine	Number of Exceedance Days at Penobscot Indian Nation	Ozone PPM Level	Date(s) of Exceedance Days at Penobscot Indian Nation Monitoring Station
2011	3	0	--	n/a (not applicable); no exceedance days recorded
2010	8	0	--	n/a
2009	3	0	--	n/a
2008	4	0	--	n/a
2007	14	2	0.080; 0.080	4/23/07; 5/25/07
2006	11	1	0.077	5/15/06

Given that ozone levels around the refuge continue to be well below the State's overall number of exceedance days, there appears to be no ozone-related air quality issues at the Sunhaze Meadows Unit.

### ***Particulate Pollution***

While particulate pollution can occur throughout the year, it peaks in the summer, due mainly to wildfires, and in the winter, primarily from wood smoke (EPA 2011). Wood burning is one of the largest sources of particulate and toxic air pollution in Maine. Wood smoke can contain nitrogen oxides, carbon monoxide, and organic gases in addition to particulate matter pollution (MDEP 2011b).

During the winter months wood smoke contributes to higher levels of particulate matter pollution in Maine, with pollution levels highest in the morning hours. Maine experiences a number of days with moderate levels of particulate matter pollution during the winter months, even when much of New England might have lower levels of particulate matter pollution. Wood smoke can cause harm to human health, particularly to the health of children, the elderly, and those with chronic conditions. It can also result in environmental and general neighborhood complaint issues (EPA 2011).

MDEP staff monitors particle pollution levels daily and provides data on recorded levels to the public in four ways:

- 24-hour toll free Air Quality hotline: 1-800-223-1196.
- Online at: <http://www.maine.gov/dep/air/ozone/index.html> (accessed September 2012).
- EnviroFlash— Email and text message alert system established by EPA in cooperation with MDEP.
- Sharing information with local media.

When levels are elevated and expected to remain elevated, staff report the levels on the air quality hotline and the air quality forecast Web site. Whenever unhealthy concentrations are expected, staff issues an advisory message.

To report on daily air quality, U.S. Environmental Protection Agency (EPA) developed the air quality index (AQI). The AQI's purpose is to help citizens understand what local air quality means to their health. MDEP uses the AQI to report on particle and ozone levels. They take the measurements of concentrations of the major pollutants at locations throughout the State and then convert them into AQI values, with an AQI value calculated for each of the individual pollutants in an area.

For ozone, the AQI is based on ozone levels averaged over an 8-hour period; for particulates, it is based on particle pollution levels averaged over a 24-hour period. Table 3.2 describes the AQI levels of health concern, including the index ranges and the color system used to represent each level.

Table 3.2. Overview of air quality index levels.

AQI Levels of Health Concern	Color	Air Quality Index
Good	Green	0 to 50
Moderate	Yellow	51 to 100
Unhealthy for Sensitive Groups	Orange	101 to 150
Unhealthy	Red	151 to 200
Very Unhealthy	Purple	201 to 300

Adapted from: <http://www.airnow.gov/index.cfm?action=aqibasics.aqi>

### Environmental Contaminants

Two landfills near the Sunkhaze Meadows Unit pose potential concerns: the Fort James (formerly James River) Corporations sludge landfill along Stud Mill Road, and the town of Milford municipal landfill along County Road. The 27-acre Fort James landfill is located approximately 3,600 feet east of Buzzy Brook along the refuges northern boundary. The landfill was closed on December 1, 1996, and covered with a combination of soil, borrow, grit, and sand. Between 1979 and 1996, the landfill received sludge from paper mill operations, woody debris, lime, tire chips, and miscellaneous material. Twenty-one groundwater wells surround the landfill, two of which are located on the refuge. However, all required groundwater monitoring has been completed and these wells are no longer sampled. The potential for overland transport of contaminants from this landfill appears remote. No established surface water drainages appear to exist between Buzzy Brook and the landfill. However, there are borrow pit ponds on the refuge within approximately 850 feet of the landfill; groundwater flow direction is towards the borrow pit ponds.

The 5-acre Milford municipal landfill is located approximately 980 feet east of Baker Brook along the southern boundary of the refuge. The Milford landfill was closed in 1995. From 1976 to 1993 the landfill received municipal solid waste, demolition debris, white goods, tires, and household waste. The landfill is capped with an impermeable clay cover and a vegetative cover. Visual inspections by Service personnel in late February 1999 (an unusual period of minimal snow cover) did not indicate any sloughing, erosion, or breakouts on the cap. Groundwater monitoring wells are located around the landfill, but there are no monitoring wells on refuge property. The three existing wells are monitored biannually for State Closure Indicator parameters: hardness, chloride, chemical oxygen demand, iron, manganese, sodium, and sulfate (CES, Inc. 1998). The potential for overland transport of contaminants from the landfill appears remote. No established surface water drainages exist between Baker Brook and the northwest corner of the landfill. The floodplain of Baker Brook is less than 1,000 feet from the landfill, and it is possible that groundwater underlying the landfill discharges to the brook.

In 1993, a screening-level contaminant survey of the Sunkhaze Meadows Unit was conducted by the Service's Maine Ecological Services Office (Mierzykowski and Carr 2004). Elevated levels of polychlorinated biphenyls (PCBs) were found in a Baker Brook sediment sample (0.78 ppm) and high chromium levels were found in chain pickerel (10.59 ppm) and yellow perch (13.20 ppm) samples from Sunkhaze Stream. In 2001, a follow up contaminant survey was conducted using additional locations along these watercourses to validate the earlier results and to

determine the extent of contamination in fish and sediments. The contaminants of concern in the 1993 collections were not found at elevated levels in the 2001 collections. In 2001, fish tissue samples from Sunkhaze Stream and Baker Brook did not contain detectable levels of PCBs or chromium. No other organochlorine compounds or inorganic elements were found at elevated concentrations in fish tissue during the follow-up study. PCBs were not detected in the five sediment samples from Baker Brook. Chromium was detected in Baker Brook sediments at low levels, but the element was not detected in any fish samples from the brook (Mierzykowski and Carr 2004).

Data collected in contaminant studies suggested that the former Milford municipal landfill, closed since 1995, may be influencing Baker Brook. Of the 21 inorganic elements identified during analysis, 10 elements exhibited their highest concentrations in the Baker Brook sediment collection site approximately one-half mile downstream of the former landfill. Of the 10 elements, however, only cadmium occurred at an elevated concentration (1.18 ppm) and at a level only slightly above the threshold effect concentration of 0.99 ppm. Arsenic was also found slightly above its threshold effect concentration (9.79 ppm), measuring 10.2 ppm at the confluence of Baker Brook and Sunkhaze Stream (Mierzykowski and Carr 2004).

The Service's Northeast Region has also participated in and coordinated its regional work with the National Abnormal Amphibian Project at various national wildlife refuges throughout the Northeast since 2000. Many amphibians (such as frogs and salamanders) are sensitive to a variety of environmental stresses, such as pollution, and may be good early indicators of the health of their environment. For this reason, the Service has had an interest in determining if amphibian abnormalities are occurring on national wildlife refuges. In their 2005 report, researchers summarized the results to date of the sampling effort conducted in 2005 as well as previous years' efforts extending back to preliminary efforts in 1997. As part of their investigation, the Service sampled frogs at Sunkhaze Meadows Unit and Carlton Pond WPA. Ongoing sampling was discontinued at Sunkhaze Meadows Unit due to small number of frogs collected and the lack of abnormalities found. A small percent (approximately 1 percent) of Carlton Pond frogs did exhibit some abnormalities (Pinkney et al. 2005). Some of these were the result of fungal infections to individuals. Other causes of abnormalities are unknown since the Carlton Pond watershed is known to be free of contaminant sites (Pinkney et al. 2005).

An underground natural gas pipeline (Maritimes and Northeast Pipeline) was constructed near the Sunkhaze Meadows Unit in the fall of 1999 and early spring 2000. The pipeline route runs along County Road, adjacent to the Sunkhaze Meadows Unit. This right-of-way crosses seven streams and tributaries that flow into the refuge. Limited surface water sampling along the pipeline corridor before and after construction detected no impacts to the refuge.

Two roads form more than half of the Sunkhaze Meadows Unit boundary: the northern and northeastern boundaries are bordered by Stud Mill Road, and County Road forms the southeastern boundary. Both roads are unpaved, typical of northern and eastern Maine. Stud Mill Road is a privately owned logging road, while County Road is maintained by the Town of Milford. Vehicle traffic along these roadways is fairly constant throughout the year. Refuge staff has observed illegally dumped debris and refuse frequently along the roadways. Numerous roadside ditches, bridges, and culverts along the Stud Mill Road and County Road are potential

pathways for vehicle-related or illegally disposed contaminants into the watercourses of Sunkhaze Meadows Unit. In the early 1990s, the refuge worked with its neighbor, James River Corporation, to install five gates on refuge access points to help curtail illegal dumping; the gates had a positive effect in controlling dumping.

No contaminants are known to impact the other refuge units or Carlton Pond WPA.

## Refuge and WPA Biological Resources

### Vegetation and Habitat Resources

In 2004, the Service contracted with the James W. Sewall Company to conduct aerial surveys and develop vegetation maps for several refuges in the Northeast, including Sunkhaze Meadows NWR and Carlton Pond WPA. Sewall delineated habitats based on the National Vegetation Classification Standard (NVCS, <http://biology.usgs.gov/npsveg/nvcs.html>; accessed September 2012). The Nature Conservancy and the Natural Heritage Network developed the NVCS as their standard system for classifying vegetation communities; the Service subsequently adopted this system to map habitats on refuges. This classification system is based on hierarchical levels so that it can be used on the finest or coarsest level as needed (Comer et al. 2003). This is useful since wildlife typically respond to coarser scale conditions rather than more fine-scale individual natural communities. Therefore, we combined several natural community types into broader habitat types to guide management objectives and strategies.

### *Sunkhaze Meadows Unit*

Sunkhaze Meadows Unit is an ecologically diverse community dominated by an expansive freshwater wetland-peatland complex surrounded by a conifer-northern hardwood upland forest. The habitat types are listed in Table 3.3 and displayed on map 3.1.

Table 3.3. Sunkhaze Meadows Unit habitat types.

Habitat Type	Acres
<i>Freshwater Wetlands-Peatland Complex</i>	
Freshwater Wetland	1,654
Open Water	158
Peatland	1,649
<i>Forested Habitats</i>	
Northern Hardwood-Mixed Forest	5,002
Conifer Forest	2,904
Young Forest	117
<b>Total</b>	<b>11,484</b>

### Freshwater Wetland-Peatland Complex

The complex contains several large raised bogs or domes, separated by extensive areas of streamside freshwater meadows. Davis et al. (1983) ranked the peat bogs of the Sunkhaze Meadows Unit high quality among 31 other peatlands in Maine based on its developmental-morphological diversity, pristine character, and exemplary quality of peatland type or feature. It

is the second largest peatland in the State, with peat thickness ranging from 5 to 20 feet. The peat is typically underlain by 10 to 20 feet of silt and clay which in turn is underlain by 20 to 30 feet of glacial till over bedrock (MGS 2011).

Peatlands are a wetland type whose soils are “peat”—partially decayed remains of dead plants. Peatlands are described by topography (flat or level, on slopes, or raised) and are classified by their water and nutrient characteristics (Johnson 1985):

- *Minerotrophic* peatlands receive water primarily from underground or surface sources; has higher nutrient concentrations because the water picks up nutrients as it passes through soil and bedrock.
- *Ombrotrophic* peatlands receive their water from precipitation; lower nutrient concentrations.
- *Oligotrophic* peatlands are between the other two in nutrient richness.
- A *fen* is a strongly enriched (primarily minerotrophic) peatland, while a *bog* is a rain-fed (largely ombrotrophic) peatland.

The Northeast U.S. supports a range of peatland types, with many different types often occurring together in large peatland complexes (Johnson 1985).

The wetland-peatland complex is just part of the diverse mix of natural communities and habitats on this unit. An exemplary floodplain forest abuts the peatland, Sunkhaze Stream meanders through a portion of the bog, and the wetland complex is surrounded by mixed upland forest (see map 3.9). The Sunkhaze Meadow focus area description in the Maine Comprehensive Wildlife Conservancy Strategy, notes that the large unpatterned fen appears to provide outstanding habitat for peatland dragonflies and damselflies (MDIFW 2005). Bog bedstraw, a species of special concern in Maine, is found in the peatlands (MNAP 2010). Sunkhaze Meadows Unit is also identified as a Statewide conservation priority focus area by MDIFW. These areas are “landscape scale areas that contain exceptionally rich concentrations of at-risk species and natural communities and high quality common natural communities, significant wildlife habitats, and their intersection with large blocks of undeveloped habitat” (MDIFW 2008a).

In August and September 1996, Famous and Famous (1997) sampled the following plant communities across environmental gradients from Sunkhaze Stream to the open bog. Their report also lists the dominant plant species found in each community type and provides recommendations for future vegetation sampling.

- |                   |   |
|-------------------|---|
| Rooted aquatic:   | A narrow zone along the streams, always inundated but shallow enough for abundant cover of aquatic vascular plants to be present; water depth may vary; minerotrophic |
| Graminoid meadow: | A zone of varying width along streams, dominated by grasses and sedges; often flooded, especially seasonally; minerotrophic   |
| Open fen:         | Low shrubs (less than 1 meter); dominance by minerotrophic species, wide variety of herbaceous species; some sedge and/or sphagnum peat accumulation                  |

- Shrub fen: Shrubs taller than open fen, averaging 1 to 2 meters; sphagnum more abundant than open fen with peat accumulation; some tree species, but usually less than 2 meters tall; minerotrophic
- Wooded fen: Shrubs 1 to 2 meters tall, tree species average 25 to 50 percent cover; sphagnum abundant, peat accumulation; minerotrophic
- Dwarf shrub heath: Dominance of ericaceous shrubs, less than 1 meter tall; close to 100 percent sphagnum cover and well developed hummocks; thick peat layer; ombrotrophic
- Wooded shrub heath: Dominance by ericaceous shrubs, but 25 to 50 percent cover by tree species; sphagnum close to 100 percent, well developed hummocks; ombrotrophic
- Forested bog: Dominated by black spruce (*Picea mariana*), possibly larch (*Larix laricina*), and ericaceous shrubs; sphagnum close to 100 percent cover, well developed hummocks; ombrotrophic
- Peatland lagg: Narrow zone between ombrotrophic peatland and upland where water collects at the edge of a bog; characterized by robust shrubs and scattered trees, mostly ericaceous but supports other shrubs as well; variety of sedges and herbs possible; sphagnum cover usually high, but many other mosses may be present; minerotrophic

High rainfall during the summer of 1996, and as recent as 2005, flooded much of the meadow areas in this unit for most of the summer. This may have changed the species composition, at least temporarily. Although perennial herbaceous species were present, annual species may not have had ample opportunity to become established. Likewise, flowering and fruiting times for both annuals and perennials may have been interrupted, causing changes for the next growing season. It is most likely that yearly fluctuations in summer rainfall are an ongoing part of the ecology of this wetland complex (Famous and Famous 1997).

*Sunkhaze Stream*—The Sunkhaze Meadows Unit includes nearly 5 miles of Sunkhaze Stream and another 16 miles of tributary streams (map 3.1). Sunkhaze Stream and its tributaries (Buzzy, Little Buzzy, Baker, Dudley, and Johnson Brooks, Birch, and Little Birch Streams) support diverse wetland communities including wet sedge meadow, shrub thicket, cedar swamp, forested wetland, and open freshwater stream habitat. Sunkhaze Stream was described earlier under the Hydrology and Water Quality subsection under Physical Landscape.

Habitat on the tributaries varies. Birch and Little Birch Streams have long, shallow riffle areas followed by shaded, deep, sand and gravel bottoms. Buzzy and Baker Brooks are similar to each other with lower reaches containing narrow, winding channels blocked by beaver dams (Smithwood and McKeon 1999).

*Conifer- Northern Hardwood Mixed Forest*—Sunhaze Meadows Unit has 7,906 acres of forested upland habitat. Much of the forest was selectively harvested prior to refuge acquisition, creating age class and structural diversity. In the late 1970s and early 1980s, the State of Maine experienced a severe spruce budworm infestation and much of the balsam fir-red spruce overstory was removed from lands along the Stud Mill and County roads. The forest today is diverse, dominated by softwood tree species (red, white, and black spruce, balsam fir, hemlock, northern white cedar, eastern tamarack, eastern white, and red pine) with a mix of northern hardwoods (aspen species, paper birch, gray birch, red maple, silver maple, sugar maple, red and white oak, ash, and beech).

Northern hardwood-mixed forests and conifer forests at Sunhaze Meadows Unit likely contain scattered vernal pool habitats. Vernal pools are small areas that seasonally fill with water in spring, but then dry out later in the year. These transient habitats provide ideal breeding and juvenile rearing habitat for a variety of amphibian species (Regosin et al. 2005, Rittenhouse and Semlitsch 2007).

At the southwestern part of the Sunhaze Meadows wetland-peatland complex, the floodplain forest forms a narrow band along Sunhaze Stream and is dominated by silver maple with some red maple. The Maine Natural Areas Program identified this approximately 100-acre floodplain forest as an exemplary natural community (MNAP 2010). Hardwood floodplain forests are classified as rare (S3) by the Maine Natural Areas Program (MNAP 2010), occurring in long and narrow floodplains or on islands of large rivers and streams throughout Maine and New England. Maine's remaining floodplain forests are generally more extensive than in other New England states. Most of the northern floodplain examples of this forest type were harvested or converted to agriculture.

*Young Forest Early Successional Habitat*—Early successional habitats (including young forests, shrublands, and grasslands) are created through some form of disturbance such as logging, clearing, fire, wind damage, or pest outbreaks. Young forest habitat contains a mix of trees and shrubs typically younger than 40 years old and often create dense, thick stands of vegetation. If left unmanaged, these habitats will eventually transition (or succeed) into more mature forested habitats.

An electric transmission corridor (power lines) transects the western portion of the refuge providing 107 acres of early successional habitat. This powerline right-of-way is a deeded property right established prior to refuge acquisition. This young forest habitat is comprised largely of speckled alder, white ash, sweet gale, and other native tree and shrub species. Another 10 acres of young forest habitat is mapped within former log yards and small clearings at the Sunhaze Meadows Unit, including 2 acres originally cleared for young forest early successional habitat management demonstration. This demonstration area is located near the Johnson Brook Trail.

### ***Benton Unit***

The 334-acre Benton Unit consists of 2 acres of freshwater marsh and open water, 96 acres of grassland, 155 acres of northern hardwoods-mixed forest, and 70 acres of conifer forest. The upland forests are a mix of sugar maple, ash, beech, white oak, and eastern white pine, and a few

stands of mature eastern white pine, spruce-fir, and on wetter ground, northern white cedar. The habitat types are listed in table 3.4 and displayed on map 3.2.

When this unit was a working farm, the fields were ditched to remove excess surface moisture. In 1993 the Service installed three dikes to plug some of these ditches to create small impoundments varying in size from 0.25 acres to over 2 acres as a wetland restoration project under the Service’s Private Lands Initiative. Most of the Benton Unit drains into Fowler Brook, which then flows into the Sebasticook River. One stream segment on refuge lands goes through the center of the unit, primarily the grassland habitat. The other stream segment follows the eastern edge of the unit and is bordered by forest. The open fields are maintained through prescribed fire and annual haying. A local farmer is currently permitted to mow approximately 72 acres of the fields each year. Mowing occurs after mid-July, to avoid disturbing grassland-nesting birds.

Table 3.4. Benton Unit habitat types.

<b>Habitat Type</b>	<b>Acres</b>
Northern Hardwoods- Mixed Forest	155
Conifer Forest	70
Grassland	96
Sedge Meadow and Open Marsh	13
<b>Total</b>	<b>334</b>

***Sandy Stream Unit***

The 58-acre Sandy Stream Unit is mainly comprised of upland shrubland and floodplain forest. The habitat types are listed in table 3.5 and displayed on map 3.3. The shrubland was hydro-axed in 1995, and burned periodically in subsequent years to maintain a balance of open grass with a 30 to 50 percent open shrub component. Some of the Sandy Stream Unit was mapped as aspen-birch woodland forest by Sewall (2004); however, from a management perspective, this is considered part of the early successional-upland shrub habitat. A narrow band of floodplain forest is located along Sandy Stream; the floodplain forest widens at the north end of the Unit. A snowmobile trail, maintained by a local snowmobile club, bisects the shrubland habitat.

Table 3.5. Sandy Stream Unit habitat types.

<b>Habitat Type</b>	<b>Acres</b>
Riparian Floodplain Forest	19
Upland Shrub	26
Grassland	13
<b>Total</b>	<b>58</b>

***Carlton Pond WPA***

The 1,068-acre Carlton Pond WPA includes most of Carlton Pond, the surrounding freshwater wetlands, and several small areas of forested lowlands and uplands (see table 3.6 and map 3.4). Carlton Pond WPA was acquired by the Service in the mid-1960s. The original rock dam was built in 1850 to power a sawmill. It was reconstructed by the Service in 1972 to maintain the

integrity of the structure and to allow for continued management of water levels using a water control structure (WCS). In partnership with Ducks Unlimited the Service repaired the WCS in 1996 to allow for more effective water level management. More than 84 percent of the site is open water or shallow freshwater marsh. The remaining 16 percent is forested, dominated by aspen, red and sugar maple, box elder, paper birch, and eastern white pine. At capacity, the pond itself consists of approximately 295 acres of open water containing 1,198 feet of water. Emergent plants such as pickerel weed, pond lily, and water lilies are abundant. Surrounding the open water is a freshwater wetland with plants typical of a graminoid marsh, including leather-leaf, buttonbush, cranberry, sweet gale, and rhodora.

Table 3.6. Carlton Pond WPA habitat types.

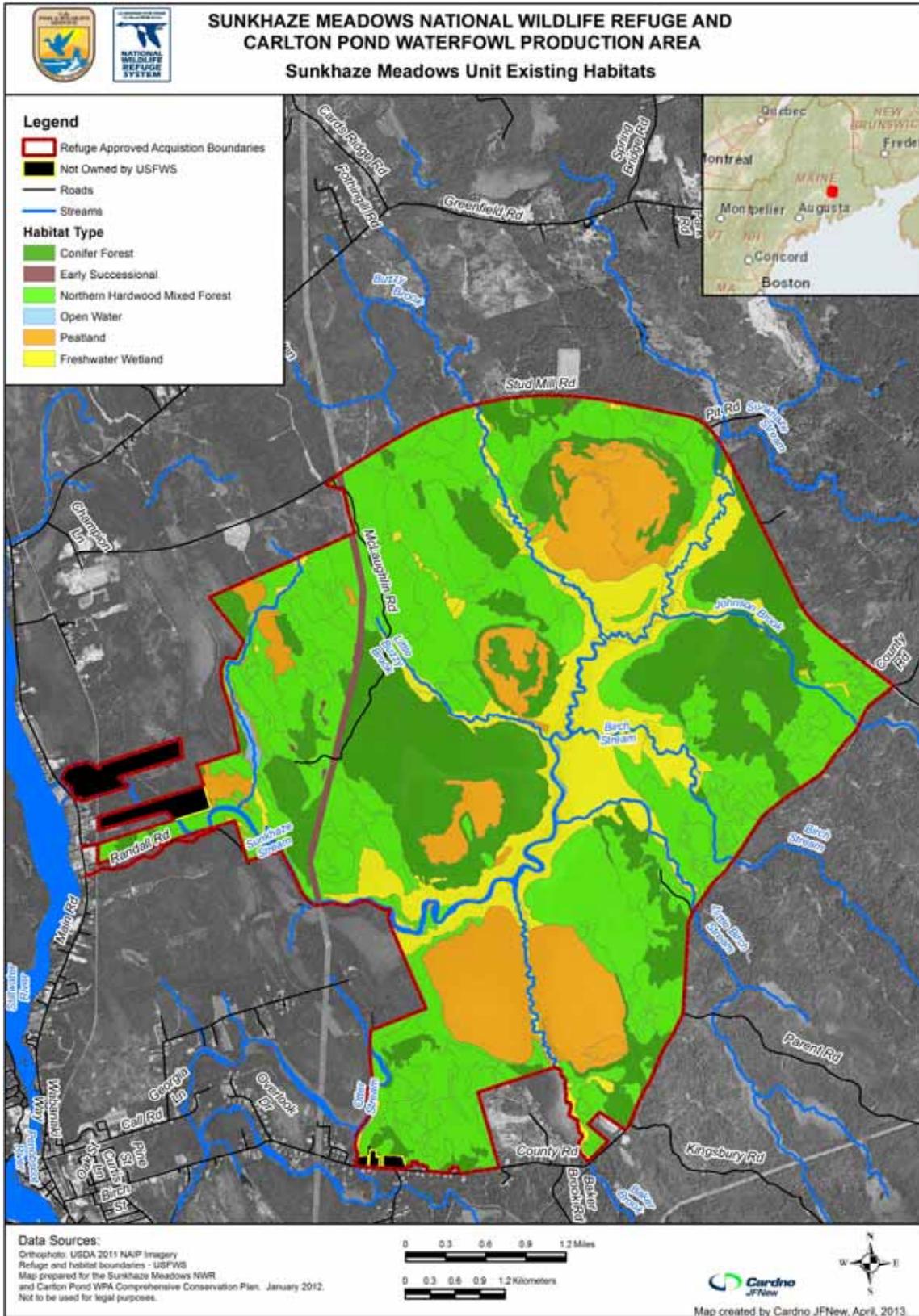
<b>Habitat Type</b>	<b>Acres</b>
Conifer Forest	45
Northern Hardwood- Mixed Forest	239
Freshwater Wetland	455
Peat Bog	34
Open Water	295
<b>Total</b>	<b>1,068</b>

## Rare or Exemplary Natural Communities and Rare Plants

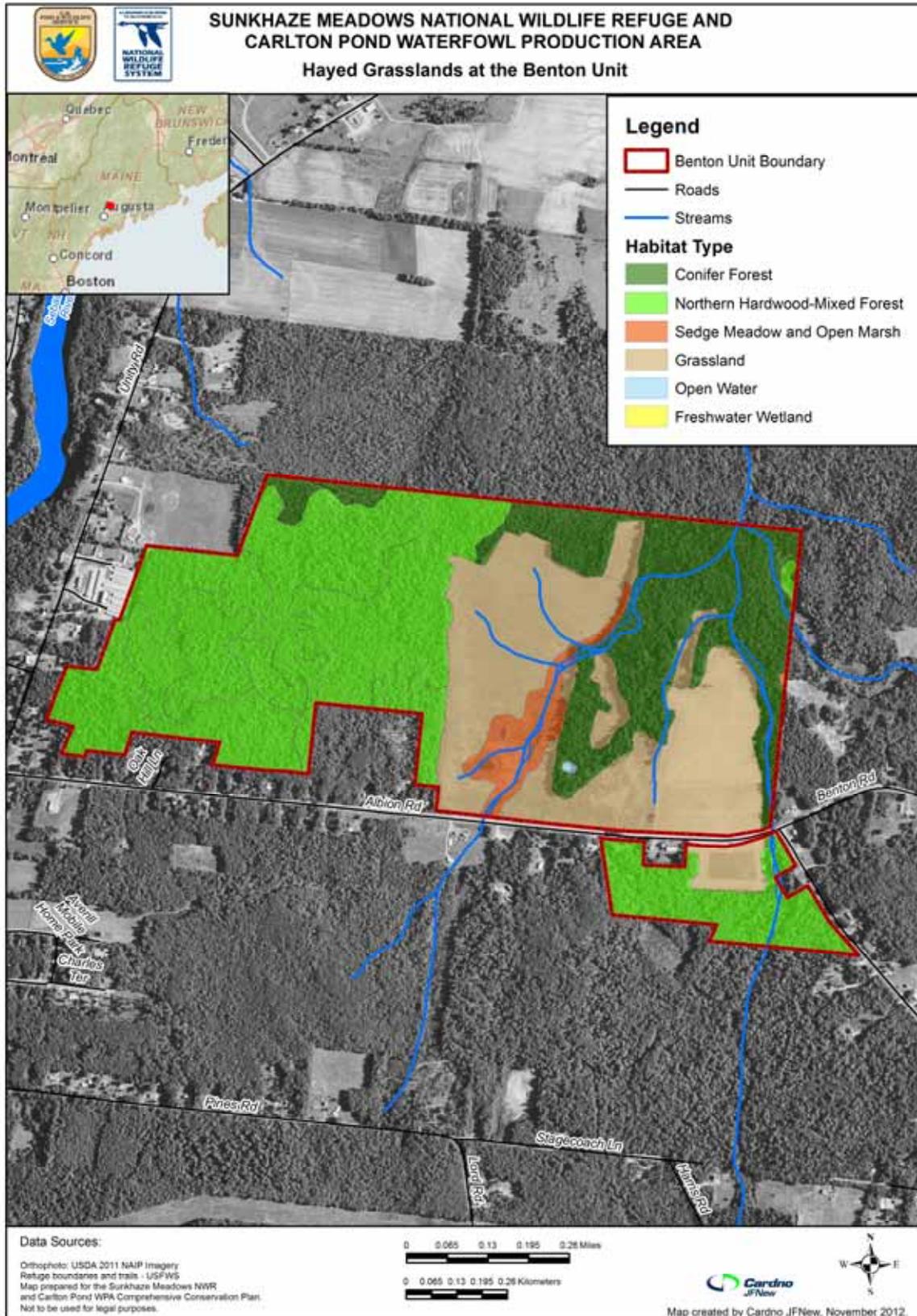
### *Exemplary Natural Communities*

The Maine Natural Areas Program (MNAP) documented several exemplary natural communities and ecosystems on the Sunkhaze Meadows Unit (MNAP 1999). These include: unpatterned fen ecosystem, domed bog ecosystem, northern white cedar woodland fen, and silver maple floodplain forest. A field survey by MNAP staff in 2010 resulted in an updated map and description of the northern white cedar woodland fen, which was previously described as a northern white cedar seepage forest (MNAP 2010). Table 3.7 lists the rare or exemplary communities and ecosystems that are known to occur on the Sunkhaze Meadows Unit. See map 3.5 for their locations.

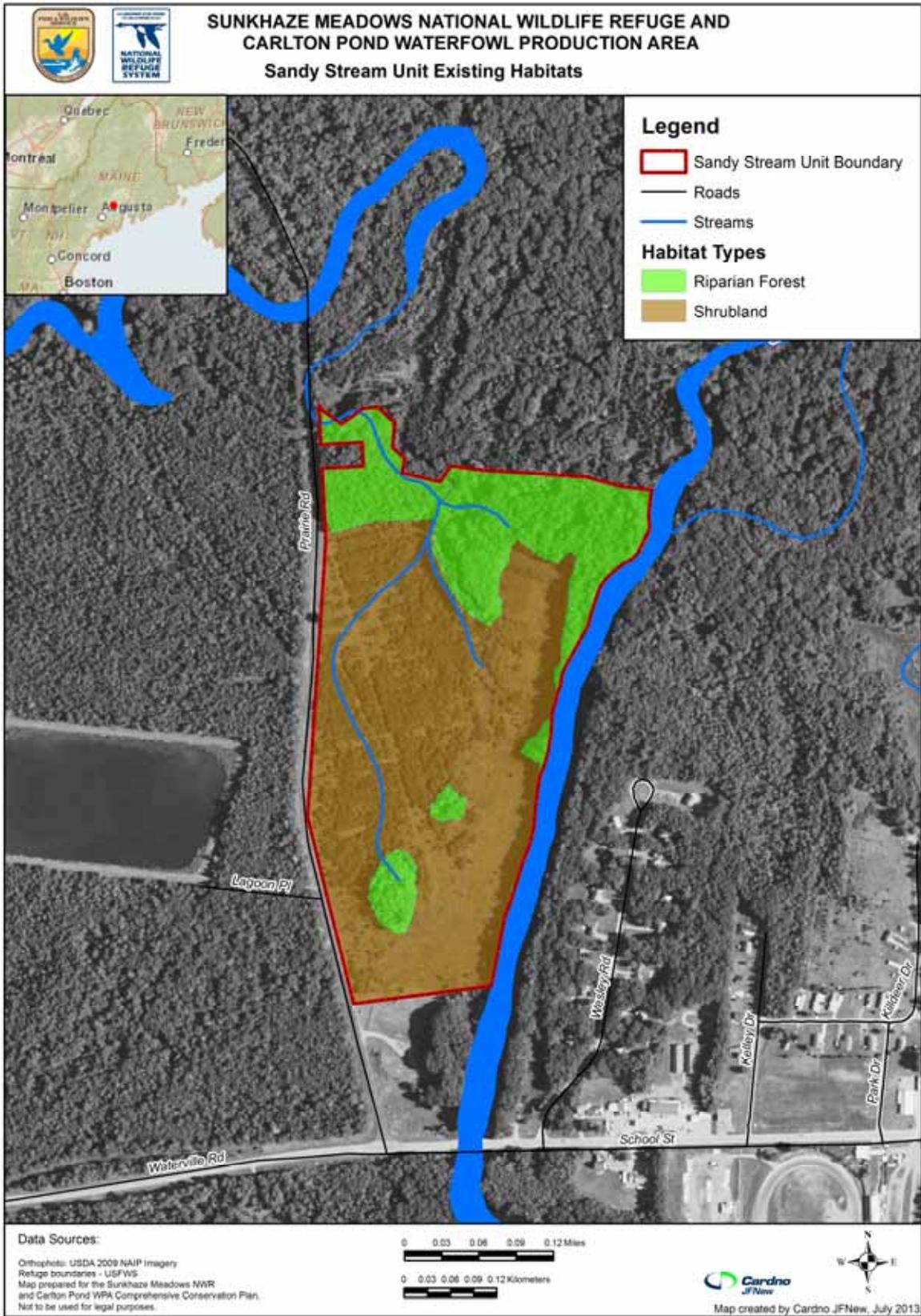
Map 3.1. Existing habitats of the Sunkhaze Meadows Unit of Sunkhaze Meadows NWR.



Map 3.2. Existing habitats of the Benton Unit of Sunkhaze Meadows NWR.



Map 3.3. Existing habitats of the Sandy Stream Unit of Sunkhaze Meadows NWR.



Map 3.4. Existing habitats of Carlton Pond WPA.

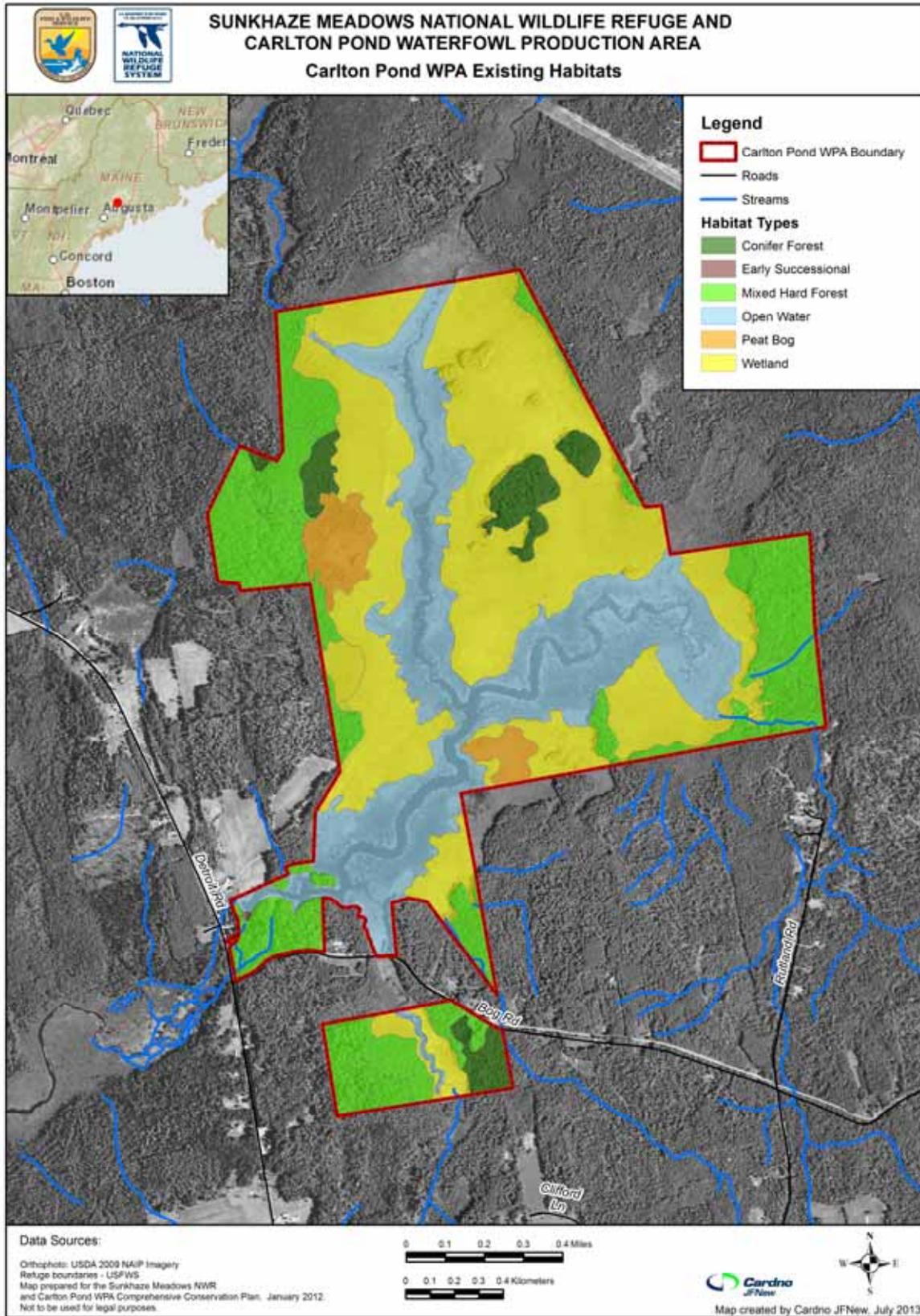


Table 3.7. Rare or exemplary natural communities and ecosystems on the Sunkhaze Meadows Unit.

Natural Community/Ecosystem/Plant	Approx Size (acres)	State Ranking
Unpatterned fen ecosystem <sub>1</sub>	6,855*	S5 – secure
Domed bog ecosystem	1,649	S3 -- uncommon
Northern white cedar woodland fen	390	S4 -- common, outstanding example
Silver maple floodplain forest	100	S3 -- uncommon

\* *Of this total, 5,949 acres of unpatterned fen ecosystem are located within the refuge boundaries.*

The 6,855-acre unpatterned fen ecosystem extends beyond the refuge boundaries, although most of it (5,949 acres) lies within the Sunkhaze Meadows Unit. Unpatterned fen ecosystems are peatlands in which groundwater or water from adjacent uplands moves through the area (MNAP 2012). As a result, plants are exposed to more nutrients, and the vegetation is typically different and more diverse than that of bogs. The dominant vegetation includes sedges, grasses, reeds, and sphagnum (Gawler and Cutko 2010).

The domed bog ecosystem is comprised of a series of islands, at a slightly higher elevation than the surrounding unpatterned fen ecosystem. These island peatlands display a vegetation pattern that reflects a nutrient gradient from the higher center of the dome out to the lower edges of the island (Gawler and Cutko 2010).

The 390-acre northern white cedar woodland fen is embedded within the unpatterned fen ecosystem. According to MNAP, the woodland fen is a broad, flat peatland dominated by a canopy of northern white cedar, with a dense mix of rough-leaved alder, winterberry, and black ash. The cedar trees range from 4 inches to 23 inches (10cm to 60cm) diameter at breast height (dbh), with smaller diameter trees being much more common than larger ones. Cinnamon and royal ferns dominate the hummocky herb layer which includes a number of sedge species and a variety of forbs characteristic of this community type. Under the ferns, mixes of low-growing sedges are common. Sphagnum and other mosses dominate the abundant hummocks, but hollows are largely unvegetated and often saturated. The MNAP also noted a small band of cedar-spruce seepage forest along the upland edge of the fen, although it was too small to map as a separate community (MNAP 2010).

The MNAP also documented a 100-acre exemplary silver maple floodplain forest along Sunkhaze Stream, from 0.25 miles upstream of the power line and continuing upstream approximately 1.5 miles on both sides. Although not the highest quality, the forest is well buffered and protected within the refuge. Hardwood floodplain forest is usually dominated by widely spaced and multi-trunk silver maple. The understory is usually sparse with few shrubs, a result of annual ice scouring. By early summer the forest floor is often lush with herbaceous plants including spring ephemerals such as trout lily and ferns. High nutrient levels in the soil are

maintained through seasonal deposition of nutrient-rich sediments as a result of seasonal flooding (MNAP 1999).

No exemplary or rare natural communities or ecosystems are documented for the other refuge units or WPA.

### **Rare Plants**

Two rare plant species are documented on the Sunkhaze Meadows Unit. A population of State-listed, threatened showy lady's slipper (*Cypripedium reginae*) is documented in the northern white cedar woodland fen in Sunkhaze Meadows Unit (MNAP 2011). Bog bedstraw (*Galium labradoricum*), a State species of concern, was documented in 1995 for this unit, although the population has not been re-surveyed since then (MNAP 1998). Two other rare species – slender blue flag iris (*Iris prismatica*, State-listed, threatened) and wild garlic (*Allium canadense*, Maine species of concern) are listed as occurring on the Sunkhaze Meadows Unit in earlier Service documents (e.g., USFWS 2001); however, these species are not in the MNAP database and are likely historical records (Don Cameron, MNAP, personal communication 2011). No other rare plant species have been documented on the other refuge units or at the WPA.

### **Invasive Plant Species**

The Service identifies an invasive species as a species that is (1) nonnative to the ecosystem under consideration, and (2) whose introduction causes or is likely to cause economic or environmental harm or harm to human health (Executive Order 13112). Invasive plant species are recorded for Sunkhaze Meadows and Benton Units and Carlton Pond WPA; no invasive plants have been detected at the Sandy Stream Unit (table 3.8).

In the early 1990s, an infestation of purple loosestrife was discovered on a portion of the Carlton Pond WPA. Refuge staff pulled loosestrife plants in 1993 and 1994 but concluded that the level of effort and cost to physically remove the infestation was not feasible. In subsequent years, refuge staff has released biological control agents (*Galerucella pusilla*) to combat purple loosestrife at Carlton Pond WPA.

Refuge staff has slowly watched purple loosestrife spread along roadsides and in private wetland areas closer to the Sunkhaze Meadows Unit. Staff members and friends have been pulling 30 to 40 purple loosestrife plants here annually between July and August to prevent its spread onto the refuge. In 2011, the Friends of Sunkhaze hired a licensed pesticide applicator. With permission from appropriate land owners and assistance from refuge staff, loosestrife plants in the ditches along County Road were killed using a glyphosate-based herbicide approved for use in wetlands. The refuge paid for a treatment in 2012. Similar treatments may be necessary for a number of years to successfully control new plants arising from the seedbed. Two groups of loosestrife were also discovered in the Sunkhaze Meadows Unit along Sunkhaze Stream south of Ash Landing in 2011. These were dug up and removed.

Map 3.5. Exemplary natural communities and deer overwintering area at the Sunkhaze Meadows Unit of Sunkhaze Meadows NWR.

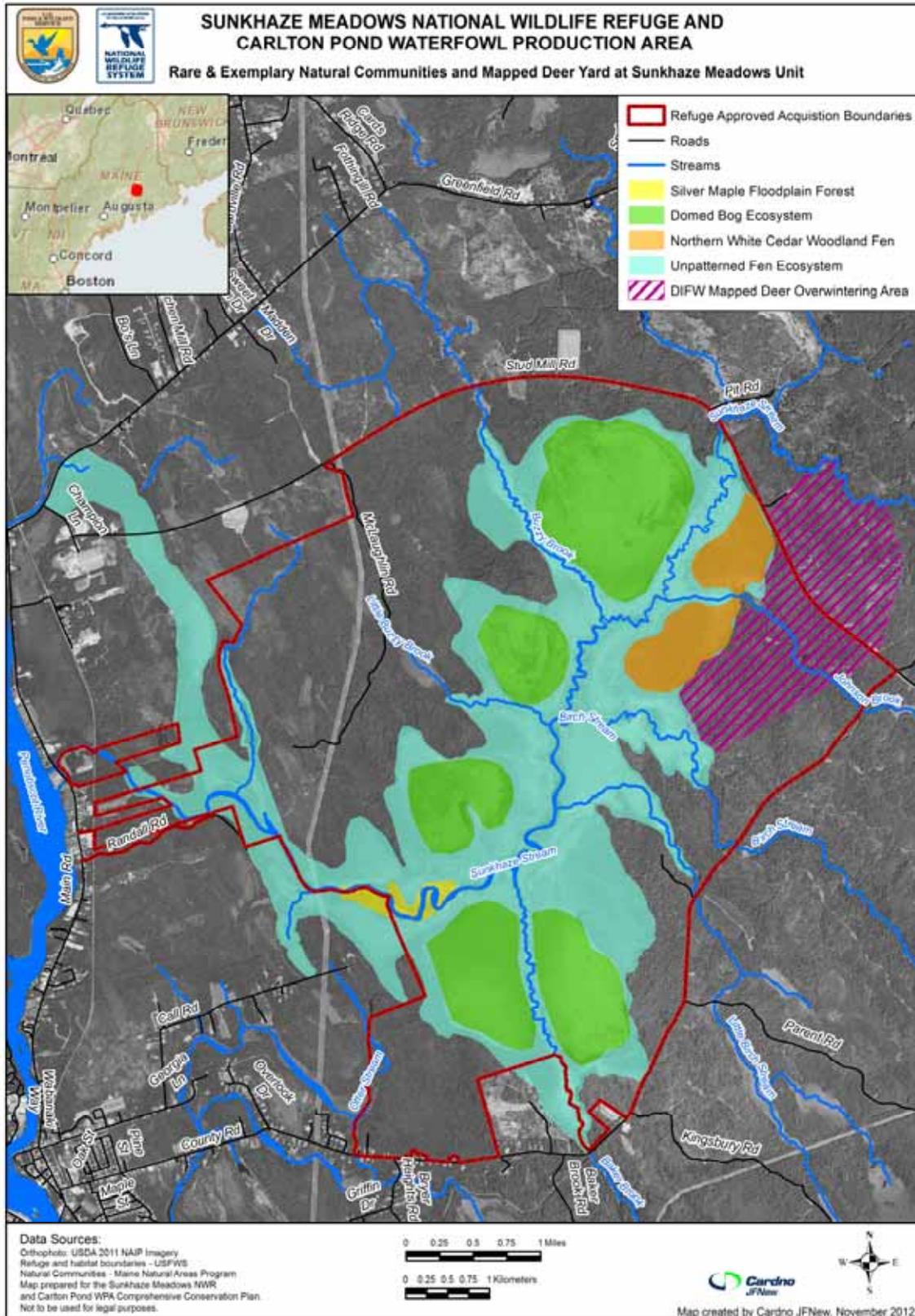


Table 3.8. Invasive plants detected on Sunkhaze Meadows NWR and Carlton Pond WPA.

Scientific Name	Common Name	Location
<i>Cirsium arvense</i>	Canada thistle	Benton Unit
<i>Cirsium vulgare</i>	Bull thistle	Sunkhaze Meadows Unit Benton Unit
<i>Elaeagnus umbellata</i>	Autumn-olive	Benton Unit
<i>Fallopia japonica</i>	Japanese knotweed	Sunkhaze Meadows Unit
<i>Lonicera tatarica</i>	Tartarian honeysuckle	Benton Unit
<i>Lythrum salicaria</i>	Purple loosestrife	Sunkhaze Meadows Unit; Benton Unit; Carlton Pond WPA
<i>Rhamnus cathartica</i>	Common buckthorn	Sunkhaze Meadows Unit Carlton Pond WPA
<i>Tussilago farfara</i>	Coltsfoot	Sunkhaze Meadows Unit

### Fish and Wildlife Resources

Table 3.9 lists the number of species by taxa that have been recorded on Sunkhaze Meadows NWR and Carlton Pond WPA since 1990. Appendix A includes a complete list of the species observed across all refuge units and the WPA.

Table 3.9. Summary of species detected by taxa on Sunkhaze Meadows NWR and Carlton Pond WPA, 1990 to 2005. Numbers compiled from available refuge inventory summary data.

	Sunkhaze Meadows Unit	Sandy Stream Unit	Benton Unit	Carlton Pond WPA
<b>Fish and Wildlife</b>				
Amphibians	17	12	16	12
Birds	202	66	98	96
Fish	21	19	1	29
Invertebrates	121	11	26	55
Mammals	45	17	23	14
Mollusks	5	4	1	4
Reptiles	10	2	4	4
<b>Plants</b>				
Plants	358	133	223	202
Fungi	22	1	2	7
<b>TOTAL</b>	<b>801</b>	<b>265</b>	<b>394</b>	<b>423</b>

## **Fish and Mussels**

The Sunhaze Meadows Unit provides habitat for both warmwater and coldwater fish species. Smithwood and McKeon (1999) compiled a list of 15 fish species as part of a Fisheries Management Plan. Included in this list are three interjurisdictional fish species: Atlantic salmon, American eel, and brook trout. Sunhaze Stream and its tributaries are designated as critical habitat for the federally listed, endangered Atlantic salmon. This listing is described in more detail under the subsection, federally listed threatened or endangered species below. Atlantic salmon has been reported entering the lower reaches of Sunhaze Stream from the Penobscot River during warmer summer months. The Penobscot River is a major migratory pathway for Atlantic salmon and American eel, but numerous dams on the river impede upstream and downstream migration of these (and other) species. Brook trout and American eel are native to the Sunhaze Stream system, while smallmouth bass were introduced sometime prior to the 1940s. Several other species have been documented on Sunhaze Meadows since the 1999 study; a full list is in table 3.10.

The primary brook trout habitat on the refuge appears to be a reach of Sunhaze Stream from Stud Mill Road extending 200 meters downstream. During warm periods of the year, brook trout appear to move farther upstream. Brook trout have also been found in Little Birch Stream. Nearly 40,000 brook trout were stocked into Sunhaze Stream between 1940 and 1950, and another 500 were stocked in Sunhaze and Birch Streams from 1974 to 1975, the last year that any fish were stocked in waters now encompassed by the refuge. The stocking period coincided with heavy fishing pressure, especially on brook trout (Smithwood and McKeon 1999).

A recent study of fish assemblages in the Penobscot River and some tributaries (Kiraly 2012) included sampling of Sunhaze Stream. All of the species found in Sunhaze Stream were warm water species. The dominant fish were golden shiner, brown bullhead, and pumpkinseed. Other species that were captured during the study included redbreast sunfish, yellow perch, chain pickerel, and common shiner.

The Benton and Sandy Stream Units and Carlton Pond WPA are also dominated by common, warm water fish species. Fish species diversity at these units is as follows: Benton Unit (1 species), Sandy Stream Unit (19 species), and Carlton Pond WPA (29 species). There are no known federally listed or State-listed fish species at any of these sites. Known species in these locations include: chain pickerel, yellow perch, bullheads, carp, golden shiner, and smallmouth and largemouth bass. Smallmouth and largemouth bass are not native to Maine (MDIFW 2001). According to MDIFW, there has been an increase of 47 percent in the number of lakes with one or more species of bass between 1980 and 2000 (MDIFW 2001). Chain pickerel are thought to be native only to southern Maine and are, therefore, not considered native to these sites (MDIFW 2008). Based on the MDIFW (2008) assessment, abundance of chain pickerel is increasing; and, despite State efforts to limit the distribution of pickerel, the species distribution is also increasing (MDIFW 2008). Bullhead and yellow perch are also considered to be nonnative to these units (MDIFW 2002). A complete list of reported fish species at each site is included in table 3.10.

Table 3.10. Fish species observed at Sunkhaze Meadows NWR and Carlton Pond WPA.

Common Name	Scientific Name	Status*	Sunkhaze Meadows Unit	Sandy Stream Unit	Benton Unit	Carlton Pond WPA
American Eel	<i>Anguilla rostrata</i>		X	X		X
American Shad	<i>Alosa sapidissima</i>					X
Atlantic Salmon	<i>Salmo salar</i>	FE	X			
Banded Killifish	<i>Fundulus diaphanus</i>					X
Black Crappie	<i>Pomoxis nigromaculatus</i>					X
Blackchin Shiner	<i>Notropis heterodon</i>					X
Blacknose Dace	<i>Rhinichthys atratulus</i>		X	X		X
Blackspotted Stickleback	<i>Gasterosteus wheatlandi</i>					X
Blueback Charr	<i>Salvelinus alpinus oquassa</i>					X
Bridle Shiner	<i>Notropis bifrenatus</i>	ME SC				X
Brook Trout	<i>Salvelinus fontinalis</i>		X	X	X	
Brown Bullhead	<i>Ameriurus nebulosus</i>		X			X
Brown Trout	<i>Salmo trutta</i>		X	X		X
Burbot (Cusk)	<i>Lota lota</i>		X	X		X
Carp	<i>Cyprinus carpio</i>			X		X
Chain Pickerel	<i>Esox niger</i>		X	X		X
Common Shiner	<i>Luxilus Cornutus</i>		X	X		X
Creek Chub	<i>Semotilus atromaculatus</i>		X	X		X
Eastern Silvery Minnow	<i>Hybognathus regius</i>		X	X		X
Emerald Shiner	<i>Notropis atheinoides</i>			X		X
Fallfish	<i>Semontius corporalis</i>		X	X		X
Fathead Minnow	<i>Pimephales promelas</i>			X		X
Fourspine Stickleback	<i>Apeltes quadracus</i>			X		X
Golden Shiner	<i>Notemigonus crysoleucas</i>		X	X		X
Largemouth Bass	<i>Micropterus salmoides</i>					X
Ninespine Stickleback	<i>Puntitius puntitius</i>		X			
Northern Pike	<i>Esox lucius</i>					X
Pearl Dace	<i>Semotilus margarita</i>			X		

Common Name	Scientific Name	Status*	Sunkhaze Meadows Unit	Sandy Stream Unit	Benton Unit	Carlton Pond WPA
Pumpkinseed Sunfish	<i>Lepomis gibbosus</i>		X	X		X
Redbelly Dace	<i>Phoxinus eos</i>		X			
Redbreast Sunfish	<i>Lepomis auritus</i>		X			X
Smallmouth Bass	<i>Micropterus dolomieu</i>		X	X		X
Spottail Shiner	<i>Notropis hudsonius</i>		X			
White (Common) Sucker	<i>Catostromus commersonni</i>		X	X		X
Yellow Perch	<i>Perca flavescens</i>		X			X

\*FE stands for federally listed, endangered. The ME SC status indicates species that are listed as Special Concern by MDIFW. These species have no special legislative protection. However, they are believed to be vulnerable and could become threatened or endangered because of factors such as their distribution, low or declining populations, or specialized habitat needs.

A handful of mussels have been found on or near refuge property as well (table 3.11). These include two State-listed, threatened freshwater mussels documented in Sandy Stream, just off refuge property: the tidewater mucket and the yellow lampmussel.

Table 3.11. Mussel species observed at Sunkhaze Meadows NWR and Carlton Pond WPA.

Common Name	Scientific Name	Status*	Sunkhaze Meadows Units	Sandy Stream Unit	Benton Unit	Carlton Pond WPA
Eastern Elliptio	<i>Elliptio complanata</i>		X			X
Eastern Lampmussel	<i>Lampsilis radiata radiata</i>		X	X		X
Eastern Pearlshell	<i>Margaritifera margaritifera</i>		X			
Tidewater Mucket	<i>Leptodea ochracea</i>	ME T		X		
Yellow Lampmussel	<i>Lampsillis cariosa</i>	ME T/ FSC		X		

\*ME T indicates Maine State-listed, threatened. FSC stands for Federal species of concern. This indicates species that are listed as Special Concern by USFWS. These species have no special legislative protection; however, they are believed to be vulnerable and could become threatened or endangered because of factors such as their distribution, low or declining populations, or specialized habitat needs.

## Birds

According to the Atlas of Breeding Birds of Maine (Adamus 1987), approximately 130 species of birds—resident and migratory—are possible, probable, or confirmed breeders in the vicinity of Sunkhaze Meadows Unit. The wetland-peatland complex is particularly valuable to songbirds during their spring and fall migration (Adamus 1987). Sixteen waterfowl species have been observed at Sunkhaze Meadows Unit, of which seven are known to breed there: wood duck, black duck, mallard, blue-winged and green-winged teals, ring-necked duck, and hooded merganser (USFWS 2008b). The wood duck and hooded merganser nest in tree cavities. Black ducks are the most common waterfowl species on the refuge in the fall (USFWS 2008b).

Other bird highlights for Sunkhaze Meadows Unit include breeding American and least bitterns and Virginia and sora rails, 23 species of breeding warblers, and documented nesting of spruce grouse, ruffed grouse, and wild turkey. Several shorebird species use the refuge during migration, while killdeer, spotted sandpiper, common snipe, and American woodcock breed there (appendix A).

Twenty-one species of raptors have been documented on the Sunkhaze Unit (USFWS 2008b) including: hawks, falcons, and owls. Ten of these are known to breed on the refuge: osprey, bald eagle, northern harrier, sharp-shinned hawk, northern goshawk, red-shouldered hawk, broad-winged hawk, great-horned owl, barred owl, and northern saw-whet owl (appendix A).

Several bird species of concern are known to breed on the Sunkhaze Meadows Unit, including American woodcock, bay-breasted warbler, American black duck, Canada warbler, wood thrush, eastern wood-pewee, chestnut-sided warbler, blackburnian warbler, and black-throated-blue warbler, among others. Bald eagles are commonly seen foraging on this unit and were first observed nesting here in 2005.

Many of the birds observed at the Benton Unit were observed during migration. For example, several shorebird species were observed during spring or fall migration, including greater yellowlegs, killdeer, upland sandpiper, and American woodcock. Red-winged blackbird and tree swallow nest in or near the emergent wetland and sedge meadow. Sedge wrens documented at this site when the unit was first acquired by the Service have not been reported since that time. The grassland habitat is maintained to support nesting grassland birds, specifically bobolink.

The two main habitat types on the Sandy Stream Unit—shrubland and floodplain forest—support breeding bird species associated with these habitats. Shrub-nesting species include eastern kingbird, willow flycatcher, yellow warbler, common yellowthroat, field sparrow, and American goldfinch. Birds associated with the floodplain forest include pileated woodpecker, hairy woodpecker, yellow-bellied sapsucker, red-eyed vireo, and veery.

Carlton Pond WPA is one of the few wetlands in Maine used by nesting black terns, a State-listed, endangered species. The black tern population in Maine has been annually monitored since 1990, reporting between 80 and 90 pairs. The MDIFW manages black tern habitat by maintaining stable water levels in impoundments, taking efforts to deter predators, and using floating nest platforms (MDIFW 2013c). Other species that use the WPA for breeding, nesting, feeding, or migration include American black ducks, hooded mergansers, common goldeneyes,

Canada geese, wood ducks, blue-winged teal, ring-necked ducks, and other waterfowl, osprey, and several species of migratory song birds. Wood duck nest boxes were installed and are now maintained by volunteers.

### **Mammals**

Forty-four species of mammals are documented for the Sunkhaze Meadows Unit (USFWS 2008b), including six species of shrews and moles, eight species of bats, eight species of the weasel family, many other species of small mammals, and an array of medium to large mammals including black bear, white-tailed deer, moose, bobcat, coyote, red and gray fox, and muskrat. Beaver are especially abundant along Sunkhaze Stream and its tributaries, as evidenced by their lodges, dams, caches, and scent mounds. MDIFW considers most furbearer populations to be stable in this part of the State; however, there are concerns over declines in fisher and bobcat harvests between 2008 and 2012 (DePue 2013 personal communication). MDIFW is also concerned about the over-harvest of river otters in this area (DePue 2013 personal communication).

A portion of the Sunkhaze Meadows Unit is part of a 1,129-acre deer wintering area. The deer wintering area extends throughout some of the eastern portion of the refuge and across the Stud Mill Road to the northeast. The mix of mature conifer, northern white cedar, and northern hardwood-mixed forest provides protection from severe weather and winter food sources for deer, which are at their northern limits of their range in Maine. The Benton Unit forest is part of a 435-acre deer wintering area that extends into the northeast corner of the unit.

The Benton Unit and Sandy Stream Unit report 23 and 17 mammal species, respectively. Moose, white-tailed deer, river otter, raccoon, woodchuck, and eastern chipmunk occur on both units. A mix of other small and medium sized mammals is reported from these two units (table 3.12).

Fifteen mammal species are reported for Carlton Pond WPA, including beaver, muskrat, river otter, and moose in the aquatic habitats. Other mammals include black bear, white-tailed deer, coyote, red fox, raccoon, woodchuck, ermine, chipmunk, and red and gray squirrels. For a full listing of all known mammal species at the different sites, see table 3.12.

We do not have estimates of mammal abundance for refuge or WPA lands. Statewide, status of mammal populations varies. According to the MDIFW, the State's deer population has increased since the early 1980s to about 255,000 wintering deer. Deer abundance in central and southern Maine ranges from 15 to 25 deer per square mile (MDIFW 2013). However, recently deer populations in Maine have been declining (MDIFW 2011). White-tailed deer are near their northern range limit in Maine and are not well adapted for harsh winter conditions (Jakubus 1999). Consequently, winter severity is considered to be the greatest contributor to deer mortality in Maine (MDIFW 2011). Statewide, furbearer populations (e.g., beaver, mink, otter, and muskrat) are thought to be stable or increasing, with the exception of fisher and marten (M. Caron personal communication 2013).

Table 3.12. Mammal species observed at Sunkhaze Meadows NWR and Carlton Pond WPA.

Common Name	Scientific Name	Status*	Sunkhaze Meadows Unit	Sandy Stream Unit	Benton Unit	Carlton Pond WPA
Beaver	<i>Castor canadensis</i>		X	X	X	X
Big Brown Bat	<i>Eptesicus fuscus</i>	ME SC	X			
Black Bear	<i>Ursus americanus</i>		X		X	X
Bobcat	<i>Lynx rufus</i>		X			
Coyote	<i>Canis latrans</i>		X		X	X
Deer Mouse	<i>Peromyscus maniculatus</i>		X	X		
Eastern Chipmunk	<i>Tamias striatus</i>		X	X	X	X
Eastern Gray Squirrel	<i>Sciurus carolinensis</i>		X		X	X
Eastern Mole	<i>Scalopus aquaticus</i>			X		
Fisher	<i>Martes pennanti</i>		X		X	
Gray Fox	<i>Urocyon cinereoargenteus</i>		X			
Hoary Bat	<i>Lasiurus cinerues</i>	ME SC	X			
Keen Myotis	<i>Myotis keeni</i>		X			
Least Weasel	<i>Mustela rixosa</i>		X			
Little Brown Myotis	<i>Myotis lucifugus</i>	ME SC	X			
Long-tailed Shrew	<i>Sorex dispar</i>		X			
Long-tailed Weasel	<i>Mustela frenata</i>		X			
Marten	<i>Martes americana</i>		X			
Masked Shrew	<i>Sorex cinereus</i>		X	X	X	
Meadow Jumping Mouse	<i>Zapus hudsonius</i>		X	X	X	
Meadow Vole	<i>Microtus pennsylvanicus</i>		X	X	X	
Mink	<i>Mustela vison</i>		X			
Moose	<i>Alces alces</i>		X	X	X	X
Muskrat	<i>Ondatra zibethicus</i>		X		X	X
Northern Flying Squirrel	<i>Glaucomys sabrinus</i>		X	X	X	
Northern Short-tailed Shrew	<i>Blarina brevicauda</i>		X	X	X	
Northern Water Shrew	<i>Sorex plaustris</i>		X	X		
Porcupine	<i>Erethizon dorsatum</i>		X		X	

Common Name	Scientific Name	Status*	Sunkhaze Meadows Unit	Sandy Stream Unit	Benton Unit	Carlton Pond WPA
Pygmy Shrew	<i>Sorex hoyi</i>		X			
Raccoon	<i>Procyon lotor</i>		X	X	X	X
Red Bat	<i>Lasiurus borealis</i>	ME SC	X			
Red Fox	<i>Vulpes vulpes</i>		X			X
Red Squirrel	<i>Tamiasciurus hudsonicus</i>		X		X	X
River Otter	<i>Lutra canadensis</i>		X	X	X	X
Short-tailed Weasel (Ermine)	<i>Mustela erminea</i>		X			X
Silver-haired Bat	<i>Lasionycteris noctivagans</i>	ME SC	X			
Smoky Shrew	<i>Sorex fumeus</i>		X		X	
Snowshoe Hare	<i>Lepus americanus</i>		X		X	X
Southern Bog Lemming	<i>Synaptomys cooperi</i>		X			
Southern Redback Vole	<i>Clethrionomys gapperi</i>		X	X	X	
Star-nosed Mole	<i>Condylura cristata</i>		X			
Striped Skunk	<i>Mephitis mephitis</i>		X	X	X	
White-footed Mouse	<i>Peromyscus leucopus</i>		X			
White-tailed Deer	<i>Odocoileus virginianus</i>		X	X	X	X
Woodchuck	<i>Marmota monax</i>		X	X	X	X

\*The ME SC status indicates species that are listed as Special Concern by MDIFW. These species have no special legislative protection. However, they are believed to be vulnerable and could become threatened or endangered because of factors such as their distribution, low or declining populations, or specialized habitat needs

### Reptiles and Amphibians

As shown in tables 3.13 and 3.14, Sunkhaze Meadows NWR and Carlton Pond WPA support many amphibians and reptiles. A majority of these are frogs and salamanders. A Unity College student conducted an amphibian study at the Benton Unit and reported 10 amphibian species and 2 reptile species (Bishop et al. 1996). Seventeen amphibian species are reported from all three Sunkhaze Meadows NWR units and Carlton Pond WPA as listed in table 3.14. Three amphibian species of special concern in Maine are reported: blue-spotted salamander (Sunkhaze Meadows Unit, Sandy Stream Unit, Benton Unit) and leopard frog (Sunkhaze Meadows Unit, Sandy Stream Unit, Carlton Pond WPA). Wood turtle, a species of special concern in Maine, is reported from Sunkhaze Meadows Unit, Sandy Stream Unit, and Carlton Pond WPA.

Table 3.13. Reptile species observed at Sunhaze Meadows NWR and Carlton Pond WPA.

Common Name	Scientific Name	Status*	Sunhaze Meadows Unit	Sandy Stream Unit	Benton Unit	Carlton Pond WPA
Common Musk Turtle	<i>Sternotherus odoratus</i>	ME SC				
Common Snapping Turtle	<i>Chelydra serpentina</i>		X	X		X
Eastern Garter Snake	<i>Thamnophis sirtalis</i>		X		X	X
Eastern Painted Turtle	<i>Chrysemys picta</i>		X			X
Milk Snake	<i>Lampropeltis triangulum</i>		X			
Northern Brown Snake	<i>Storeria dekayi</i>	ME SC	X			
Northern Redbelly Snake	<i>Storeria occipitomaculata</i>		X		X	
Northern Ribbon Snake	<i>Thamnophis sauritus</i>	ME SC	X		X	
Northern Ringneck Snake	<i>Diadophis punctatus edwardsii</i>		X		X	
Smooth Green Snake	<i>Liochlorophis vernalis</i>		X			
Wood Turtle	<i>Glyptemys insculpta</i>	ME SC	X	X		X

\*The ME SC status indicates species that are listed as Special Concern by MDIFW. These species have no special legislative protection. However, they are believed to be vulnerable and could become threatened or endangered because of factors such as their distribution, low or declining populations, or specialized habitat needs.

Table 3.14. Amphibian species observed at Sunhaze Meadows NWR and Carlton Pond WPA.

Common Name	Scientific Name	Status*	Sunhaze Meadows Unit	Sandy Stream Unit	Benton Unit	Carlton Pond WPA
American Toad	<i>Bufo americanus</i>		X	X	X	X
Blue-spotted Salamander	<i>Ambystoma laterale</i>		X	X	X	
North American bullfrog	<i>Rana catesbeiana</i>		X	X	X	X
Red-spotted Newt	<i>Notophthalmus viridescens</i>		X	X	X	X

Common Name	Scientific Name	Status*	Sunkhaze Meadows Unit	Sandy Stream Unit	Benton Unit	Carlton Pond WPA
Four-toed Salamander	<i>Hemidactylium scutatum</i>	ME SC	X		X	
Gray Tree Frog	<i>Hyla versicolor</i>		X	X	X	X
Green Frog	<i>Rana clamitans</i>		X	X	X	X
Mink Frog	<i>Rana septentrionalis</i>		X	X	X	X
Northern Dusky Salamander	<i>Desmognathus fuscus</i>		X	X	X	
Northern Leopard Frog	<i>Rana pipiens</i>	ME SC	X	X	X	X
Red-backed Salamander	<i>Plethodon cinereus</i>		X	X	X	
Spring Peeper	<i>Hyla crucifer</i>		X	X	X	X
Spring Salamander	<i>Gyrinophilus porphyriticus</i>	ME SC	X	X	X	
Northern Two-lined Salamander	<i>Eurycea bislineata</i>		X		X	X
Pickerel Frog	<i>Rana palustris</i>		X		X	X
Spotted Salamander	<i>Ambystoma maculatum</i>		X	X	X	X
Wood Frog	<i>Rana sylvatica</i>		X	X	X	X

\*The ME SC status indicates species that are listed as Special Concern by MDIFW. These species have no special legislative protection. However, they are believed to be vulnerable and could become threatened or endangered because of factors such as their distribution, low or declining populations, or specialized habitat needs.

### Invertebrates, Excluding Mussels

According to refuge records, a large number (121 species) of invertebrates have been inventoried at the Sunkhaze Meadows Unit, a majority of which are butterflies, moths, dragonflies, and damselflies. This includes two species of special concern in Maine: tomah mayfly and pygmy snaketail dragonfly. As expected, fewer invertebrate species are documented for the Benton and Sandy Stream Units (26 and 12 species, respectively), and Carlton Pond WPA (55 species). Carlton Pond WPA is dominated by dragonflies, damselflies, and butterflies. The Benton and Sandy Stream Units have a mixed diversity of invertebrates including butterflies, crickets, mosquitoes, and bees.

### Nonnative, Invasive Wildlife Species

While there are several nonnative fish species that occur in refuge and WPA waters, these are not considered to be invasive by MDIFW in these locations. No other nonnative wildlife species are known to occur on Sunkhaze Meadows NWR or Carlton Pond WPA.

### Federally Listed Threatened or Endangered Species

Sunkhaze Stream and its tributaries are also designated as critical habitat for the federally listed, endangered Atlantic salmon. In 2009, the Gulf of Maine Distinct Population Segment (GOM DPS) of Atlantic salmon was listed as an endangered species pursuant to the Endangered Species Act (ESA). The Gulf of Maine Atlantic salmon population was divided into three separate Salmon Habitat Recovery Units, located in the Penobscot, Merrymeeting, and Downeast watersheds of Maine. The Atlantic salmon is an anadromous species, i.e., it relies on both freshwater and marine environments to complete its life cycle. Each phase of the life cycle (i.e., egg, juvenile, adult) is marked by distinct physical changes and habitat needs (Kircheis and Liebich 2007). Sunkhaze Stream was evaluated for its contribution to potential habitat for Atlantic salmon as part of the 2009 designation of critical habitat for Atlantic salmon (NMFS 2009). This watershed-scale analysis was based on the quantity and quality of Atlantic salmon migrating, spawning, and juvenile rearing habitat needs. As part of this analysis, Sunkhaze Stream was determined to be within the Critical Habitat Area for Atlantic salmon. However, it did rank low for habitat availability when compared to other streams within the watershed. Sunkhaze Stream's primary contribution to Atlantic salmon is likely as a cool water refuge. Spawning adults typically return to spawning waters early and find short-term cold water refuge in streams (e.g., deep pools, springs, and mouths of smaller tributaries) during the summer months before spawning in October and early November (Baum 1997).

While not included as critical habitat for Atlantic salmon, the Benton Unit, Sandy Stream Unit, and Carlton Pond WPA are also located within the GOM DPS for this species.

The Service is currently reviewing the status of the American eel as a potential candidate for listing under the Endangered Species Act. The American eel is native to the Sunkhaze Stream system and was documented on the unit in Birch Stream, one of the tributaries.

Although recently delisted from the Federal list, bald eagles are still protected under the Bald and Golden Eagle Protection Act. They are also still listed as State threatened by MDIFW.

No other federally endangered or threatened species are known to occur on other units of Sunkhaze Meadows NWR or Carlton Pond WPA.

### State-listed Species

State-listed, threatened or endangered wildlife species are described in more detail in the previous section. Below is a summary table of State-listed species documented on the refuge or WPA (see table 3.15).

Table 3.15. State-listed, threatened or endangered species documented on Sunkhaze Meadows NWR and Carlton Pond WPA.

Common name	Scientific Name	Status	Division
Black tern	<i>Chlidonias niger</i>	State endangered	Carlton Pond WPA
Least bittern	<i>Ixobrychus exilis</i>	State endangered	Sunkhaze Meadows Unit and Carlton Pond WPA
Sedge wren	<i>Cistothorus platensis</i>	State endangered	Benton Unit

Common name	Scientific Name	Status	Division
Tomah mayfly	<i>Siphonisca aerodromia</i>	State threatened	Sunkhaze Meadows Unit
Pygmy snaketail dragonfly	<i>Ophiogomphus howei</i>	State threatened	Sunkhaze Meadows Unit
Tidewater mucket	<i>Leptodea ochracea</i>	State threatened	Sandy Stream Unit
Yellow lampmussel	<i>Lampsilis cariosa</i>	State threatened	Sandy Stream Unit

### Wildlife Trends and Changes

While some species such as alpine plants have been in Maine for 10,000 years or more, the region also supports recent arrivals, such as coyotes, which appeared in the last 75 years. The majority of change to the area occurred over the last 400 years, significantly altering the landscape that was previously there (Foss 1992).

The 1800s witnessed the demise of many forest wildlife species from loss of habitat due to forest clearing, bounty and market hunting, millinery trade, and natural history specimen collecting (Foster et al. 2002). Heath hen, passenger pigeon, great auk, Labrador duck, and sea mink became extinct because of humans during the same period (DeGraaf and Yamasaki 2001, Foster et al. 2002).

Mountain lion, gray wolf, elk, and caribou were extirpated by the mid-1800s or early 1900s in Maine, and only the gray wolf has recently returned to New England. Two wolves were documented in Maine in the 1990s, although there has been no evidence of a breeding population. Lynx have returned to northern Maine.

In contrast, grassland species such as meadowlark, bobolink, upland sandpiper, woodchuck, and meadow vole increased as hayfields and pastures expanded during the early 19th century (Foss 1992, Foster and Motzkin 2003). Open land plant and animal species reached their peak abundance in the mid-1800s. The historical record is unclear on the abundance and distribution of these species prior to the surge in farming. DeGraaf and Yamasaki (2001) and Foster and Motzkin (2003) suggest that open land species were opportunistic, expanding into large, newly cleared lands from small, scattered populations in the pre-settlement era. In a similar pattern, other species expanded their range into New England from the Midwest.

After farm abandonment escalated in the early 1900s, grassland habitats ebbed, while thickets, brush lands, and young forests surged (Litvaitis 2003). Populations of black bear, bobcat, and broad-winged hawk increased. Intense logging, wildfire activity and natural events such as heavy rains, ice storms and early snow storms, significantly altered the northern forest landscape, changing both plant and animal species in abundance and diversity. Many of the barren mountaintops below 3,800 feet and other hardwood-dominated hillsides seen today are artifacts of early 20th century land use (Foss 1992, DeGraaf and Yamasaki 2001).

The young hardwood forests that emerged in the 1920s and 1930s after the old-field pine harvests provided premier habitat for ruffed grouse (DeGraaf and Yamasaki 2001). As these forests reached maturity late in the 1900s, there was a noticeable decline in the grouse population

along with an increase in other species preferring more mature forest stands. Hence species dependent on early succession habitats declined to almost pre-settlement levels (Litvaitis 2003).

Eastern coyotes were first sighted in northern Maine in the 1930s, Vermont and New Hampshire in the 1940s, and Massachusetts in the 1950s. The turkey vulture, tufted titmouse, northern mockingbird, and Virginia opossum are newer arrivals. Wild turkey, reintroduced in the 1960s and 1970s, are flourishing well beyond their historic ranges.

## **Cultural Landscape Setting and Land Use History**

Sunkhaze Meadows NWR and Carlton Pond WPA contain cultural resources that indicate use from prehistoric through historic time periods. These resources may contribute to further understanding of Maine's prehistory and history. This is especially true in the areas involving Native American settlement and subsistence, prehistoric and historic travel, and use of the peat bog. Archaeological investigations in areas surrounding Sunkhaze Meadows Unit indicate that activities relating to travel, hunting and fishing, fortifications, and group gatherings all likely occurred within today's boundaries of the Sunkhaze Meadows Unit (Robinson 2011).

Archaeological investigations near Carlton Pond WPA revealed areas of prehistoric settlement, resource procurement, and tool manufacture (Shaffer 2011). Furthermore, "at least 95 percent of the known prehistoric habitation and workshop sites in Maine are found next to waters that are (or were) navigable by canoe" (Shaffer 2011). The identification of archaeological sites adjacent to the waterways at both the refuge and WPA suggests that both Sunkhaze Meadows NWR and Carlton Pond WPA were heavily used waterways throughout prehistory.

### **Native Peoples**

The first inhabitants along the Penobscot River and present-day Sunkhaze Meadows Unit were the Penobscot Indian Nation. Archaeological evidence shows native inhabitants on the Penobscot River fished for American shad as early as 8,000 years ago and for sturgeon as early as 3,000 years ago. Shad bones found in native settlements along the Sebec River in Milo (approximately 30 miles northwest of the refuge) are dated from 6,000 to 8,000 Before Current Era (BCE) (Penobscot River Restoration Trust, n.d.). Land adjacent to Sunkhaze Meadows Unit contains archaeological deposits of American eel, white perch, and bullhead dating to 8,500 BCE (Robinson 2011).

Archaeological excavations adjacent to the Sunkhaze Meadows Unit indicate prehistoric occupation in the area occurred from 8,500 years ago to at least 5,000 years ago (information pertaining to the last 5,000 years of occupation was lost when the land was stripped for loam in the 1960s) (Robinson 2011). Additionally, records dating from 1671 indicate that this area contained the location of a Penobscot Indian Nation fort or stronghold (Robinson 2011). Fortifications were often constructed along access routes, in an area accessible from multiple locations (Robinson 2011). Research indicates that Sunkhaze Stream was an access route to the Union River and Blue Hill Bay, both important cultural areas throughout history (Cook 2007). The identification of a Penobscot Indian Nation stronghold so close to the Sunkhaze Meadows Unit indicates the area was heavily used prehistorically.

In addition to known resources around Sunkhaze Meadows Unit, at least 17 prehistoric archaeological sites have been documented near Carlton Pond WPA (Shaffer 2011). These sites relate to settlement and resource procurement and use, and 94 percent has been documented along the Seabasticook River, many near rapids or a confluence with another stream (Shaffer 2011).

### **Early European Settlement**

European contact (e.g., explorers and traders) with native people began in the 16th century in much of New England. Foster and Motzkin (2003) suggest 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 changing quickly.

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 exporting natural resources (Foss 1992). By 1830, central New England was 80 percent cleared. In Maine, commercial logging for pine began as early as 1650, and all forest types have been cut since 1850 (Lorimer 1977). Archaeological sites from the European contact period have been documented near Carlton Pond WPA. Two sites have produced 17th century objects including kaolin pipes and a metal counters with fleurs-de-lis (Dunn 1968).

Despite initial heavy settlement, by the mid-19th century, many Euro-American settlers had left New England. The California gold rush, industrial revolution, new railroads, richer Midwestern soils, and the Civil War all contributed to movement to new lands. Abandoned farm fields began reverting back to forest. White pine seeded into the fields and pastures, and by 1900 was ready for harvest (Marchand 1987, DeGraaf and Yamasaki 2001). Between 1895 and 1925, 15 billion board feet of lumber was logged from central New England. An understory of hardwoods, released from the shade of white pine, emerged as the new dominant vegetation, a legacy that remains today (Marchand 1987, DeGraaf and Yamasaki 2001).

### **20th Century Influences**

Farming activities dominated the landscape surrounding the town of Unity, including Carlton Pond WPA and the Benton and Sandy Stream units, well into the 1900s. Agriculture is still common today in this area.

Prior to becoming a national wildlife refuge in 1988, the Sunkhaze Meadows Unit was owned by Diamond Occidental Forest, Inc. The general land use in the area during this period was logging. During the 1970s energy crisis, the quality and depth of peat in the Sunkhaze Meadows Unit caught the eye of a peat mining company that wanted to mine the peat for use as a heating source. The sale of the Sunkhaze Meadows Unit to a mining company did not happen, and the land remained in limbo for several years until the Service was able to secure funding, with the help of The Nature Conservancy, to permanently conserve the area as a national wildlife refuge. Much of the surrounding lands remain in private ownership and have been heavily logged.

## Socioeconomic Environment

### Population

In 2010, the U.S. Census Bureau recorded Maine's population as 1,328,361, which was 0.43 percent of the total U.S. population at that time (308,745,538) (U.S. Census Bureau 2011). The population estimate for Maine is a 4.2 percent increase over the 2000 estimate (1,274,923) and a 3.8 percent increase over the 1990 estimate (1,227,928) (U.S. Census 2010).

The predominant racial group in Maine is identified as white (95.2 percent). Of the remaining 4.7 percent, 1.6 percent identify with two or more racial groups, 1.2 percent identify as black, 1 percent as Asian, 0.6 percent as American Indian or Alaskan native, and 0.3 percent as another race. For the entire state population, for any race, 1.3 percent identifies themselves as Hispanic or Latino.

Compared to the total U.S. population, Maine has a higher proportion of its population in the 45 to 64 years and 65 years and older age groups (see table 3.16).

Table 3.16. Gender and age group breakdown for residents of Maine and the U.S.

	<b>Male</b>	<b>Female</b>	<b>Under 18 years (percent)</b>	<b>18-44 years (percent)</b>	<b>45-64 years (percent)</b>	<b>65 years and older (percent)</b>
<b>Maine</b>	650,056	678,305	274,533 (20.7)	432,072 (32.5)	410,676 (30.9)	211,080 (15.9)
<b>U.S.</b>	151,781,326	156,964,212	74,181,467 (24)	112,806,642 (36.5)	81,489,445 (26.4)	40,267,984 (13)

Also, Maine has a higher median age (42.7 years) compared to the rest of the U.S. The 2010 median age in Maine is older than the median age recorded for the State for 2000 (38.6 years). According to the 2010 U.S. Census, the U.S. median age is 37.2 years (Howden and Meyer 2011).

### County Demographics

On a county level, Penobscot County (Sunhaze Meadows Unit) is the most populous of the three counties that include refuge and WPA lands, with 153,923 people reported in 2010. Kennebec County (Benton Unit) had 122,151 people, and Waldo County (Carlton WPA and Sandy Stream Unit) had 38,786 people. At 39.9 years, Penobscot County had the second youngest median age in the State (U.S. Census 2010; MSPO 2011).

### Economic Data

Maine's population was projected as growing 0.5 percent from 2000 to 2010, slightly faster than in the 1990s (MSPO 2002). The area surrounding Sunhaze Meadows NWR and Carlton Pond WPA is largely rural. Land in the vicinity of the Sunhaze Meadows Unit is almost entirely forested, while areas near the Benton and Sandy Stream Units and Carlton Pond WPA are in

agricultural or residential use. For decades the forest products industry was the major landowner and employer near the Sunhaze Meadows Unit in Milford, although recent real estate sales indicate a shift to residential housing development. The lower Penobscot River Watershed ranks number one in the nation for projected housing density increases, more than 310,000 acres of its surface area are predicted to be developed in the next three decades (Stein et al. 2005).

The most current income data for Maine and its counties is for 2009. Table 3.17 provides the per capita and median household income for the U.S., Maine, and the three counties that include refuge and WPA lands as recorded for 2009. Both per capita and median household income in the U.S. are greater than in Maine or in the three counties.

In November 2011, the total civilian labor force in Maine was 691,538, of which 645,005 were employed and 46,533 were unemployed. The unemployment rate was 6.7 percent. The average weekly wage for Maine is equivalent to about \$15.73 per hour or \$32,708 per year, assuming a 40-hour week worked the year around (MDL 2011). By comparison, in 2009, the national average wage totaled around \$45,500 per year (U.S. Census Bureau 2012).

Table 3.17. Per capita and median household income for the U.S., Maine, and selected counties (2009).

	<b>Per Capita Income (\$)</b>	<b>Median Household Income (\$)</b>
<b>United States</b>	27,041	50,221
<b>Maine</b>	24,980	45,708
<b>Kennebec County</b>	24,575	46,368
<b>Penobscot County</b>	22,813	42,366
<b>Waldo County</b>	21,790	41,697

Source: U.S. Census Bureau 2011

The total number of employees located in Maine in 2005 was 594,733. Statewide, the largest major industry sector was Health Care and Social Assistance, with 17 percent of the employment, followed by Retail Trade with 15 percent, and Manufacturing with 11 percent (MDL 2011).

### **Refuge and WPA Contribution to the Local Economy**

According to Carver and Caudill (2007), in fiscal year 2006, recreational use on national wildlife refuges generated almost \$1.7 billion in total economic activity Nationwide. Other key data from that study are as follows:

- Nearly 35 million people visited national wildlife refuges in 2006, supporting almost 27,000 private sector jobs and producing about \$543 million in employment income.
- Recreational spending on refuges generated nearly \$185.3 million in tax revenue at the local, county, State, and Federal level.
- Approximately 82 percent of total expenditures at national wildlife refuges were from recreation other than hunting and fishing; fishing was 12 percent, and hunting was 6 percent.

The 2011 National Survey of Fishing, Hunting and Wildlife-Associated Recreation (USFWS 2011) found that more than 90 million Americans, or 38 percent of the U. S. population age 16 years or older, pursued outdoor recreation in 2011. They spent \$145 billion pursuing outdoor activities. More than 71 million people observed wildlife, while 33 million fished and 13.7 million hunted.

Specific data on recreation expenditures associated with Sunkhaze Meadows NWR or Carlton Pond WPA are not available. However, statewide data are available for Maine, in the 2006 National Survey of Fishing, Hunting, and Wildlife-Associated Recreation report for Maine (<http://www.census.gov/prod/2008pubs/fhw06-me.pdf>; accessed September 2013). Total expenditures statewide for 2006 are listed below in table 3.18. Expenditures include trip-related expenditures, equipment purchases, licenses, contributions, land ownership and leasing, and other items (USFWS 2006).

Table 3.18. Total expenditures in 2006, for wildlife-dependent recreation activities in Maine (U.S. Department of the Interior, Fish and Wildlife Service, and U.S. Department of Commerce, U.S. Census Bureau 2006).

	<b>Residents and Nonresidents</b>	<b>Residents</b>	<b>Nonresidents</b>
<b>Hunting</b>	\$241,301,000	\$201,439,000	\$39,862,000
<b>Fishing</b>	\$257,124,000	\$132,312,000	\$124,812,000
<b>Wildlife Watching</b>	\$865,644,000	\$724,461,000	\$141,183,000

In addition to revenue sharing payments described under the subsection, Distributing Refuge Revenue Sharing Payments, under Refuge Administration, expenditures such as these have a direct benefit to local economies.

## Refuge and WPA Administration

### Staffing

Prior to the establishment of Sunkhaze Meadows NWR, Carlton Pond WPA was administered by Moosehorn NWR in Calais, Maine. Sunkhaze Meadows NWR was first staffed in 1990, and administration for Carlton Pond WPA was transferred to Sunkhaze Meadows NWR staff. The refuge's office was located in Old Town, Maine, not far from the Sunkhaze Meadows Unit in Milford. Fully staffed, the refuge and WPA employed four permanent staff, including a refuge manager, deputy refuge manager, outdoor recreation planner, and fire management officer, all stationed at Sunkhaze Meadows NWR. A seasonal fire crew was also stationed at the refuge. In 1999, the refuge lost three of the permanent positions, leaving just the refuge manager. That position was eliminated in 2008, and administrative responsibilities for Sunkhaze Meadows NWR and Carlton Pond WPA shifted to the Maine Coastal Islands NWR Complex located in Rockland, Maine.

## Budget

Operations funding includes salaries, supplies, utilities, fuel, and all other operational activities (including wildlife inventories, habitat surveys, and management) that are not funded by special projects. Base maintenance funds, which are used to repair vehicles, equipment, and facilities, have been decreasing over the past 5 years. The replacement of vehicles, larger pieces of equipment (e.g., tractor, backhoe), or larger facilities (buildings) are funded as special projects.

Annual funding fluctuates according to the number and size of special projects funded that year (e.g., vehicle or equipment replacement, visitor service enhancements, and facility improvements). Funding has decreased substantially from the annual budget of nearly \$300,000 in 2006. In 2010, the refuge operated on a budget of \$5,800 for maintenance needs. While the refuge has applied for and received some grants, it did not receive any special project funding from the Refuge System from 2006 through 2011. In 2012, the refuge received about \$67,800 to rehabilitate the Ash Landing trail and parking lot and some of the Johnson Brook trail. This work is scheduled to be conducted in 2013.

Table 3.19 provides the operations, maintenance, and total budget for Sunkhaze Meadows NWR and Carlton Pond WPA from 2006 to 2012. This includes funding for special projects from other Refuge System programs (e.g., Northeast Region Refuge System Roads Program).

Table 3.19. Allocated budget for Sunkhaze Meadows NWR and Carlton Pond WPA, 2006 to 2012.

Fiscal Year	Operations	Maintenance	Total
2006	\$ 130,691	\$ 162,238	\$ 292,929
2007	\$ 127,222	\$ 29,755	\$ 156,977
2008	0	\$ 5,800	\$ 5,800
2009	0	\$ 5,800	\$ 5,800
2010	0	\$ 5,800	\$ 5,800
2011	0	\$ 5,800	\$ 5,800
2012	0	\$ 73,600	\$ 73,600

## Land Acquisition

Table 3.20 summarizes the land acquisition history of the refuge. The Service currently owns 11,484 acres within its 11,666-acre approved acquisition boundary of the Sunkhaze Meadows Unit. The Benton and Sandy Stream units are owned in their entirety, 334 acres and 58 acres, respectively. Carlton Pond WPA is also owned in the entirety of the acquisition boundary of 1,068 acres.

One resident of Milford has a right-of-way to access his leased cabin on Carter Meadow Road on the Sunkhaze Meadows Unit. The cabin is owned and maintained by the owner under a life-use

agreement. Bangor Hydro-Electric Company has a 250-foot wide utility right-of-way through the western portion of the refuge to accommodate a 345 kV power transmission line.

Table 3.20. Land acquisition history for Sunkhaze Meadows NWR and Carlton Pond WPA.

<b>Unit Name</b>	<b>Acres</b>	<b>Year</b>	<b>Funding Source*</b>
Sunkhaze Meadows	11,484	1988 to 2007	LWCF
Benton	334	1992	FmHA
Sandy Stream	58	1992	FmHA
Carlton Pond WPA	1,068	1965 to 1968	MBCF
<b>Conservation Easements (named by location)</b>			
Towns of Corinth and Exeter	213.5	1996	FmHA
Town of Starks	36.8	1996	FmHA
Town of Fairfield	15.7	1993	FmHA
Town of Patten	54.2	1990	FmHA

\*MBCF = Migratory Bird Conservation Fund: the funding source is receipts from the sale of Federal Migratory Bird Hunting and Conservation Stamps.

LWCF = Land and Water Conservation Fund: funding sources include revenues from the sale of surplus Federal real property, motorboat fuel taxes, fees for recreation on Federal lands, and receipts from mineral leases on the outer continental shelf.

FmHA = Farmers Home Administration

### **Distributing Refuge Revenue Sharing Payments**

Since 1935, the Service has made refuge revenue sharing payments to local municipalities containing lands under its administration. The actual amount of the payments is determined by formulas specified in the Revenue Sharing Act (16 U.S.C. 715) and annual funding appropriated by Congress. The formulas used to determine payments to local municipalities are based on the number of acres in each municipality and the appraised value of refuge lands in their jurisdiction. Currently for Sunkhaze Meadows NWR and Carlton Pond WPA, the Service makes revenue sharing payments to the towns of Milford, Benton, Troy, and Unity. Between fiscal years 2005 and 2009, combined payments to all municipalities have averaged about \$7,500 per year. Between 2010 and 2011, combined payments to all municipalities have averaged about \$4,400 per year (see table 3.21).

No entrance or user fees are charged for admission to any Service-owned lands that are part of Sunkhaze Meadows NWR or Carlton Pond WPA.

Table 3.21. Revenue sharing payments to local municipalities between 2005 and 2011.

<b>Fiscal Year</b>	<b>Amount Paid</b>	<b>Town Receiving Payment</b>	<b>Fiscal Year</b>	<b>Amount Paid</b>	<b>Town Receiving Payment</b>
2005	\$7,298.00	Milford	2009	\$5,011.00	Milford
	\$164.00	Unity		\$107.00	Unity
	\$873.00	Benton		\$569.00	Benton
	\$553.00	Troy		\$361.00	Troy
2006	\$6,755.00	Milford	2010	\$3,531.00	Milford
	\$152.00	Unity		\$76.00	Unity
	\$808.00	Benton		\$401.00	Benton
2007	\$6,874.00	Milford	2011	\$3,784.00	Milford
	\$147.00	Unity		\$81.00	Unity
	\$781.00	Benton		\$430.00	Benton
	\$495.00	Troy		\$273.00	Troy
2008	\$5,333.00	Milford			
	\$114.00	Unity			
	\$606.00	Benton			
	\$384.00	Troy			

## Refuge and WPA Facilities

### *Cabins*

When the refuge was established in 1988, there were five active cabin leases on the land. These cabins were owned by individuals while the land was leased under an agreement with the prior owner, Diamond Occidental Corporation. After the Service acquired the Sunkhaze Meadows Unit, the cabin owners were allowed to retain the cabins according to an annual special use permit and fee, but they were not allowed to sell the cabins or transfer ownership. While the Service owns the land, one cabin is still privately owned. The other owners have since given up their lease agreements and the Service acquired ownership of the cabins. One of these four cabins was demolished because the building was not needed and leaving the building posed a potential safety hazard because it was in disrepair.

The remaining cabins are important to achieving refuge purposes because they store materials and equipment for our habitat management and public use programs, and help support activities (including interpretive programs) of the refuge’s Friends group.

### *Roads and Trails*

Sunkhaze Meadows Unit has about 4 miles of gravel roads that provide management access. Because of past problems with illegal dumping, these roads are gated to control access. Many of the old logging roads created by previous owners have reverted to forest. Approximately 3 miles of trails are present primarily for management access and wildlife observation. The Sunkhaze

Meadows Unit has six trails: Carter Meadow, Oak Point, Johnson Brook, Ash Landing, North Buzzy Brook, and South Buzzy Brook. There are no roads or dedicated trails on the Benton or Sandy Stream units or Carlton Pond WPA. See maps 2.6 through 2.9 for the location of public use infrastructure and trails. The Benton and Sandy Stream units have snowmobile trails that are maintained by snowmobile clubs through special use permits. Visitors are allowed to walk on these trails during the warmer months.

### ***Other Infrastructure***

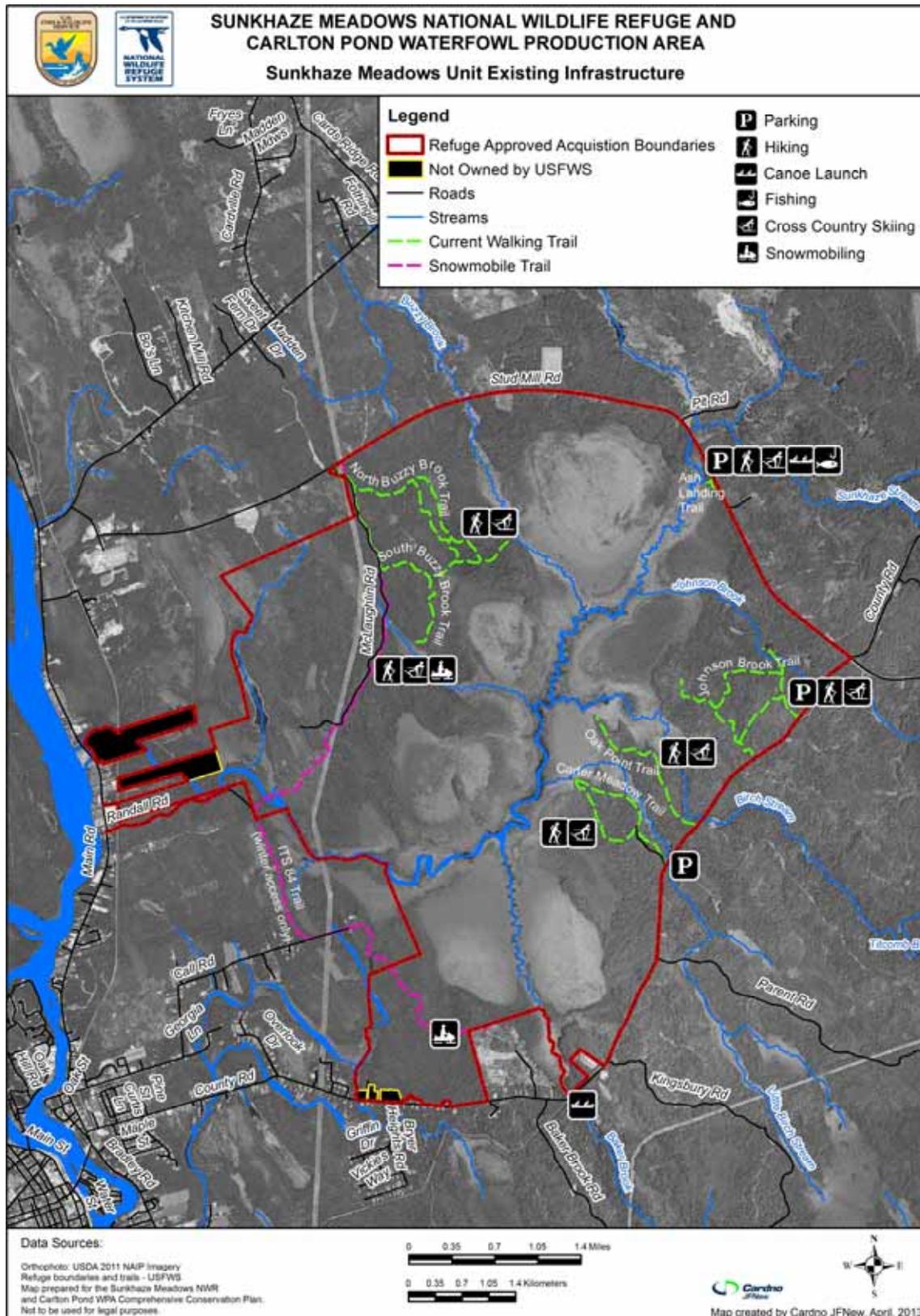
Other infrastructure at the Sunkhaze Meadows Unit includes information kiosks, boardwalks on some trails, three small parking areas, and several locked gates. The infrastructure currently located at Sunkhaze Meadows Unit is summarized in table 3.22.

Developed access to other refuge units and the WPA are more limited, although all are open to public access. Carlton Pond WPA has a water control structure and 150-foot long earthen dike built in 1965. Parking is available along adjacent roadside right-of-ways. There is a small dirt parking lot located on the Benton Unit. At Sandy Stream, visitors can park at an abutting gravel parking area owned by the town.

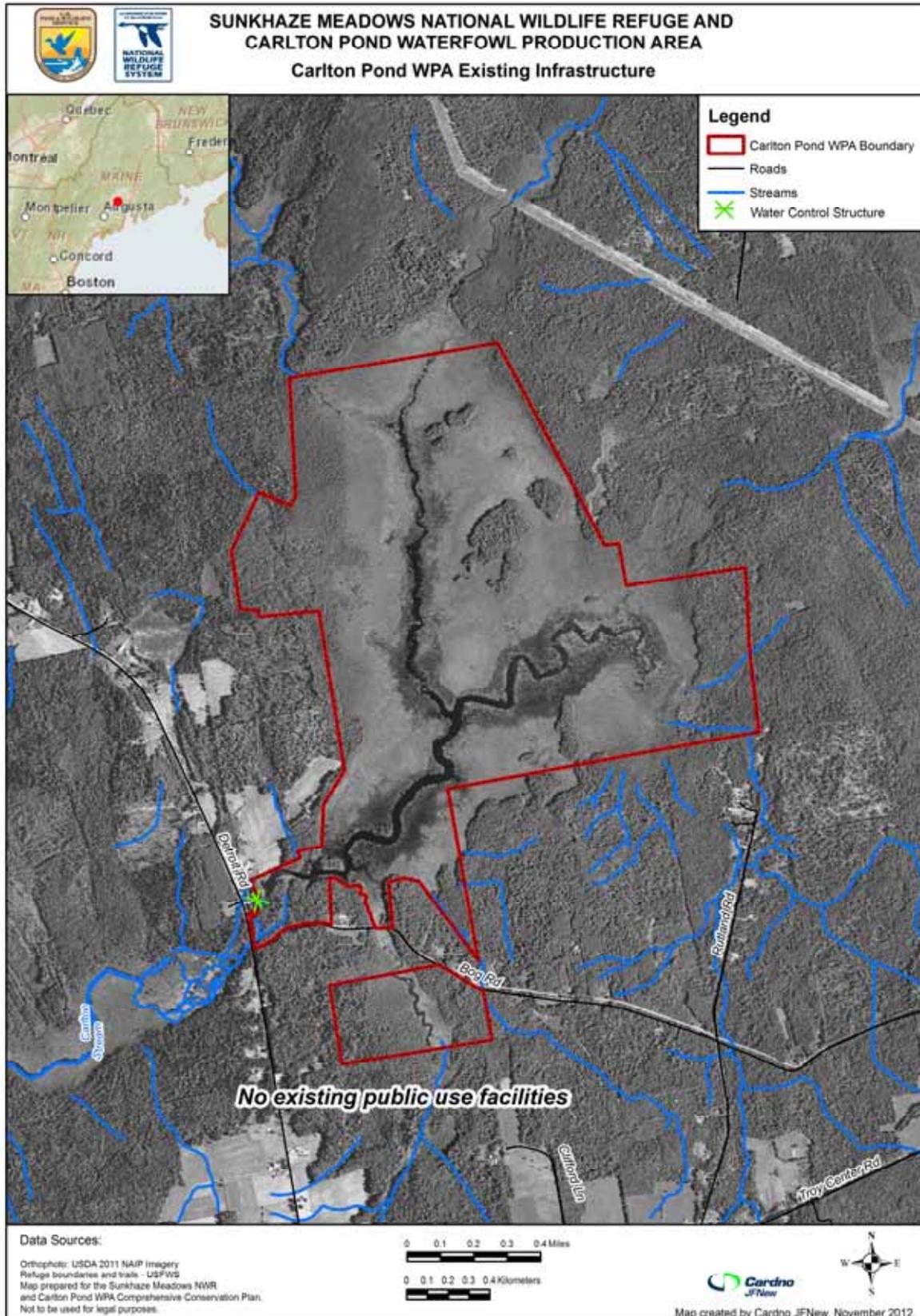
Table 3.22. Sunkhaze Meadows Unit infrastructure.

<b>Infrastructure Type</b>	<b>Location</b>	<b>Date Constructed</b>
Wildlife observation platform	Carter Meadow Trail overlooking the bog	2003
One panel information kiosk	Johnson Brook Trailhead	1999
Small gravel parking area	Along County Road, Johnson Brook Trailhead	1997
Three panel information kiosk	Ash Landing Trailhead	1997
Small gravel parking area	Along Stud Mill Road, Ash Landing Trailhead	1997
Gravel parking area (open only during hunting season)	Along McLaughlin Road, North Buzzy Brook Trailhead	1998
Small gravel parking area	Along County Road, for Carter Meadow/Oak Point Trails	2004
Single panel information kiosk	Carter Meadow/ Oak Point Trails Parking lot	2011
Single panel information kiosk	Off-site at the town of Milford boat launch along the Penobscot River	2011

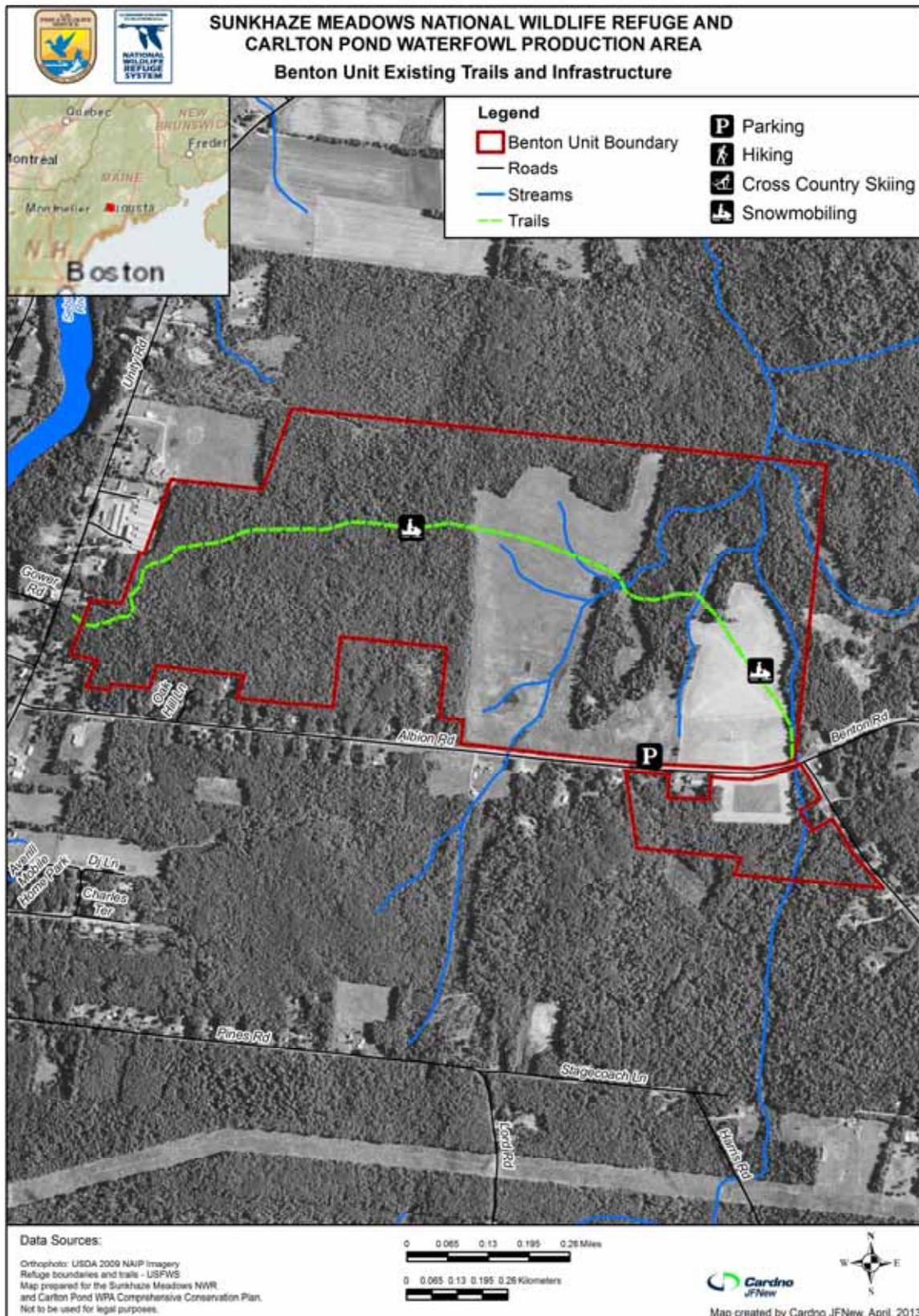
Map 3.6. Existing infrastructure at the Sunhaze Meadows Unit of Sunhaze Meadows National Wildlife Refuge.



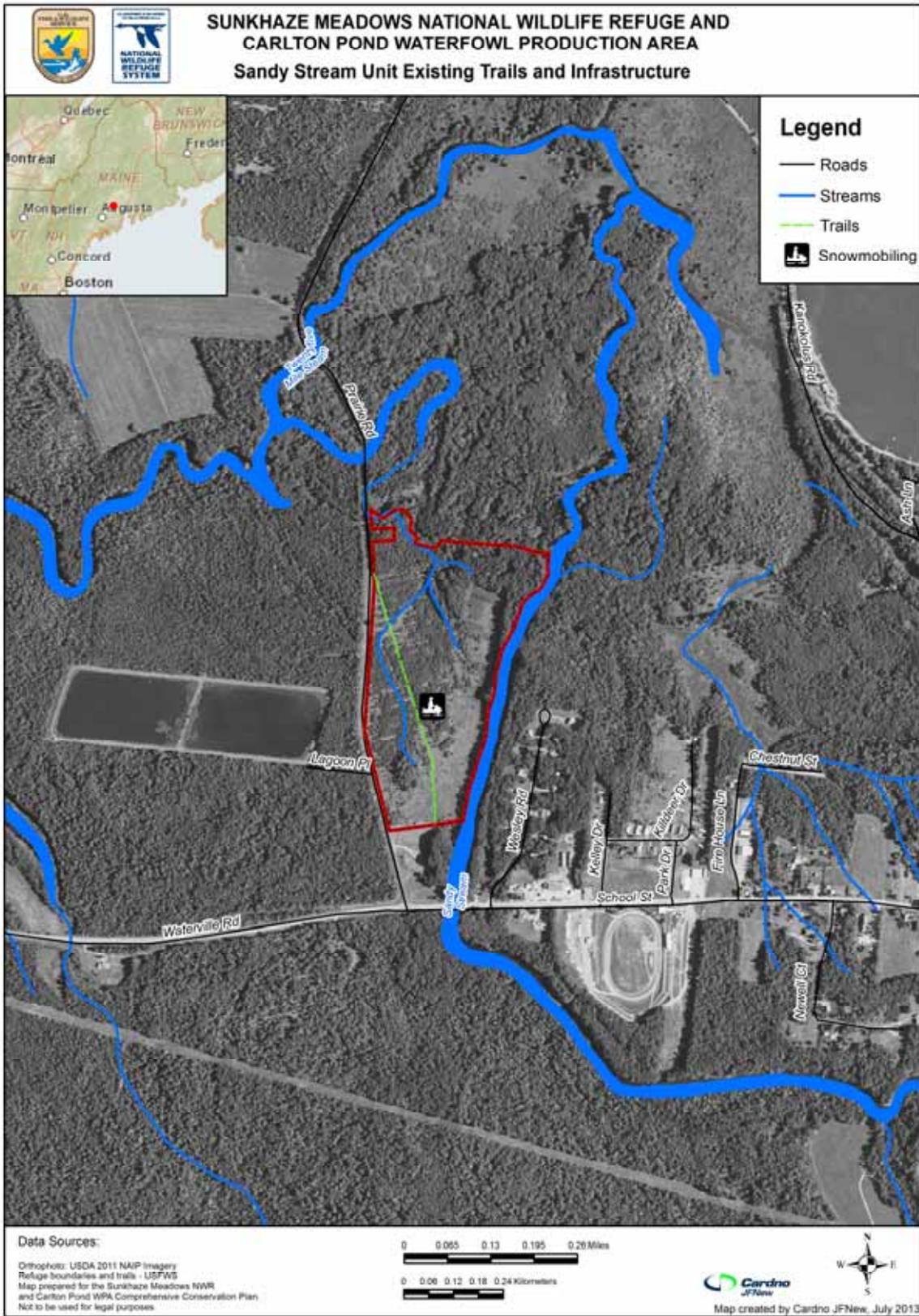
Map 3.7. Existing infrastructure at Carlton Pond WPA.



Map 3.8. Existing infrastructure at the Benton Unit of Sunkhaze Meadows NWR.



Map 3.9. Existing infrastructure at the Sandy Stream Unit of Sunkhaze Meadows NWR.



## Special Use Permits, Including Research

Special use permits are issued to individuals, organizations, and agencies that request the use of refuge facilities or resources beyond what is usually available to the public. To ensure that wildlife disturbance is minimized, special conditions and restrictions are analyzed individually for each request.

Currently, the refuge maintains several special use permits for various activities authorized on the various refuge properties:

- The Friends of Sunkhaze Meadows are authorized to access various portions of the refuge for biological management assistance, trail maintenance, and wildlife interpretation programming at the Sunkhaze Meadows Unit.
- The Sebasticook Land Trust has been allowed to provide public interpretive programs on refuge units.
- High school and college teachers are allowed to take classes to refuge units for various instructional activities.
- Researchers are allowed access for specific research projects.
- Trapping is considered a management activity. Individuals are authorized to trap certain wildlife at Sunkhaze Meadows Unit. All trapping on the refuge is subject to State licensing regulations as well as Service seasons and regulations.
- A farmer is permitted to annually mow 72 acres of the existing grasslands at the Benton Unit to maintain grassland habitat. Timing restrictions are included to protect grassland nesting birds during the summer nesting and fledgling period.
- Snowmobile clubs maintain existing snowmobile trails at Sunkhaze Meadows Unit (Maine's Interconnected Trail System [ITS] 84), Benton Unit, and Sandy Stream Unit.
- We currently authorize up to two field trial events for hunting dogs each year at Carlton Pond WPA if requested.

## Refuge and WPA Public Use

A variety of public uses are authorized on refuge and WPA lands. By regulation (50 CFR 25.21), refuges are closed to public uses until they are opened by the Service. As discussed in chapter 1, Service and Refuge System Policies and Mandates Guiding Planning, to open a refuge to a public use the refuge staff must first determine if a use is appropriate. If the use is appropriate, we must then determine if it is compatible by analyzing potential effects of the use on the refuge's habitats and wildlife. Only activities that are determined to be both appropriate and compatible are allowed on refuges. In contrast, WPAs are open to fishing (50 CFR 32.4), trapping (50 CFR 31.16), and hunting of migratory game birds, big game, and upland game (50 CFR 32.1) per Federal and State regulations, unless we officially close a WPA to these uses.

To minimize confusion, we have made the authorized public uses on all of the refuge units and the WPA as consistent as practicable. This section describes public access and wildlife recreation opportunities for the refuge units and WPA. Additional information on recreation features on the refuge and at the WPA is available from the refuge Web site and in appendix B.

## Public Access and Visitation

In 2011, over 90 million adults in the U.S. (16 years or older) participated in wildlife-related recreation. Of this total, 33.1 million people fished, 13.7 million hunted, and 71.8 million participated in at least one type of wildlife observation activity including observing, feeding, or photographing fish and other wildlife (USFWS and Census Bureau 2012). A similar level of participation is seen in Maine. According to Maine's Statewide Comprehensive Outdoor Recreation Plan (or SCORP), residents participate in outdoor recreation activities at a higher rate than the national average. Maine participation rates are especially high in nature-based activities (MBPL 2009). Sunhaze Meadows NWR and Carlton Pond WPA are both located within a 2-hour drive from urban centers such as Bangor and Augusta and surrounding communities.

Sunhaze Meadows NWR headquarters are located in Rockland, Maine, and are open Monday through Friday from 8 a.m. to 4:30 p.m. The Sunhaze, Benton, and Sandy Stream Units, and Carlton Pond WPA are open daily from sunrise to sunset. The Service does not charge entrance fees for the refuge or WPA. Pedestrian access is allowed both on and off trail at all refuge units and the WPA. The Service currently maintains the following access areas:

*Sunhaze Meadows Unit*—As described under facilities, there are three parking areas open year-round, although these are not usually plowed by the Service in winter. There are six trails that total approximately 3 miles for visitors to access the Sunhaze Meadows Unit. Visitors may also access this unit via small watercraft in Sunhaze Stream. Canoe and kayak access is offered at Ash Landing for those willing to portage their watercraft in a few hundred yards. Visitors can access the southwest corner of the refuge via the State snowmobile trail (ITS 84).

*Benton and Sandy Stream Units*—There is one small parking area at the Benton Unit. Public parking for the Sandy Stream Unit is available adjacent to the refuge in a gravel parking area owned by the town. Visitors can also access both of these units via snowmobile trails.

*Carlton Pond WPA*—There are no public parking areas or trails at Carlton Pond WPA. Visitors usually access the WPA by boat. All launch sites are located off Service property, along roadside right-of-ways or on private lands.

In 2011, the Service completed an internal visitor services review (Toniolo 2011). This review summarized the current state of public use on the refuge and WPA, current programming, and condition of public use infrastructure. This review also provided recommendations for the planning team's consideration during development of this CCP. Much of the background information contained within this section is compiled from this review as well as current estimates provided by Service staff.

Our best estimates of visitation show approximately 6,300 visits were made to the refuge and WPA in 2012 (table 3.23). These visits generally consist of residents from the surrounding communities for each unit or the WPA, birdwatchers, hunters, anglers, snowmobilers, as well as college students and local, State, and Federal officials (Toniolo 2011). This contrasts Statewide trends for Maine public lands, where residents of other states make up 53 percent of day visitors and over 90 percent of overnight visitors (MBPL 2009). Visitors participate in a variety of authorized public uses including bird watching in the spring; fishing, paddling, and hiking in the

summer; hunting primarily in the fall; and snowshoeing and skiing in the winter (see table 3.24). Based on refuge staff observations, overall visitation is highest in August and September, when most visitors are participating in wildlife observation or photography. A refuge visit is defined by the Service as, “the entry of one person onto a Refuge System station to engage in one recreational or educational activity. ...One visitor could account for several visits.” (USFWS 2005).

Table 3.23. Annual visitation estimates for Sunkhaze Meadows NWR and Carlton Pond WPA (based on refuge staff estimations).

<b>Annual Visitation Totals</b>	<b>2005</b>	<b>2006</b>	<b>2007</b>	<b>2008</b>	<b>2009</b>	<b>2010</b>	<b>2011</b>	<b>2012</b>
<b>Sunkhaze Meadows NWR</b>								
Total Visitation	4,606	4,700	4,800	4,870	4,700	4,950	5,100	5,200
<b>Carlton Pond WPA</b>								
Total Visitation	900	950	975	960	975	980	1,050	1,100
Total Combined Visitation	5,506	5,650	5,775	5,830	5,675	5,930	6,150	6,300

Table 3.24. Estimated levels and types of use occurring at Sunkhaze Meadows NWR and Carlton Pond WPA between 2005 and 2008 (based on refuge staff estimations).

<b>Type of Visit</b>	<b>2005</b>	<b>2006</b>	<b>2007</b>	<b>2008</b>
<b>Sunkhaze Meadows NWR</b>				
Total Visitation	4,606	4,700	4,800	4,870
Hunting	626	640	666	656
Fishing	676	680	700	690
Wildlife Observation and Photography	1,020	1,085	1,135	1,162
Environmental Education	475	153	153	44
Interpretive Program	35	20	50	197
<b>Carlton Pond WPA</b>				
Total Visitation	900	950	975	960
Hunting	132	135	145	145
Fishing	518	550	550	550
Wildlife Observation and Photography	210	220	245	240
Environmental Education	53	53	53	0
Interpretive Program	7	25	0	0

We anticipate visitation will continue to increase nominally as populations around the refuge and WPA continue to grow. According to data included in Maine's SCORP (MBPL 2009), the counties surrounding the refuge and WPA have experienced some growth between 2000 and 2008, and this growth is expected to continue. Kennebec County grew approximately 4 percent over this period. Penobscot County grew by approximately 3 percent, and Waldo County by 5 percent (MBPL 2009).

### **Priority Public Uses**

The Refuge Improvement Act identifies six wildlife-dependent public uses that each refuge should evaluate for compatibility with its wildlife-first mandate:

1. Wildlife observation
2. Wildlife photography
3. Environmental education
4. Interpretation
5. Hunting
6. Fishing

All six wildlife-dependent public uses are authorized at Sunhaze Meadows NWR and Carlton Pond WPA. Because of limitations in staff time and resources, the majority of the activities are self-directed, occurring when and where they are allowed by refuge regulations.

#### ***Wildlife Observation and Photography***

Nationally, over 71 million people participate in some form of wildlife observation activity such as watching, feeding, or photographing wildlife (USFWS and Census Bureau 2012). Citing trends identified by the National Survey on Recreation and the Environment, Maine's SCORP highlights public recreation related to wildlife viewing and observation has experienced an 80 percent increase in participation between 2002 and 2009 across the Northeast (MBPL 2009). According to the 2006 National Survey of Fishing, Hunting, and Wildlife-Associated Recreation, Maine's experiences over 800,000 participants in wildlife observation. These participants spent more than \$865 million on activities and equipment related to wildlife watching (USFWS and Census Bureau 2008). Similar State-specific estimates of participation were unavailable for the 2011 survey at the time of this writing. However, according to surveys included in Maine's SCORP, a majority of State residents participate in natural scenery viewing or photography (73 percent) or wildlife observation and photography (62 percent) (MBPL 2009).

Visitors to the Sunhaze Meadows Unit can access six wildlife observation trails and a portion of Maine's ITS snowmobile trail for opportunities to observe and photograph wildlife. Hikers may access the interior of the refuge on the Carter Meadow, Oak Point, Johnson Brook, Ash Landing, North Buzzy Brook, and South Buzzy Brook trails. An observation platform is located on the edge of the Sunhaze Meadows peatlands at the end of the Carter Meadow Trail. Wildlife may also be observed by traversing McLaughlin Road. Visitors also canoe Sunhaze Stream to view wildlife and experience the Sunhaze Meadows Unit wetlands up close. Both Sunhaze Meadows NWR and Carlton Pond WPA allow off trail use for public use access (on foot) for the purposes of wildlife observation, photography, berry picking, snowshoeing, cross country skiing, trapping, and hunting.

We currently use mechanized tools to maintain refuge trails, boardwalks, the observation platform, and other public use facilities in the wilderness study area. However, in recent years, some of the existing infrastructure at the Sunkhaze Meadows Unit has fallen into disrepair. Trails have become blocked by downed trees or overgrown by trailside vegetation. Boardwalks have buckled as a result of frost heave, making them difficult to use (Toniolo 2011). Maintaining trails to remove downed, overhanging, or hazard trees and vegetation relies on many hours of staff and volunteer time. Currently, the refuge cannot maintain all the trails present on the refuge. Based on feedback received during initial CCP scoping, we learned that most visitors use the trails on the south and eastern side of the refuge.

Because Carlton Pond WPA is dominated by open water and emergent wetlands, we have not developed a trail system here. However, many people enjoy paddling Carlton Pond to observe and photograph wildlife. At the Benton and Sandy Stream Units, no formal walking trails exist. Both units have snowmobile trails, allowed through special use permits. While not the primary use of these trails, they are used for occasional wildlife photography and observation during warmer months.

### ***Environmental Education and Interpretation***

The Friends of Sunkhaze Meadows NWR provides the majority of environmental education and interpretive programming, but this is limited to the Sunkhaze Meadows Unit. Refuge staff and the Friends of Sunkhaze Meadows NWR work with local teachers and students to help them use the Sunkhaze Meadow Unit for educational purposes. A National Science Foundation-sponsored education consortium conducts annual training seminars for teachers at the University of Maine. Teachers and students who participate in this program use refuge lands as an outdoor laboratory. Other interpretive programming and events sponsored by Friends of Sunkhaze Meadows NWR include presentations, guided walks, and canoe tours. Refuge staff also participate in a small number of educational and interpretive events upon request.

In addition, interpretive kiosks and trail-side exhibits are located in the vicinity of the Johnson Brook Trail on the County Road and the Ash Landing Trail on the Stud Mill Road. There is an additional interpretive kiosk on a single panel located offsite at the town of Milford boat launch along the Penobscot River. These kiosks exhibit information related to the Sunkhaze Meadows Unit, including maps, wildlife profiles, and ecosystem highlights.

There are no kiosks, exhibits, or environmental education or interpretive programs at Carlton Pond WPA or at the Benton or Sandy Stream Units at this time.

### ***Hunting***

According to the 2011 National Survey of Fishing, Hunting, and Wildlife-Associated Recreation, over 13 million people nationally participate in hunting. Across New England, hunting has experience a slight increase in participation since consistent surveys were started in 1955 (USFWS and Census Bureau 2012). Specific to Maine, in 2006, there were over 146,000 hunters participating in an average of 14 days per hunter that year (USFWS and Census Bureau 2008).

Consistent with Statewide population trends, deer harvests have generally declined across the State and in the towns surrounding the refuge units and WPA (see table 3.25).

Table 3.25. Deer harvest data for Maine and towns surrounding Sunkhaze Meadows NWR and Carlton Pond WPA (MDIFW 2013b).

<b>Year</b>	<b>Maine</b>	<b>Unity</b>	<b>Milford</b>	<b>Benton</b>	<b>Troy</b>
2011	18,839	102	18	60	70
2010	20,063	136	12	92	84
2009	18,092	111	13	82	105
2008	21,061	138	15	91	94
2007	28,884	170	14	121	122
2006	29,918	207	13	132	139
2005	28,148	213	17	142	137

Sunikhaze Meadows NWR and Carlton Pond WPA are open to all hunting seasons established by the MDIFW. This includes, but is not limited to, deer, coyote, bear, waterfowl, and upland game. Refuge hunt seasons coincide with State seasons except for coyote and bear seasons. Hunting has occurred at Sunikhaze Meadows NWR and at Carlton Pond WPA for decades, including prior to refuge and WPA establishment.

The refuge's hunt program follows Federal and State regulations for annual harvest levels and seasons by species. Coyote hunting on refuge lands is limited to October 1 through March 31 (50 CFR 32.38); this is more restrictive than the State season. Bear hunting season is limited to October 1 through the end of the State season (50 CFR 32.38). Non-toxic shot is required for all hunting seasons except deer and turkey (50 CFR 32.2 and 32.38), and, per Refuge System regulations (50 CFR 32.2) the use of bait is prohibited on the refuge and WPA. A refuge-issued permit is not required to hunt on the refuge or WPA. Hunters are responsible for knowing Federal and State laws and regulations that apply on Service-owned lands.

### ***Fishing***

In 2011, over 33 million people participated in fishing nationally. Across New England, public participation in fishing has increased slightly since consistent surveys were started in 1955 (USFWS and Census Bureau 2012). According to the 2006 profile for Maine, over 350,000 anglers took to Maine's waters that year (USFWS and Census Bureau 2008).

Fishing is authorized at the Sunikhaze Meadows Unit and Carlton Pond WPA according to State fishing regulations. At the Sunikhaze Meadows Unit, waters are open to sport fishing under State of Maine fishing regulations. Lead-free sinkers are required for all fishing. Areas open for fishing on the refuge include: Baker Brook, Little Birch Stream, Birch Stream, Buzzy Brook, Johnson Brook, Little Buzzy Brook, Dudley Brook, and Sunikhaze Stream. Anglers can fish by boat in Sunikhaze Stream and its tributaries, or on the stream bank.

We have not established any trails or access areas to allow anglers to fish Carlton Pond. However, off-trail use is allowed for pedestrian access only (e.g., walking), and anglers are allowed to fish from the bank, or to ice fish. Anglers are also allowed to fish in Carlton Pond by boat. Fish species commonly sought by anglers include pickerel, yellow perch, bullheads, and black bass (Toniolo 2011).

The Benton Unit does not have access or habitat to support fishing. The Sandy Stream Unit does not have a formal trail system (except for the snowmobile trail) which is located away from the stream. While the Service does not have jurisdiction over Sandy Stream itself, visitors are allowed access to the stream for fishing from refuge lands.

### ***Other Allowed Public Uses***

Snowmobiling, cross country skiing, snowshoeing, berry picking, research, bicycling (Sunkhaze Meadows Unit only), and boating are currently allowed as other recreational use opportunities on Sunkhaze NWR and Carlton Pond WPA. Dog trials are another public use activity allowed only at Carlton Pond WPA. In the 1988 EA establishing the refuge (USFWS 1988), canoeing and snowmobiling are specifically mentioned as uses which we will allow on the refuge at appropriate times or in places where no conflict would occur with the objectives of the Refuge System. In addition, many of the non-priority public uses that we allow are also important for connecting people with nature.

Snowmobiling is currently authorized from December 1 until April 15 when there is enough snow. Snowmobiling is a tradition for the local community who use snowmobiles on a portion of ITS 84 (Statewide Interconnecting Trail System) and a connector trail at the Sunkhaze Meadows Unit. It is also allowed on two other trails, one each on the Benton Unit and Sandy Stream Unit of the refuge. These trails existed prior to refuge establishment. The portion of the ITS-84 and the connector trail on the Sunkhaze Meadows Unit is approximately 4.6 miles long. Trails on the Benton Unit and Sandy Stream Unit are 1.0 mile and 0.5 miles respectively.

Local snowmobile clubs are responsible for maintaining the trails within the clubs' designated areas of operation, and they coordinate trail maintenance with refuge staff to ensure methods and timing does not adversely affect sensitive species. Trail maintenance activities are authorized through a special use permit, which also include stipulations to ensure minimal impacts to habitat and wildlife. Members of the local clubs are also responsible for placing trail junction, trail number, safety, and speed limit signs along the trails prior to December 1, and then maintaining them through the period of snowmobile use. The clubs then are required to collect the signs and pick up any litter prior to the reopening of refuge roads after the mud season closure (typically before Memorial Day weekend). New trail construction or off trail use is not permitted.

The 4.6-mile-long trail at Sunkhaze Meadows Unit runs for a short distance down the powerline right-of-way until it intersects with the McLaughlin Road then follows the road until it ends and crosses Sunkhaze Stream (see map 3.6). By allowing the snowmobile traffic on the road for the majority of that distance it minimizes effect to both vegetation and wetlands. The traditional trail route will be maintained into the future, but we reserve the right to adjust the route between the trail and McLaughlin Road to address future safety concerns as the need arises. Trails at the Benton and Sandy Stream Units (one mile and one-half mile respectively) are maintained in the same location each year (See map 3.8 and 3.9).

Bicycling at Sunkhaze Meadows NWR is limited to the dirt-surfaced McLaughlin Road at the Sunkhaze Meadows Unit, where this use has been allowed in the past. Bicycling on the hiking trails or off trail is not allowed.

Walking and hiking on the refuge and WPA are permitted throughout the year from sunrise to sunset daily. There are no restrictions during hunting season, but visitors are encouraged to wear blaze orange vests. Cross country skiing and snowshoeing, were originally authorized in 1994 on refuge trails when enough snow is present. Cross country skiing and snowshoeing is permitted December through March (Toniolo 2011).

Berry picking is permitted on Sunkhaze Meadows NWR. Visitors can pick raspberries and blackberries in the summer and blueberries and cranberries in the fall. Harvesting is allowed during daylight hours.

Boating is allowed on Sunkhaze Stream and in Carlton Pond. Some visitors believe it's one of the best ways of experiencing these areas. Based on comments from visitors, spring is typically when most motorized boating occurs on the refuge. In spring, Sunkhaze Stream and its tributaries flood sections of peat bog and forested wetland which creates a large lake. During flooding, the stream channel is not visible and navigation can be disorienting. Because there is no easy trailer access to Carlton Pond, boating is largely limited to small boats that can be hand-carried to the water. Boating is also more common at Carlton Pond when water levels are higher.

Retriever trials at Carlton Pond WPA are also occasionally allowed (not more than a few days each year) under a special use permit. This is not a priority public use itself; however, the use of dogs to retrieve downed game is related to the priority public use of hunting.

## Archaeological and Historical Resources

Sunikhaze Meadows NWR and Carlton Pond WPA contain cultural resources that indicate use from prehistoric through historic time periods (see "Wildlife Trends and Changes" section above). Archaeological investigations in areas surrounding Sunikhaze Meadows indicate that activities relating to travel, hunting and fishing, fortifications, and group gatherings all likely occurred within the Sunikhaze Meadows Unit (Robinson 2011). There is one documented archaeological resource on the Sunikhaze Meadows Unit. It is the oldest known Native American 'formal' (i.e., a special location used repeatedly) cemetery in Maine (Robinson 2011). While the cemetery was likely completely destroyed in 1922 during road construction, records created by the construction foreman provide detailed information on the cemetery, which dates to at least 7,000 years B.C.E. (Robinson 2011).

Given the known prehistoric activities in the area surrounding the Sunikhaze Meadows Unit and the environmental setting, several additional types of cultural resources may be located within the refuge itself. The Sunikhaze Stream likely was a major access route to the upper tributaries of the Union River (Robinson 2011). As such, campsites near portages may be common along the main channel of Sunikhaze Stream. The wetland-peatland complex and other areas along Sunikhaze Stream may also contain additional archaeological resources dating between 3,000 and 11,000 years ago associated with receding lake and pond shorelines (Spiess, personal communication April 7, 2011). In addition, the wide range of resources located within Sunikhaze Meadows Unit suggests hunting, trapping and fishing all occurred within the refuge from prehistoric through historic times. Given this setting, fishing and trapping gear may be preserved within the permanently saturated conditions of the wetland.

Archaeological investigations near Carlton Pond WPA have located areas of prehistoric settlement and resource procurement and tool manufacture (Shaffer 2011). Documented resources near the Carlton Pond WPA include 17 prehistoric sites dating to the Archaic (from 8500 to 800 B.C.E.), Ceramic (from 800 B.C.E. to Anno Domini (A.D.) 1500), and Contact (A.D. 1500 to 1675) periods, and three historic sites which contain contact-period artifacts as well as early 19th century artifacts. Given that “at least 95 percent of the known prehistoric habitation and workshop sites in Maine are found next to waters that are (or were) navigable by canoe” (Shaffer 2011), there is a high likelihood that additional unidentified archaeological resources are located within Carlton Pond WPA. Historic sites identified near Carlton Pond WPA include a petroglyph, likely representing a surveyor’s mark from the mid-19th century, two contact-period sites containing lithic artifacts as well as kaolin pipes and a metal counters dating to the 17th century, and a late 19th to early 20th century site containing artifacts, the base of a bridge or dam, and a dam-related structure (Shaffer 2011).