

## Chapter 3

Edward Henry/USFWS



*Tidal marsh*

# Summary of Refuge and Resource Descriptions

- Landscape-Level Features
- Socioeconomic Environment
- Public Use
- Refuge Administration and Resources
- Biological Resources

## Landscape-Level Features

### Gulf of Maine Ecosystem

The refuge lies in the Gulf of Maine watershed, an immense area extending from eastern Quebec to Cape Cod, Massachusetts. Its land base is 69,115 square miles; its water surface, 33,054 miles. Maine is the only state located entirely within that watershed (USFWS 2004).

The watershed includes various, interconnected coastal habitats: salt marshes, mudflats, sandy beaches, intertidal and near-shore subtidal zones and islands. They all play a vital role in sustaining the natural environment and human activity in the watershed. Estuaries, where fresh river water and salty ocean water mingle, provide productive nurseries for many marine species and important feeding and nesting areas for migrating waterfowl, wading birds, and songbirds. For example, estuaries provide homes for 70 percent of all commercially harvested fish in the Gulf. Salt marshes also produce abundant nutrients through decomposition, and provide food and cover for marine and terrestrial animals and a natural water purification system. Mudflats, which may look barren on first glance, abound with animal life just below the surface. Huge concentrations of worms, clams, mollusks, crustaceans and migrating shorebirds depend on healthy mudflats to survive.

Sandy beaches, rocky intertidal and near-shore subtidal zones, and islands also play an important role in sustaining the natural environment. Sand beaches provide habitat for two rare bird species: the least tern and piping plover. Intertidal and near-shore subtidal habitats support marine algae and provide homes for a broad array of organisms, including scallops, flounders, urchins, lobsters and waterfowl (USFWS Gulf of Maine Coastal Program).

### Maine's Coastline

Maine has more miles of coastline than any other state in the continental United States: 250 miles in a straight line from border to border, but 7,039 miles including the shores of all its bays and headlands (Conkling 1999). In contrast with its downeast coast, which is a mix of gradual slopes, rocky shorelines, and abrupt cliffs as high as 100 feet, miles of sandy beaches and tidal marshes characterize the southern coast of Maine. Most of its salt marshes occur from Cape Elizabeth south. We believe most of them developed behind protective barrier beaches at the mouths of tidal waterways and rivers. The barrier beaches developed offshore, often across the mouths of inlets and smaller streams, creating basins that eventually became freshwater ponds that gradually filled with vegetation. In time, the ocean breached the barrier beaches and tidal flow resumed, allowing the present-day salt marshes to develop.

### Geology

The Maine coast has experienced continental collisions, uplifting, folding, weathering, submersion, and deformation by many glacial events, inundation by the sea, and rebounding from retreating glaciers. It is still being subjected to waves, wind, and rising sea levels. During the most recent glaciation, continental ice sheets scoured and shaped the resistant bedrock, depositing boulders, sand, and till. Ice sheets covered an area extending well beyond the present shoreline of the Atlantic Ocean. When those sheets receded from the coast of Maine, the Atlantic flooded the land, still warped from the weight of the massive ice sheets. Even so, the sea level was several hundred feet lower than it is today, because of the vast amounts of water still held in glacial ice. Huge rivers of meltwater deposited thick beds of fine glacial flour; the ice-ground silt and clay that now underlie the coast and areas up to 64 miles inland.

### Topography and Soils

The topography of the refuge ranges from 0 feet to 20 feet above mean sea level. The soils that form the tidal marshes are mostly sulfhemists: deep, poorly drained

organic soils inundated by the tides. Sulphhemists consist of peat that developed from hundreds of years of plant growth and senescence in salt marshes. Other common soil types in and on the edge of the refuge marshes are Lyman rock outcrop complex, Adams loamy sand, Croghan loamy sand, and Naumburg sand. The average slopes range between 0 percent over much of the marsh and beach areas to 20 percent where the wetlands give way to the sloped bank of upland ridges and low hills. Elevations range from mean sea level to more than 30 feet.

### Hydrology

One-half of the average annual precipitation becomes run-off, settling in the upper reaches of the marshes. The refuge receives fresh water from direct precipitation, run-off from surrounding areas, and rivers and streams that pass through refuge boundaries. The mean tidal fluctuation is 8.7 feet in this part of Maine. Spring tides average 11 feet, with higher storm tides. Periodically, tides greater than 12 feet completely flood all refuge salt marshes.

### Climate

The ocean strongly influences Maine's climate. Average coastal temperatures tend to be cooler in summer and warmer in winter than in the interior of the state. Prevalent sea breezes moderate those temperatures. The average annual temperature along the coast varies from 40 degrees in the north to 45 degrees in the south. The coastal region enjoys the longest growing season in the state, averaging 140 to 160 days. On average, Maine receives 42 inches of precipitation. Along the coast, the cooling effect of the ocean suppresses precipitation in the summer, and nor'easters enhance it in the winter (USFWS 2004).

### Water Quantity and Quality

The tidal streams and rivers that meander through the refuge marshes drain more than 250 square miles of land. Approximately half the water coming into these marshes originates as rainfall on adjacent uplands. That run-off may contribute to decreasing water quality. Developed areas show faster rates of storm water run-off. Faster water carries more sediment and pollutants, and erodes topsoil. Sediments cover aquatic plants, block sunlight from reaching the bottom, and clog the filtering and respiratory organs of aquatic animals. Run-off from uplands carries excess nutrients that can destroy that fragile ecosystem and, eventually, deplete the oxygen in backwaters and coastal ponds. Increased run-off may also cause changes in plant communities along upland edges. Freshwater plants such as cattail (*Typha spp.*) may increase in breadth or establish themselves in new areas because of that increased run-off.

Two state agencies primarily assess in estuarine, riverine, lacustrine, and coastal water quality: the Department of Marine Resources (DMR) and the Department of Environmental Protection (DEP). The DMR extensively monitors pathogen indicators and phytotoxins. The purpose of that program is to manage the risk of human illness caused by the consumption of contaminated fish or shellfish. The DEP Marine Environmental Monitoring Program monitors and researches other water quality issues in the 7,039 miles of shoreline and near-coastal waters. Three other coastal projects also collect site-specific or project-specific water quality information. The Casco Bay Estuary Project has supported several monitoring projects in Casco Bay. The Shore Stewards Program supports a diverse array of volunteer monitoring groups that operate in specific embayments and estuaries. The Gulf of Maine Council Gulfwatch Project surveys toxic contamination in coastal waters from Cape Cod to Yarmouth, Nova Scotia.

Both point and nonpoint source pollution affect the quality of Maine's waters. Point source pollution originates from a single discharge point; nonpoint pollution sources can originate from numerous sources in the watershed, typically as runoff from the land. Point source pollution includes sewer overflows, sewage pipes leading directly to the water, and industrial discharges from paper mills and other manufacturers. Nonpoint source pollution includes nutrients, bacteria, sediment, oil, and heavy metals that are transported to water bodies from different sources

by runoff from storms. That threat is much harder to manage and control, and is exacerbated by development and increased impervious and polluted surfaces. We have not done systematic, refuge-wide testing of water quality and quantity.

## Socioeconomic Environment

Some say that Maine's seacoast is the backbone of the state economy. Maine's southern coast and mid-coast regions grew at almost twice the rate of the rest of the state between 1990 and 1996. Their natural beauty and the rich resources of the shore and ocean draw people to the coast. Most Maine residents live in coastal counties.

## Demographics

The estimated population of Maine is 1,274,923, at an average density of 41.3 persons/ square mile (U.S. Census, 2000; <http://quickfacts.census.gov/qfd/states/23000.html>). The three counties with the highest population densities are Cumberland (318 persons/square mile), Androscoggin (221 persons/square mile), and York (188 persons/square mile). All are located in southern and mid-coastal Maine, in the heart of the Rachel Carson refuge.

A Brookings Institution report in July 2001 listed Portland as the ninth fastest growing metropolitan area in the nation. Between 1982 and 1997, its population increased by 17 percent. Between 1990 and 2000, the state population increased by only 3.8 percent. Other populated cities or towns along the coast are Kittery, York, Wells, Kennebunkport, Biddeford, Saco, Yarmouth, Freeport, Brunswick, Bath, Boothbay Harbor, Damariscotta, Rockland, Camden, Belfast, Bucksport, Ellsworth, Bar Harbor, Machias, and Calais.

The State Planning Office estimates that between 1970 and 1990, land development in Maine proceeded at four times the rate that the population increased. People are moving away from villages and city centers into the countryside. That creates sprawl, characterized by low-density, sporadic development, strip malls, and traffic congestion. If unchecked and unplanned, sprawl impacts our health, our environment, our communities, and our productive agricultural and natural areas. The City of Portland serves as a prime example. Between 1982 and 1997, when Portland's population increased by 17 percent, the amount of farmland and forestland converted to urban uses increased by 108 percent.

According to the 2000 U.S. Census, the majority of the people in Maine are employed in the "management, professional and related" occupations, followed by "sales and office" occupations. The mean household income, including benefits, is approximately \$47,000. Approximately 95 percent of the population is white, and retirees are disproportionately concentrated in the southern coastal towns.

The characteristic land use in some areas around the refuge is strip commercial, as along Route 1 in Wells. Extensive primary and secondary residential development has occurred on the seacoast, as along York Beach. Other areas are characterized as rural with scattered development, as along sections of Route 9 in Kennebunkport, or a series of small towns or village centers, such as York Harbor, Ogunquit, Kennebunkport, and the historic resort village of Biddeford Pool. Others have extensive recreational land uses, theme attractions, as in Old Orchard Beach, and recreational beaches, as in Scarborough Beach and Ferry Beach. Suburban residential development characterizes areas near Portland and Biddeford/Saco. A series of visitor attractions ranges from York's Wild Kingdom, the Wells National Estuarine Research Reserve, and the Rachel Carson refuge. Most of those are outdoor attractions for both local and tourist populations. Other land uses include tourist and summer resident housing, which ranges from rustic cabins to luxury hotels and condominiums.

## Cultural Resources

Humans have played an integral role in the environment within and beyond the boundaries of the refuge since the glaciers retreated from the Northeast about

13,000 years ago. The refuge contains diverse ecosystems that provided humans subsistence on wide ranges of flora and fauna. Changes in the environment during the end of the Pleistocene and throughout the Holocene caused dynamic changes in the refuge landscape. Human choices about where and how to foster their livelihood have caused anthropogenic changes in the landscape throughout history. Humans have been active agents in species representation in the biosphere in historic times by choosing which flora and fauna they exploit, clearing land by fire to provide fresh, green forage for deer, and clearing large expanses of land for farming. Each generation has acted upon the landscape differently than the previous one, thus creating subtle or obvious changes that affect future environments (Victoria Barr, USFWS, personal communication).

The prehistoric period began about 11,500 years ago, with the settlement of the Paleoindians, and ended with the arrival of European explorers, such as Samuel de Champlain, around 1604. During that period, human cultures shifted from primarily gatherer-hunter economies to the horticultural cultures of the Late Ceramic period that grew the three sisters: maize, beans and squash. Humans also used coastal, inland and ocean resources. The prehistoric people of Maine produced a wide, complex variety of artifacts, including stone material for tool-making, which was traded from far-away places such as Labrador; a wide variety of groundstone tools and, toward the end of the prehistoric period, a diverse array of ceramic styles, which represents the complexity of the various indigenous cultures of Maine.

The Historic Period began with the arrival of fur trappers in the late 16th century. The Massachusetts Bay Colony established authority over Maine between 1652 and 1658, a position that it held with several brief interruptions until Maine achieved statehood in 1820. Early European settlers focused mostly on coastal resources for their livelihood. By 1760, the Maine frontier opened rapidly, and the economy thrived on its timber industry. Timber was used for the ship-building industry, which remained active in York County until the 1840s. In the late 19th century, tourism was beginning to replace most traditional economic activities in York County. That tradition of tourism has increased in the 20th century, hastening the development of coastal areas in York County.

The refuge contains 50 known archaeological sites, 13 of which are eligible for inclusion in the National Register of Historic Places. Only a small percentage (less than 1 percent) of refuge lands has been evaluated for the presence of archaeological resources. The number of sites will likely increase as more archaeological surveys are completed. The landforms and various environments within the refuge, through time and space, have the potential of yielding archaeological sites from Paleoindian through late Colonial times.

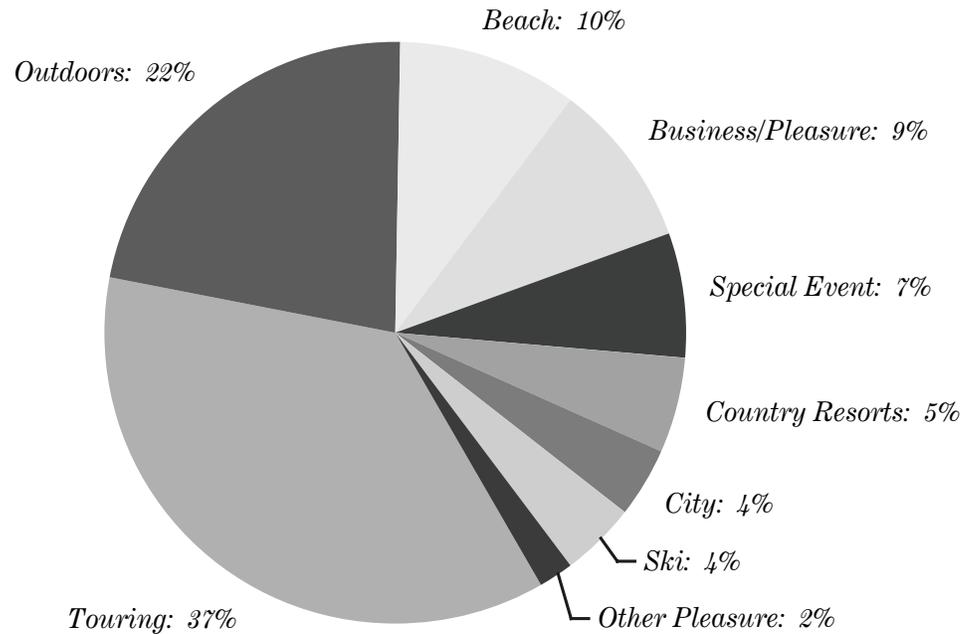
A detailed archeological report, “Rachel Carson National Wildlife Refuge Historic and Prehistoric Archeological Resource Survey” (1995), is on file at the refuge headquarters. It identifies areas of high, moderate, and low or unknown sensitivity of archeological resources. For more information, see Appendix H, “Cultural Resources Report.”

## **Public Use**

Predominant outdoor recreational activities in Maine include hunting, fishing, boating, and observing wildlife. In September 1999, The Portland Press Herald reported that statewide tourism accounts for \$8 billion a year in sales and employs 104,000 people at a payroll of \$2.3 billion. The Maine Office of Tourism estimates that more than 7 million people visit the state each year; about two-thirds go to coastal areas. See figure 3.1 below for more information.

**Figure 3.1. Maine tourism activities**

Source: Maine Office of Tourism



We attempted several times to develop and implement a Public Use/Visitor Services Plan (1990, 1993, and 1994), but none were completed. Despite the lack of that plan, we implemented some visitor opportunities and programs. An internship program that began in 1996 has provided limited programs, primarily on summer weekends, to visitors at the refuge headquarters in Wells. Refuge staff also provide a small number of programs, depending on their individual workloads and interests. However, nothing is routinely scheduled. A partnership with the Kittery Trading Post began in 2002, for an expert from the Trading Post to hold a fly fishing demonstration for kids in late June or early July. In fall 2002, the refuge assumed the responsibility for coordinating and hosting the Federal Junior Duck Stamp Competition in Maine. In 2004, that competition received more than 425 entries.

#### **Wildlife Observation, Trails, and Access**

In the 1980s, we upgraded the Carson Trail at the refuge headquarters in Wells to wheelchair accessibility. It provides year-round wildlife viewing opportunities to an estimated 100,000 visitors annually. We completed a wildlife observation platform on the Goosefare Brook Division in 2002 and the Cutts Island Trail on the Brave Boat Harbor Division in 2003. The Youth Conservation Corps started a wildlife observation platform on the Mousam River Division in 2003 and finished it in 2004. Several other trails owned and maintained by refuge partners cross through or lie next to the refuge (e.g., WNERR in Wells, the Harts Road and Bridle Path in Kennebunk, the Atlantic Way Trail, the Plymouth Way Trail in Saco, the Ted Wells Trail in Old Orchard Beach), providing recreation opportunities to an estimated 75,000 users. Maps 4-1 through 4-11 show public use opportunities on each division.

#### **Interpretation**

Interpretation is presently limited to a self-guided trail and, on a few divisions, several interpretive signs that talk about salt marsh restoration, shorebirds, waterfowl, wading birds, and wetlands. In the summer, interns conduct programs on the Carson Trail at the Wells Division, but those are very limited. See chapter

4, objective 5.1 for our new management strategies to expand and enhance interpretation opportunities at the refuge.

### **Hunting**

The refuge first opened for hunting in 1980; its most recent Hunting Plan was approved in 1990. We prepare annual hunt programs, seek State review, and have instituted several changes in the 1990 Hunting Plan. Those include reinstating a permit requirement (1992), implementing a user fee (1995, modified in 1996), closing the refuge to the hunting of New England cottontail and other small game (1998), and opening the Little River Division for archery deer hunting (2001).

Portions of eight divisions on the refuge are now open for shotgun and archery deer hunting in all state seasons except the muzzleloader season. These include the Brave Boat Harbor, Lower Wells, Upper Wells, Mousam River, Goose Rocks, Little River (bow hunting only), Goosefare Brook, and Spurwink divisions. The Moody Division is closed to hunting, because it is so close to residential development. Biddeford Pool is also closed to hunting. Migratory bird hunting (waterfowl and woodcock) and falconry are allowed on portions of 6 of the 10 divisions. Upland game bird hunting (pheasant and grouse) is permitted on the same eight divisions above, and in areas that are open for deer hunting.

We adjust the refuge hunt program annually to ensure public safety and good wildlife management. When the refuge acquires new lands that traditionally have been hunted, they will remain open at least until we have completed their public use planning. Unless we determine that biological or safety concerns would make hunting incompatible, they will remain open to hunting.

An annual average of 387 people have hunted on the refuge since the 2000 season. The number of permits issued annually has averaged 423 for the same time period (a hunter can have more than one permit, e.g., for deer and for migratory birds). In fiscal year 2004, hunters spent an estimated 6,600 days on the refuge. See chapter 4, objective 5.3 for more information about hunting.

### **Fishing**

The refuge officially opened for sport fishing in September 2000. We will continue to provide access for bank fishing at designated areas at the Brave Boat Harbor, Moody, Lower Wells, Upper Wells, Mousam River, and Spurwink divisions. Goosefare Brook Division offers saltwater fishing. All of the divisions allow fishing from boats in tidal waters.

In fiscal year 2004, anglers spent an estimated 1600 days on the refuge, fishing primarily for striped bass and sea-run brown trout. Most anglers either fly fish or use bait, primarily for those two species, although other species can be caught as well. See chapter 4, objective 5.4 for more information about fishing.

## **Refuge Administration and Resources**

### **Administration and Office**

The refuge stretches along 50 miles of coastline in York and Cumberland counties in southern Maine (map 1-2). Ten divisions encompass 5,293 acres between Kittery and Cape Elizabeth. Each division initially was created to protect a tidal river or an estuary resource. Subsequent boundary expansions included adjacent uplands, to protect wetlands and water quality and provide critical wildlife habitat. The present refuge headquarters and a small visitor contact area are located in Wells, Maine.

We began in 1966 as an unstaffed satellite of Parker River refuge in Newburyport, MA. The first staff position at the Rachel Carson refuge occupied a small cabin off

Drakes Island Road in the Lower Wells division in 1977. A new office/residence was built in 1980 at its present location on Route 9 in the Upper Wells division. Three staff occupied a one-room office.

From 1989 to 1990, a new office was constructed to accommodate the three staff, with private offices for the manager and assistant manager, a general work area for the administrative staff, a small visitor contact area, a garage and a workshop. In 1996, the building was modified to add about 300 square feet for a new visitor contact area and convert the garage into office space for a staff that had grown to four positions.

In 1997, the permanent refuge staff increased to five, with the addition of a visitor services specialist. Our staff continued to grow, adding three permanent positions, two permanent seasonal positions, and as many as seven temporary positions, a YCC crew, and a collocated wildland urban interface (WUI) coordinator. The maintenance area was converted into offices, and an 18'x30' addition was built for staff space. In 2004, the staff total swelled to 22. The present building has crowded office and workspace, no additional file storage, only one bathroom, and inadequate parking for visitor, staff, and work vehicles.

**Staffing and Budgets**

The current refuge staff consists of nine permanent employees: a refuge manager (GS-13), a deputy refuge manager (GS-12), a wildlife biologist (GS-11), a LMRD biologist (GS-12/13), a visitor services specialist (GS-11), a maintenance worker (WG-8), an administrative officer (GS-7), and two career-seasonal forestry technicians (GS-6 and GS-4). The visitor services specialist and forestry technician (GS-4) positions are vacant.

Four additional permanent positions that have been approved as essential staff at the refuge have not yet been funded. Those are located in the RONS Tier 1 list, and include three full time positions: park ranger/law enforcement (GS-9), maintenance worker (WG-9), and visitor services specialist (GS-5); and, one part time position: administrative support assistant (GS-5). One of two regional wildland urban interface (WUI) coordinators is collocated at the refuge, and receives administrative support from our staff.

Table 3.1 shows permanent staff, operating, and maintenance budgets over the past 7 years. Operations funding (1261) includes funds for salaries, new purchases, contracts, and new construction. Maintenance funding (1262) maintains the refuge infrastructure.

**Table 3.1. Refuge budgets from 1999 to 2005**

<i>Year</i>	<i>Permanent Staff</i>	<i>Operations Funds</i>	<i>Maintenance Funds</i>
1999	5.3	\$344,700	\$16,000
2000	6.6	\$503,300	\$127,000
2001	7.9	\$399,400	\$102,000
2002	7.1	\$429,400	\$155,000
2003	7.1	\$550,200	\$117,000
2004	7.1	\$538,000	\$102,300
2005	7.4	\$469,000	\$107,700

**Refuge Revenue Sharing Payments to Towns**

The refuge contributes directly to the economies of several coastal towns in coastal Maine. The fiscal year 2003 revenue sharing checks for Service-owned land in

each town are paid in accordance with the Refuge Revenue Sharing Act. That act provides for the Service to pay the greater of three-quarters of 1 percent of the fair market value, 25 percent of net receipts, or \$0.75 per acre. The payments are meant to partially offset the tax revenues lost to local jurisdictions as a result of Service land ownership. In 2004, revenue receipts and a supplemental Congressional appropriation provide for slightly less than one-half of what would be full payment amounts based on the current, appraised fair-market value; so the payments were approximately 46.6 percent of full value. That is down slightly from 2003.

**Table 3.2. Rachel Carson revenue sharing payments in fiscal year 2004**

<i>Town/City</i>	<i>Payment</i>
Biddeford	\$5,665.00
Cape Elizabeth	\$94.00
Kennebunk	\$16,137.00
Kennebunkport	\$5,321.00
Kittery	\$6,178.00
Ogunquit (precinct of)	\$104.00
Old Orchard Beach	\$118.00
Saco	\$9,872.00
Scarborough	\$4,399.00
Wells	\$7,883.00
York	\$2,248.00
Total	\$58,019.00

**Research and Special Uses**

Because we are located near many universities and the Wells National Research Reserve, our having an active research and special use permit program is not surprising. In 2004, we issued 34 permits: 22 of them for research projects. The remaining permits were granted for surveys, education, or access to refuge lands. We track permitted projects, and require that reports documenting their findings be filed. Several research projects on the refuge have appeared in peer-reviewed publications. We strive to ensure that permitted activities do not adversely affect wildlife or habitat resources. Given the large volume of research requests for low-impact and manipulative research, we plan to track their cumulative impacts and designate some parts of the refuge as high value wildlife areas that receive no manipulation and limited disturbance.

**Refuge Divisions**

Each refuge division initially was created to protect a tidal river or an estuary resource. Subsequent boundary expansions included adjacent uplands to protect wetlands and water quality and provide important edge habitat for wildlife.

*Brave Boat Harbor Division.*—The division encompasses 707 acres in fee title and an additional 41 acres managed under a conservation easement (map 4–1). This division is located in the towns of York and Kittery. Oak-pine forest with vernal pools and old field upland habitats surround salt marsh and estuary habitat. Portions of upland forest have a dense understory of serviceberry (*Amelanchier canadensis*), bayberry (*Myrica pensylvanica*), sweet gale (*M. gale*), high bush blueberry (*Vaccinium corymbosum*), male-berry (*Lyonia liqustrina*), and spirea (*Spirea latifolia*). Some forested areas have an understory of speckled alder (*Alnus rugosa*), winterberry (*Ilex veticillata*), honeysuckle (*Lonicera morrowi*), sweet gale, spirea, poison ivy (*Toxicodendron rydbergii*), and Virginia rose (*Rosa*

*virginiana*) (Lortie and Pelletier 1988). Several rare plants, including white wood aster (*Aster divericatus*), saltmarsh false-foxglove, wild coffee (*Triosteum aurantiacum*), and dwarf glasswort (*Salicornia bigelovii*), are found at Brave Boat.

This area was nominated for inclusion in the Maine Ecological Reserves program because of its saltmarsh ecosystem, and the presence of oak-pine forest, exemplary white oak-red oak forest and perched hemlock-hardwood swamp, acidic fen, shrub swamp, and vernal pool communities (McMahon 1998). It also lies within a Maine Beginning With Habitat Focus Area (Greater Brave Boat Harbor/Gerrish Island) known to harbor rare natural communities, including red oak-white oak forest, dune grassland, and spartina saltmarsh (Maine Department of Inland Fisheries and Wildlife). Brave Boat Harbor falls within the Mount Agamenticus to the Sea Conservation Initiative, a region in southern Maine that encompasses the York River, the Brave Boat Harbor Estuary, Gerrish Island, and the largest intact coastal forest between Acadia and the New Jersey Pine (Mount Agamenticus to the Sea Conservation Initiative).

*Moody Division.*—This division encompasses 399 acres in fee title, and manages an additional 4 acres under a conservation easement (map 4-3). The division lies in the towns of Ogunquit and Wells. The Ogunquit River flows through it, and it is almost entirely salt marsh, with some old field and coastal scrub-shrub habitat.

*Lower Wells Division.*—This division is 997 acres in fee title, with an additional 6 acres under easement in the town of Wells (map 4-4). Lower Wells is almost entirely salt marsh, with some maritime forest edges, coastal shrublands, and open fields. This division includes the Webhannet salt marshes, one of the largest salt marsh systems in the state. It is an important black duck wintering area, and also has concentrations of breeding sharp-tailed sparrows. Most of the historic barrier beach is now dense residential and commercial development. Scoters congregate in winter in the near-shore marine waters.

*Upper Wells Division.*—This division in the town of Wells encompasses 653 acres in fee title and an additional 14 acres under easement (map 4-5). It is approximately 50 percent mixed pine and hardwood forest, with the remaining lands in salt marsh, beach dune, old field and shrub habitat. Several rivers run through it: the Little and Merriland rivers, and Branch Brook. Crescent Surf Beach lies within this division, and usually supports the largest concentration of nesting least terns in Maine. Up to 8 pairs of federally listed threatened piping plovers have nested on the beach, and it is a staging area for the federally listed endangered roseate tern. New England cottontails live in the scrub-shrub habitat. Upper Wells encompasses parts of a pitch pine bog natural community, a sparsely forested peatland. Upland forests contain an overstory of pitch pine, white pine, red maple, and red oak. Their understory contains dense thickets of serviceberry, bayberry, sweet gale, high bush blueberry, male-berry, and spirea (Lortie and Pelletier 1988).

*Mousam River Division.*—This division encompasses 500 acres in fee title and 16 acres under conservation easement (map 4-6). It lies in the town of Kennebunk. The division is primarily forested uplands with abundant vernal pools. The rest of the habitats include salt marsh, river, estuary, open field and scrub-shrub.

*Goose Rocks Division.*—This division, in the town of Kennebunkport, encompasses 541 acres in fee title and 1 acre under easement (map 4-7). Its habitats include salt marsh, river, beach, estuary and coastal shrubland, Smith Brook, Batson River, Goose Rocks Creek, and Sampson Cove. Piping plovers historically nested at the end of Marshall Point Road. Upland forests contain an overstory of pitch pine, white pine, red maple, and red oak. Their understory contains dense thickets of serviceberry, bayberry, sweet gale, high bush blueberry, male-berry, and spirea. Some forested

areas have an understory of speckled alder, winterberry, honeysuckle, sweet gale, spirea, poison ivy, and Virginia rose (Lortie and Pelletier 1988).

*Little River Division.*—This division encompasses 207 acres in fee title and 59 acres under conservation easement (map 4–8) in Kennebunkport and Biddeford. Most of this division is tidal (about 60 percent); the rest is forested upland and scrubland. The Little River runs through the division.

*Biddeford Pool Division.*—This division in Biddeford encompasses 121 acres in fee title and 5 acres under easement (map 4–9). Biddeford Pool holdings protect some of the state’s most important estuarine habitats, and it is superb shorebird, waterbird and waterfowl habitat. Most of this area is salt marsh, coastal shrublands, and grasslands with some pitch pine forest.

*Goosefare Brook Division.*—This division, in the towns of Saco and Old Orchard Beach, consists of 494 acres in fee title and 8 acres under easement (map 4–10). It consists of a small beach, salt marshes, and several hundred acres of pitch pine and mixed pine/hardwood forest. Goosefare Brook runs through this area. One pair of nesting piping plovers commonly uses the beach.

*Spurwink River Division.*—This division, in the towns of Scarborough and Cape Elizabeth, encompasses 493 acres in fee title and 27 acres under easement (map 4–11). It is centered along the Spurwink River, Pollack Creek, and several other small waterways. It consists of high-quality salt marsh with high densities of sharp-tailed sparrows, upland shrublands supporting a population of New England cottontail, fields, and some mature forest.

## Biological Resources

### Habitats

Refuge habitat is about 35 percent tidal, 10 percent freshwater wetlands and 55 percent uplands. Tidal habitats include beach, dune, dune grassland, river, rocky shore, estuarine, bay and salt marsh. Freshwater wetlands include cattail marsh, bog, emergent scrub-shrub wetland, pocket swamp, red maple swamp and floodplain forest. Most of the upland forest consists of mixed oak and pine; however, hemlock, spruce and pitch pine stands, as well as hickory and maple forests, also occur. Viburnums, winterberry, blueberry, serviceberry, Virginia rose and male berry comprise much of the shrub understory. Other upland habitats are composed of grassland and thicket. Habitats are quite diverse, containing elements of the more southerly oak-pine forests and the softwood forests of the north. Those two community types blend here, creating a wealth of biodiversity.

### Threatened and Endangered Wildlife Species

Federally designated endangered or threatened species at the refuge include the piping plover, roseate tern, and bald eagle. State-listed endangered species at the refuge, not already federal-listed, include the black tern, least tern, American pipit, peregrine falcon, black racer, Blanding’s turtle, and the ringed boghaunter. State-listed threatened species at the refuge, not already federal-listed, include the Arctic tern, harlequin duck, upland sandpiper, and the northern bog lemming. In August 2006, the Service designated the New England cottontail as a candidate for Endangered Species Act protection.

The federal-listed endangered shortnose sturgeon is found in large rivers and associated estuaries throughout its range. In Maine, populations of shortnose sturgeon inhabit the Sheepscot, Kennebec, Androscoggin, and Penobscot rivers, and Merrymeeting Bay, although no formal surveys have been performed.

### Piping Plovers

The piping plover is federal-listed as threatened and state-listed as endangered in Maine. Fifty percent to 75 percent of the Maine piping plover population nests

at sites on or near the refuge, including Crescent Surf Beach, Goosefare Brook, and Marshall Point at Goose Rocks. Since 2000, we have assumed the primary responsibility for monitoring piping plover sites on and off the refuge at Parsons, Laudholm, and Ferry beaches. That involves cooperating with private landowners, the Maine Audubon Society, state partners, and the Wells National Estuarine Research Reserve to protect nesting plovers on their lands. The piping plover recovery plan has a recovery objective of 1.5 chicks per pair average over 5 years (USFWS 1996a).

In 2003, 19 plover pairs nested, resulting in 26 nesting attempts, and 8 successful nests: 27 chicks hatched, and 20 fledged. Nesting success was particularly low at Crescent Surf Beach because of crow predation, where crows learned how to enter the twine-topped exclosures and eat eggs. We control diurnal predators such as crows and foxes with several techniques, including hazing, fencing, trapping, and shooting. Occasional vandalism of the fencing around plover nests by people or by dogs to kill plover chicks causes plovers to abandon the nests. Refuge staff work with willing beach front landowners and the public to protect nesting plovers.

Human development, including houses, seawalls, and jetties, has caused the loss of more than two-thirds of Maine's 30 miles of beaches as nesting habitat for piping plovers. Even in the suitable habitat remaining, beachgoers may inadvertently crush nests or chicks or leave garbage that attracts predators. Piping plover nesting, feeding, and brood-rearing habitats were given legal state protection in 1995, when Maine designated them as Essential Habitats (McCullough et al. 2003).

### **Roseate Terns**

The northeastern population of the roseate tern is federal- and state-listed as endangered. Together with Arctic and common terns, roseate tern populations were decimated in the Gulf of Maine in the late 1800's due to a combination of shooting and egging for food and bait, and feather collection for the millinery trade (Drury 1973). Conservation legislation passed in the early 1900s provided protection from human persecution, but expanding gull populations soon caused tern numbers to again decrease significantly (Kress 1983).

By 1977, within the entire Gulf of Maine, all three tern populations had decreased to 5,321 total pairs while the number of island supporting nesting terns had decreased by half. Cooperative efforts by members of the Gulf of Maine Seabird Working Group (GOMSWG) to attract new birds to islands and to control gull predation have reversed that decline, and all three species are experiencing population growth. After 15 years of active management, the roseate tern population in Maine has risen from a low of 76 pairs to a record high of 289 pairs in 2001. That represents a 278-percent increase in Maine's population. In 2002, 379 pairs of roseate terns nested at six sites in the Gulf of Maine (including Canada).

Although the numbers of breeding pairs has increased in recent years, we continue to be concerned over the poor distribution of nesting pairs across the region. Approximately 87 percent of the Northeast roseate tern population breeds on three islands: Bird and Ram islands in Massachusetts and Great Gull Island in New York. In Maine, roseate terns nest on only three or four islands. The terns' limited nesting distribution significantly increases the potential for a single catastrophic event to affect a major percentage of the population.

Roseate terns historically have nested on two islands adjacent to the Rachel Carson refuge, one in Biddeford and the other in Kennebunkport. Currently, most of that use is by post-breeding and migrating birds that use refuge beach habitat

for resting. Given the increases in nesting pairs in recent years, we are optimistic that the population will continue its current growth trend over the next 15 years, resulting in significant progress towards recovery of this species.

**Bald Eagles**

The northern population of the bald eagle is federal- and state-listed as threatened. Historically, threats to bald eagles have included environmental contaminants, shooting, habitat loss, and human disturbance at nest sites. Extensive public education efforts and federal and state legislation have significantly reduced many of those threats. The bald eagle population in Maine has responded to that protection, and the population has increased nearly 8 percent per year for the past 10 years. The state now supports more than 290 pairs of eagles (MDIFW 2002). MDIFW has identified permanent protection of eagle nesting areas as the top priority for the future recovery of this species in Maine. In particular, they have specified a recovery objective of at least 50 nesting areas under permanent habitat protection (conservation ownership or easement), with an additional 100 nesting areas under permanent protection or cooperative agreement (MDIFW 2001).

Bald eagles currently use the refuge and adjacent lands primarily during the migration and wintering season. Over the last several years, their use of the many tidal rivers and estuaries has increased as their population in the state has expanded.

**Rare Plants and Exemplary Natural Communities**

Although we have not completed a comprehensive botanical survey, we know that several state-listed rare plants live on the refuge. See table 3.3. Table 3.4 lists exemplary natural communities found at the refuge.

**Table 3.3. Rare plants**

<i>Scientific Name</i>	<i>Common Name</i>
<i>Aster divericatus</i>	white wood aster
<i>Carex silicea</i>	sea beach sedge
<i>Eupatorium fistulosum</i>	hollow joe-pye weed
<i>Ilex laevigata</i>	smooth winterberry
<i>Iris prismatica</i>	slender blue flag iris
<i>Nyssa sylvatica</i>	black tupelo
<i>Platanthera flava</i>	pale green orchis
<i>Prunus Maritima</i>	beach plum
<i>Rhododendron viscosum</i>	clammy azalea
<i>Saliconia bigelovii</i>	dwarf glasswort
<i>Sassafras albidum</i>	sassafras
<i>Suaeda calceoliformis</i>	American sea blight
<i>Suaeda richii</i>	Rich’s sea blight
<i>Triosteum aurantiacum</i>	wild coffee

**Table 3.4. Exemplary natural communities**

Coastal dune marsh ecosystem
Spartina saltmarsh
White oak – red oak forest
Dune grassland
Pitch pine bog

## Other Wildlife on the Refuge

### Salt Marsh Birds

In 1995, sharp-tailed sparrows were divided into two separate species: the Nelson's sharp-tailed sparrow, and the saltmarsh sharp-tailed sparrow. Saltmarsh sharp-tailed sparrows are found in salt marshes along the Atlantic coast from the Delmarva Peninsula north to southern Maine. Nelson's sharp-tailed sparrows are found in saltwater and freshwater marshes from Nova Scotia south to southern New Hampshire and, occasionally, in northern Massachusetts. The two species are thought to overlap from the Weskeag River in Maine south to Parker River, Massachusetts (Hodgman 2002).

In 1997, the MDIFW initiated surveys in southern salt marshes to assess the status, range, and distribution of both species. They established more than 200 survey points on salt marshes from Kittery to Georgetown, which were surveyed two or three times during the summer. We cooperated in that survey; more than 100 survey points were located within the refuge boundary. In 1998, the state expanded its research northward along the coast. In 1999, we began sparrow surveys on marshes at those previously established points. In 2004, we helped collect nesting data for a graduate student from the University of New Hampshire. Her work helped clarify the relationship between nest density, nest fate and other abiotic and biotic factors. Nests were monitored in Wells and Ogunquit. However, nesting sharp-tailed sparrows also were found at Granite Point and the Spurwink River. In 2004, follow-up work with BioDiversity Research, Inc., and the State of Maine examined the levels of mercury in saltmarsh sparrows at Scarborough Marsh WMA and the Rachel Carson, Parker River, Stewart B. McKinney and Ninigret refuges. The Rachel Carson refuge assisted by writing the grant to support that work and assisting in capturing and processing birds.

Data obtained since 1997 has expanded the range of the saltmarsh sharp-tailed sparrow northward along the coast to the Weskeag River. Nelson's sharp-tailed sparrows have been found as far south as Newburyport, Massachusetts. Field observations and genetic testing of individuals with markings of both species indicate hybridization. Although the Nelson's sharp-tailed sparrow primarily occurs in freshwater wetlands in the northern portion of their range, both species within the refuge are found only on salt marshes. In fact, the saltmarsh sharp-tailed sparrow is an obligate salt marsh species that spends its entire life cycle on salt marshes.

### Waterbirds and Marsh Birds

Common loons (*Gavia immer*) frequent the lower reaches of tidal creeks in all refuge divisions from late fall through early spring. They are commonly observed feeding on green crabs and small fish. During spring, summer and fall migration, 11 species of wading birds use the estuarine systems of the refuge. Great blue herons (*Ardea herodias*) and snowy egrets (*Egretta thula*) are the species most commonly observed feeding in salt pannes and tidal creeks, and are often seen in groups of 10 to 15 birds. The overall significance of those habitats to these migrating or breeding birds is not very well understood. It is possible that snowy egrets, great egrets (*A. alba*), little blue heron (*E. caerulea*), and glossy ibis (*Plegadis falcinellus*) nest on offshore islands and visit refuge salt marshes to feed. Green herons (*Butorides striatus*) nest on several of the refuge divisions along the edge of the salt marsh and adjacent forested community. Those birds are commonly observed feeding along the edge of salt pannes during the summer. Breeding black-crowned night-herons (*Nycticorax nycticorax*) were first recorded here in the early 1980s. Virginia rails (*Rallus limicola*) breed at a few divisions on the refuge, and are more commonly seen during migration. Clapper rails (*R. longirostris*) were observed on Drakes Island in 1999, but sightings are exceedingly rare. American bitterns (*Botaurus lentiginosus*) are often found using refuge marshes during fall migration, although their breeding on the refuge has not been documented.

### Waterfowl

Twenty-six species of waterfowl have been recorded on the refuge. Those most commonly observed are American black duck (*Anas rubripes*), Canada goose (*Branta canadensis*), mallard (*A. platyrhynchos*), green-winged teal (*A. crecca*), common goldeneye (*Bucephala clangula*), bufflehead (*B. albeola*), and red-breasted merganser (*Mergus serrator*). Dabbling ducks use salt pannes and the upper reaches of tidal creeks, while diving ducks prefer the deeper parts of the tidal creeks and the mouths of rivers and streams. Black ducks, mallards, and increasing numbers of Canada geese breed on each division of the refuge. Wood ducks (*Aix sponsa*) breed on the Upper Wells and Mousam River divisions each year. Canada geese were first recorded breeding on the Upper Wells Division in 1987. During spring and fall migrations, small numbers of approximately 25 species of waterfowl may be seen on the refuge, particularly during inclement weather.

Hundreds of black ducks use the refuge in winter. They occupy unfrozen tidal creeks, where they feed on snails, nine-spine sticklebacks (*Pungitius pungitius*), and mummichogs (*Fundulus heteroclitus*). Small numbers of mallards, Canada geese, and the occasional green-winged teal also winter on the refuge. Its tidal creeks, river mouths, and onshore intertidal waters commonly host many rafts of common eiders (*Somateria mollissima*), white-winged, black, and surf scoters (*Melanitta fusca*, *M. nigra*, and *M. perspicillata*), long-tailed ducks (*Clangula hyemalis*), common goldeneyes, buffleheads, and red-breasted mergansers. In winter, common loons are sighted in moderate numbers (10–15) at the mouth of the Mousam River and elsewhere on the refuge.

### Shorebirds

Southern coastal Maine is a migrating and staging area for many species of shorebirds that breed in North America, particularly during fall migration. Thousands of shorebirds feed along coastal beaches and mud flats as they migrate through the state. Biddeford Pool serves as one of the top shorebird staging areas in southern Maine. In 2004, we conducted a weekly fall migration shorebird survey at several spots on the refuge. That survey documented an average of 555 shorebirds at 8 sites, with peak numbers (>1400 birds) in late August. Thirty-six species of shorebirds are recorded for the refuge: five of those are considered regular breeders. Most of the use by shorebirds occurs during fall migration, beginning in early July and continuing through early November in a variety of habitats within the estuarine community, but the greatest use occurs in tidal mudflats and salt pannes. Areas used during major fall migrations include the Webhannet River at low tide, several salt pannes on the Lower Wells and Upper Wells divisions, the Batson River and Goose Rocks tidal mudflats, and numerous locations at the Biddeford Pool Division. The great diversity of shorebirds found in those areas compares to only a few other sites in Maine.

The species most commonly observed in the fall include the semipalmated plover (*Charadrius semipalmatus*), black-bellied plover (*Pluvialis squatarola*), least sandpiper (*Calidris minutilla*), greater yellowlegs (*Tringa melanoleuca*), short-billed dowitcher (*Limnodromus griseus*), and semipalmated sandpiper (*Calidris pusilla*). Those species and others typically feed in the mudflats at low tide. Most shorebirds feed in salt pannes, and roost in pannes and adjacent uplands during high tides. Shorebirds roost on several islands near the Biddeford Pool Division at high tide.

Spotted sandpipers (*Actitis macularia*) most likely nest on all the refuge divisions. They are commonly sighted scurrying along tidal creek channels in the summer. In the mid-1980s, willets (*Catoptrophorus semipalmatus*) first began nesting on the Lower Wells, Upper Wells, Little River, Goose Rocks, Biddeford Pool, and Spurwink River divisions. Their numbers are increasing in Maine: they are now

found on almost every refuge salt marsh during the breeding season. Willet chicks feed in salt marsh pannes in the Little River Division. Willets typically nest in the salt hay community. Killdeer (*Charadrius vociferus*) occasionally nest in the salt marsh, although typically they are found in drier, open fields next to the estuary.

The American woodcock (*Scolopax minor*) is found in suitable habitat on all refuge divisions. Spring surveys of “peenting” males and spring, summer, and fall observations of flushed birds have shown that they use old fields, shrub swamp, transitional hardwood, and early successional forest communities. The development of upland areas next to refuge marshes and the abandonment or succession of old farms have reduced the amount of woodcock habitat.

### Gulls and Terns

Herring gulls (*Larus argentatus*) and great black-backed gulls (*L. marinus*) are the most common gull species sighted on the refuge. They frequent all divisions throughout the year, but are most abundant in the fall and winter, when they roost on the marsh and tidal flats and occasionally steal food from diving ducks in tidal creeks. Ring-billed gulls (*L. delawarensis*) also are common throughout the refuge, particularly during non-breeding season. During fall and winter migration, Bonaparte’s gulls (*L. philadelphia*) feed and roost at the mouths of tidal creeks and rivers throughout the refuge, but they are most abundant on the Biddeford Pool, Upper Wells, and Lower Wells divisions.

Least terns nest on the refuge in several locations. (See “Threatened and Endangered Wildlife Species” above for more on least terns.) In the mid-1980s, common terns nested in the salt marsh on the Lower Wells and Little River divisions. Roseate terns (*Sterna dougallii*) nested on West Goose Rocks Island in 1985, and lately have been observed along Crescent Surf Beach in the Upper Wells Division. In 2003, Crescent Surf Beach hosted the largest nesting colony (157 pairs) of least terns in Maine. Early season crow predation and late season owl and coyote predation depressed productivity. We control diurnal predators such as crows and foxes with several techniques, including hazing, fencing, trapping, and shooting. Least terns also nest at Laudholm Beach, Goose Rocks, Higgins, and Reid State Park. During migration, large numbers of common terns, along with smaller numbers of roseate terns (15), stage at Crescent Surf Beach

### Land Birds

Forests, woodlands, and swamps surrounding the refuge salt marshes provide habitat for many raptors. Many migrating raptors use forested areas next to marshes as hunting perches and feeding areas. Sharp-shinned hawk (*Accipiter striatus*), Cooper’s hawk (*A. cooperii*), and broad-winged hawk (*Buteo platypterus*) have nested in forested habitat on the refuge. Northern goshawks (*A. gentilis*) and red-tailed hawks (*B. jamaicensis*) nest in the area. During migration (primarily fall), many raptors move through the refuge. Northern harriers are the only raptor species thought to breed in the estuarine communities of the refuge. During the mid-1980s, the “30-acre” marsh, a brackish marsh north of Drakes Island Road in Wells, hosted courting harriers in the spring and juvenile harriers in mid-summer—evidence that breeding probably did occur at that time. However, sightings of harriers during the breeding season since then have not been documented. Ospreys nested on a platform in the Upper Wells Division in 2003 and 2004.

Great horned owls (*Bubo virginianus*), barred owls (*Strix varia*), and northern saw-whet owls (*Aegolius acadicus*) are common throughout the refuge, but only great horned owls are confirmed nesters. Long-eared owls (*Asio otus*) are occasionally sighted on or near the Upper and Lower Wells divisions. In winter, American bald eagles (*Haliaeetus leucocephalus*) infrequently linger on some

divisions, where they feed primarily on herring gulls and black ducks. Rough-legged hawks (*Buteo lagopus*), northern harriers, and sharp-shinned hawks also can be seen hunting over the salt marshes in winter. Short-eared owls (*Asio flammeus*), great horned owls, and snowy owls (*Nyctea scandiaca*) feed on small mammals and birds in the salt marsh in winter.

Ruffed grouse (*Bonasa umbellus*) use forested areas on or near all of the divisions. In spring, drumming grouse frequently are heard, particularly in previously cut oak-pine forests. A wild turkey (*Meleagris gallopavo*) reintroduction program initiated nearly 20 years ago in southern Maine was successful. We expect their abundance and distribution to continue to increase; they may become more common in oak-pine forests on the refuge.

Diverse habitats around refuge estuarine communities support more than 120 passerine birds. Year-round residents, short-distance migrants, and Neotropical migrants alike find nesting, feeding, and roosting habitat in the uplands close to refuge estuaries. A visitor checklist, "Birds: Rachel Carson National Wildlife Refuge," provides a comprehensive list of birds identified on or seen from the refuge. Land bird surveys have been conducted on many of the refuge divisions. Many of the species detected are on the North American Landbird Conservation Plan Watch List for our area.

### **Mammals**

White-tailed deer (*Odocoileus virginianus*) are the mammal most commonly observed on the refuge. Their trails cut through parts of the salt marsh on each division, although they more typically are observed along marsh edges and in surrounding forests. According to the MDIFW "White-tailed Deer Assessment and Strategic Plan" (1997), the 1985–1996 statewide goal for a winter deer population was 9 to 11 deer per square mile. During that period, a statewide level of about 8 deer per square mile was achieved.

The refuge lies entirely within Wildlife Management District (WMD) No. 24, which had an estimated winter population of 30 deer/mi<sup>2</sup> in 1997. The Wildlife Division Research and Management Report (2000) stated that the herd has continued to grow at 15 percent per year, and the wintering population is now nearly 40 deer/mi<sup>2</sup>.

In certain areas of the refuge, hunting (including white-tailed deer) is prohibited because of state-designated game sanctuaries. Deer populations in those areas are estimated from 50 to more than 100 deer/mi<sup>2</sup>. Those populations far exceed the state target of 50 percent to 60 percent of carrying capacity. The report further states that the actual biological carrying capacity in southern Maine may have been underestimated, and that 25 deer/mi<sup>2</sup> is less than the targeted 50 percent of maximum carrying capacity. The state implemented a limited experimental hunt in 2002 to reduce the affects on habitat and health of a large deer herd in Wells.

Raccoon (*Procyon lotor*) tracks and scats abound on all divisions. Their sign most often appears along the edges of tidal creeks and salt pannes, where they search for green crabs and small fish. Care must be taken to distinguish raccoon sign from that of river otters (*Lutra canadensis*), another mammal that forages extensively in the marshes and is infrequently observed in the salt hay along the edges of tidal creeks. Most recently, river otters were seen in the Merriland River and Branch Brook in the Upper Wells Division.

Mink (*Mustela vison*), striped skunk (*Mephitis mephitis*), red fox (*Vulpes fulva*), and coyote (*Canis latrans*) also hunt in the estuary. Beaver (*Castor canadensis*) and muskrat (*Ondatra zibethica*) are occasionally seen swimming in tidal creeks.

A few haul-out sites for harbor seals (*Phoca vitulina*) exist on the Brave Boat Harbor, Lower Wells, Mousam River, and Goose Rocks divisions. Peak use occurs in the winter, but individuals are observed throughout the year. The Lower Wells haul-out site receives the most use, with peak counts of 30 seals. In the winter, harp seals (*Pagophilus groenlandicus*) and, occasionally, hooded (*Cystophora cristata*) and grey seals (*Halichoerus grypus*), can be found basking on refuge salt marshes and in offshore waters. Seal strandings are a common occurrence, and are reported to marine animal rescue agencies.

Many large mammals are found on or near the refuge. Moose (*Alces alces*) and black bear (*Ursus americanus*) are becoming more common in southern Maine as their populations continue to grow. They have been sighted on all refuge divisions except Moody. A bobcat (*Lynx rufus*) was reported as using the Upper and Lower Wells divisions sporadically in 1991 and 1992. Fishers (*Martes pennanti*) are sighted increasingly often on the refuge; a vehicle killed a fisher near refuge headquarters in 1998, and several sightings around our headquarters have occurred since then. Gray fox (*Urocyon cinereoargenteus*) and short-tailed weasel (*Mustela erminea*) most likely use several refuge divisions. Porcupines (*Erethizon dorsatum*) and woodchucks (*Marmota monax*) are found in varied habitats throughout the refuge.

Snowshoe hare (*Lepus americanus*) are found in forests throughout the refuge in areas with dense understory. The species of rabbit found in Maine is the New England cottontail (*Sylvilagus transitionalis*), not the Eastern cottontail. Cottontails inhabit early successional habitat that was relatively abundant in the early to mid-20th century. As farms were abandoned, the species did very well. Subsequently, increasing development and reforestation led to a population decline as that type of habitat became increasingly rare. We prohibited rabbit hunting starting in 1998 because of ongoing population declines. Subsequently, the Service was petitioned in 2000 to list the New England cottontail under the Endangered Species Act.

White-footed mice (*Peromyscus leucopus*), meadow jumping mice (*Zapus hudsonius*), and meadow voles (*Microtus pennsylvanicus*) occasionally use the edge of salt marsh habitat. Masked shrews (*Sorex cinereus*), short-tailed shrews (*Blarina brevicauda*), red-backed voles (*Clethrionomys gapperi*), and pine voles (*Microtus pinetorum*) have also been caught in salt marshes.

Other small mammals that commonly are found on the refuge include eastern chipmunk (*Tamias striatus*), red squirrel (*Tamiasciurus hudsonicus*), and grey squirrel (*Sciurus carolinensis*). Those species are most common in oak-pine forests where acorns are abundant. Southern flying squirrel (*Glaucomys volans*) is recorded for the Upper Wells and Brave Boat divisions, but they probably also occur in other areas with mature oak-pine forest. Other small mammals that are known or are likely to occur on the refuge include hairy-tailed mole (*Parascalops breweri*), star-nosed mole (*Condylura cristata*), smoky shrew (*Sorex fumeus*), and house mouse (*Mus musculus*). Refuge staff provide visitors a guide listing 47 refuge mammals.

### Reptiles and Amphibians

The refuge has a limited amount of freshwater cattail marsh or pond habitat. However, within its uplands, the refuge protects an extensive network of rivers, uplands and vernal pools, which provide important amphibian and reptile habitat.

Anuran call counts and limited vernal pool surveys were conducted on the refuge. American toad (*Bufo americanus*), green frog (*Rana clamitans*), wood frog (*R. sylvatica*), pickerel frog (*R. palustris*), bullfrog (*R. catesbeiana*), gray treefrog

(*Hyla versicolor*) and spring peeper (*Pseudacris crucifer*) are documented as breeding on most refuge divisions. In addition, yellow-spotted salamanders (*Ambystoma maculatum*), red-backed salamanders (*Plethodon cinereus*) and eastern newts (*Notophthalmus viridescens*) are recorded as common breeders. The blue-spotted salamander (*A. laterale*) and Northern leopard frog (*R. pipiens*) are uncommon, but likely are also breeders on the refuge.

We have yet to conduct any formal surveys for turtles or snakes. However, the following species are documented on the refuge: garter snake (*Thamnophis sirtalis*), ribbon snake (*T. sauritus*, Maine—Special Concern), smooth green snake (*Liocholrophis vernalis*), redbelly snake (*Storeria occipitomaculata*), painted turtle (*Chrysemys picta*), snapping turtle (*Chelydra serpentina*) and spotted turtle (*Clemmys guttata*, state-listed as threatened).

Species that are likely to use the refuge but are not documented include the ringneck snake (*Diadophis punctatus*), milk snake (*Lampropeltis triangulum*), northern water snake (*Nerodia sipedon*), brown snake (*Storeria dekayi*, state species of special concern), Blanding's turtle (*Emydoidea blandingii*, state-listed as endangered) and possibly, eastern racer (*Coluber constrictor*, state-listed as endangered), wood turtle (*Clemmys insculpta*, state species of special concern) and common musk turtle (*Sternotherus odoratus*). Records indicate that both the Blanding's turtle and spotted turtle occur in many locations along the refuge boundary. Wood turtle and black racer records are much less common, and musk turtle records in the vicinity of the refuge are nonexistent. Surveys targeted at detecting turtles and snakes should be developed and implemented on refuge lands, with particular attention to the occurrence of the rare, secretive Blanding's turtle. Lands within the proposed acquisition boundary in Kennebunk and Biddeford have extensive vernal pool habitat that will benefit several species of concern.

### Fish

Coastal marshes, bays, tidal creeks and rivers support diverse shellfish and finfish populations. Sunfish (*Lepomis spp.*), creek chub (*Semotilus atromaculatus*), cunner (*Tautoglabrus adspersus*), golden shiner (*Notemigonus crysoleucas*), common mummichog, American eel (*Anguilla rostrata*) and white sucker (*Catostomus commersoni*) abound. Brook trout (*Salvelinus fontinalis*) and brown trout (*Salmo trutta*) are stocked in rivers and estuaries each year.

The Ogunquit River sustains alewife (*Alosa pseudoharengus*), blueback herring (*A. aestivalis*), pollock (*Pollachius virens*), bluefish (*Pomatomus saltatrix*), longhorn sculpin (*Myoxocephalus octodecimspinosus*), and winter flounder (*Pleuronectes americanus*). The Webhannet River has native species such as winter flounder, northern pipefish (*Syngnathus fuscus*), Atlantic herring (*Clupea harengus*), common mummichog, Atlantic silversides (*Menidia menidia*) and Atlantic mackerel. The Merriland River sustains populations of American eel, brown trout, and brook trout. The Mousam River attracts little skate (*Raja erinacea*), American shad (*Alosa sapidissima*), striped bass (*Morone saxatilis*), bluefish, cunner, Atlantic mackerel (*Scomber scombrus*), pollock, and rainbow smelt (*Osmerus mordax*). The Spurwink River supports blueback herring, Atlantic menhaden (*Brevoortia tyrannus*), American shad, pollock, cunner, winter flounder, and little skate. Striped bass and brown trout are popular recreational fishing resources in the area.

The National Marine Fisheries Service has designated as “essential fish habitat” areas that provide substrate necessary for fish spawning, breeding, feeding, or growth to maturity. Estuaries within the refuge boundaries form part of that essential fish habitat.

## Invasive Plants

The Service identifies an “invasive species” as a species (1) that is non-native (or alien) 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 No. 13112). That order requires the National Invasive Species Council to produce a National Invasive Species Management Plan every 2 years. In January 2001, the Council released its first plan, which serves as a blueprint for all federal action on invasive species. It focuses on those non-native species that cause or may cause significant negative impacts and do not provide an equivalent benefit to society. One report estimates the economic cost of invasive species in the United States at \$137 billion every year (Pimentel et al. 2000). Invasive species have negatively affected up to 46 percent of the plants and animals federally listed as endangered species (Wilcove et al. 1998; National Invasive Species Council 2001).

Our Northeast Region began to identify and map invasive plant species systematically on refuge lands for an effective, integrated management plan. Our refuges will use that information to guide their development of control, monitoring and evaluation projects. It will also be instrumental in developing refuge CCPs, HMPs and Integrated Pest Management Plans. We provided the survey data for the Rachel Carson refuge to our Regional GIS specialist to develop GIS coverage. Regional coverage will be consolidated for the purposes of prioritizing regional initiatives for controlling species, monitoring their rates of spread, and evaluating both. For example, hemlock is a subcanopy species in low abundance at Gerrish Island, where hemlock woolly adelgid has been documented.

Data collection began in 2002, and was completed in 2004. The acreage of phragmites includes native and non-native stands. In general, refuge salt marshes are practically free of invasive plant species. More appear in the uplands, brackish waters, and freshwater areas. The refuge appears to be quite clean; however, that is largely due to our abundant, clean salt marsh habitats. Invasive plants covering more than 20 acres throughout the refuge include Asiatic bittersweet, bush honeysuckle, common barberry, glossy buckthorn, Japanese barberry and reed canary grass. Less than 15 acres of non-native and native phragmites and less than 3 acres of purple loosestrife are found on the refuge. Of all the refuge divisions, Brave Boat Harbor has the worst problem: non-native plants cover about 33 percent of its land mass.

To date, invasive plant management on the refuge has focused on largely on removal by hand, biological control, and mechanical treatment. We try to target new invasions of plants before they get out of control. Table 3.5 on the next page lists those found on the refuge. We derived its “percent clean” from areas covered by one or more invasive plants divided by clean areas.

## Special Management Areas

In 2000, President Clinton signed an Executive Order on marine protected areas with a goal of strengthening the protection of oceans and coastal resources. An inventory of potential Marine Protected Areas (MPA) was completed, although none have been officially designated. The Rachel Carson refuge and neighboring Wells National Estuarine Research Reserve are on the list of potential MBAs.

## Relationship between Rachel Carson refuge and Other Protected Areas (see map 1–2)

### Kennebunk Plains

Located five miles west of the Mousam Division in Kennebunk, Maine, the Plains is an important grassland nesting area and also globally significant for unique vegetation. Unique for its size in southern Maine, Kennebunk Plains is a 1,600-acre barrens and woodland. Formed from a glacial marine delta, this site includes extensive grasslands and a pitch pine–scrub oak forest. It supports birds and habitat found nowhere else in the state. Formerly commercially managed for blueberries, the Plains is jointly managed for plants and wildlife by The Nature Conservancy and the MDIFW. More than 87 bird species are recorded nesting

**Table 3.5. Invasive species found on the refuge**

<i>Species</i>	<i>BB</i>	<i>MD</i>	<i>LW</i>	<i>UW</i>	<i>MR</i>	<i>GR</i>	<i>LR</i>	<i>BP</i>	<i>GFB</i>	<i>SR</i>
Asiatic Bittersweet ( <i>Celastrus orbiculata</i> )	24.07	3.30	3.40	1.43	0.90	0.02	0.14	5.56	0.63	5.73
Autumn Olive ( <i>Elaeagnus umbellata</i> )	0.01	<0.01	0	0.34	0	0	<0.01	0	3.19	4.27
Black Locust ( <i>Robinia pseudoacacia</i> )	0.11	0	0.13	<0.01	<0.01	0	0	0.03	0.43	0
Black Swallow-wort ( <i>Cynanchum louiseae</i> )	0	0	0	0	0	0	0	0	0	0.02
Burning Bush ( <i>Euonymus alata</i> )	0.16	0.20	0	<0.01	<0.01	0	0	<0.01	0	0
Canada Thistle ( <i>Cirsium arvense</i> )	0.19	0	<0.01	0	0	0	0	0	0	0
Climbing Nightshade ( <i>Solanum dulcamara</i> )	1.95	1.33	0.04	<0.01	<0.01	<0.01	0.04	0.01	0.62	0.63
Common Barberry ( <i>Berberis vulgaris</i> )	29.22	0.02	<0.01	<0.01	<0.01	0	0	<0.01	0	0
Common Buckthorn ( <i>Rhamnus cathartica</i> )	<0.01	0	<0.01	<0.01	<0.01	0	0	0	0	0
Creeping Buttercup ( <i>Ranunculus repens</i> )	0	0	<0.01	0	0	0	0	0	0	0
Cypress Spurge ( <i>Euphorbia cyparissias</i> )	0	0.11	0	0	0	0	0	0	0	0
European Privet ( <i>Ligustrum vulgare</i> )	<0.01	0	0	0	0	0	0	0	0	0
Garlic Mustard ( <i>Alliaria petiolata</i> )	0.64	0	0	0	0	0	0	0	0	0
Glossy Buckthorn ( <i>Frangula alnus</i> )	162.64	0	<0.01	43.72	14.32	0	0	0	2.17	0
Goutweed ( <i>Aegopodium podagraria</i> )	0	0	0	0	<0.01	0	0	0	0	0
Honeysuckle ( <i>Lonicera sp.</i> )	18.70	9.21	14.11	30.63	13.33	8.18	0.23	12.26	2.69	44.40
Japanese Barberry ( <i>Berberis thunbergii</i> )	60.29	1.55	2.77	33.79	6.90	0.49	0	<0.01	<0.01	<0.01
Japanese Knotweed ( <i>Polygonum cuspidatum</i> )	<0.01	0.66	<0.01	1.83	<0.01	0	0	0	0.70	0.22
Japanese Honeysuckle ( <i>Lonicera japonica</i> )	0	0	<0.01	0	0	0	0	0	0	0
Multiflora Rose ( <i>Rosa multiflora</i> )	4.24	0.24	0.04	0.93	0.46	0	0	0	0	0.09
Common Reed ( <i>Phragmites australis</i> )	0.16	4.30	7.24	0.23	<0.01	1.70	0.36	0	0.24	0.09
Purple Loosestrife ( <i>Lythrum salicaria</i> )	<0.01	0.81	1.15	0	0	0	0	0.01	<0.01	0.50
Ragged Robin ( <i>Lychnis floscucli</i> )	0	0	0	<0.01	0	0	0	0	0	0
Reed Canary Grass ( <i>Phalaris arundinacea</i> )	0	1.58	0.39	7.28	0.01	3.60	2.00	0.37	<0.01	6.04
Reed Manna Grass ( <i>Glyceria grandis</i> )	0	0	0	<0.01	0	0	0	0	0	0
Rugosa Rose ( <i>Rosa rugosa</i> )	<0.01	2.43	0.72	2.52	<0.01	0.02	0.11	0.13	5.30	0
<b>Total</b>	<b>302.41</b>	<b>25.74</b>	<b>30.00</b>	<b>122.72</b>	<b>35.94</b>	<b>14.11</b>	<b>2.88</b>	<b>18.39</b>	<b>15.99</b>	<b>62.01</b>
<b>Percent Clean</b>	<b>67.76</b>	<b>92.89</b>	<b>97.45</b>	<b>85.26</b>	<b>97.22</b>	<b>96.81</b>	<b>90.76</b>	<b>83.89</b>	<b>95.68</b>	<b>75.28</b>

BB=Brave Boat Harbor MD=Moody LW=Lower Wells UW=Upper Wells MR=Mousam River  
 GR=Goose Rocks LR=Little River BP=Biddeford Pool GFB=Goosefare Brook SR=Spurwink River

at the barrens; 50 additional species are listed as migrants. Kennebunk Plains supports the largest population of northern blazing star (*Liatris scariosa v. novae-angliae*) in the world. Declining grassland-nesting birds such as upland sandpiper (*Bartramia longicauda*), Eastern meadowlark (*Sturnella magna*), and bobolink (*Dolichonyx oryzivorus*) breed here.

#### **Mount Agamenticus**

Although Mount Agamenticus and Second and Third hills are located in York and Wells, the mountain can be seen from most of coastal southern Maine. The mount and the land around it (more than 5,000 acres) is protected by the town of York, the York and Kittery Water Districts, York Land Trust, MDIFW, The Nature Conservancy, Great Works Regional Land Trust, and devoted citizens. It lies in a transition zone between the southern hardwood forest and northern woodlands characterized by conifers. This forest is largely unfragmented, providing watershed protection and rich habitat for a diversity of wildlife. “Mount A” is well known as a hawk migration site. According to “A Birder’s Guide to Maine” (1996), a yearly average of almost 4,000 hawks is recorded during fall migration. The surrounding woodland provides habitat for nearly 40 species of breeding birds. It is Maine’s southernmost breeding area for the dark-eyed junco and common raven. Blanding’s and spotted turtles, state-listed respectively as endangered and threatened, occur here.

#### **Scarborough Marsh**

This dominant marsh is located between Goosefare Brook and Spurwink divisions, where the Scarborough and Nonsuch Rivers converge. Owned and managed by the MDIFW, Scarborough Marsh is the largest salt marsh in the state. It comprises more than 3,100 acres of mudflats, brackish marsh, and salt meadow. More than 200 species of birds are recorded at the marsh, which is managed primarily for waterfowl, including American black ducks, northern pintails, blue- and green-winged teals, and common and red-breasted mergansers. Concentrations of shorebirds pass through between mid-May and early June. Wading birds, such as snowy egrets, great blue herons, glossy ibis, and green herons, are common in the summer. Saltmarsh sharp-tailed and Nelson’s sharp-tailed sparrows nest in high densities at the marsh.

#### **Wells National Estuarine Research Reserve**

The Wells National Estuarine Research Reserve, adjacent to the Wells Division of the refuge across the Merriland and Little Rivers, conducts research and education on 1,600 acres of estuarine waters, marshes, shore lands, and adjacent uplands. The Reserve is an overlay of portions of the Upper and Lower Wells divisions. It was established in 1986 as part of the National Estuarine Reserve System “to improve the ecological health of coastal habitats and resources through a unique, integrated program of research, education and resource management.”

#### **Water District Lands (Wells and Kennebunk)**

The York and Kittery Water Districts own important habitat in the Mount Agamenticus to the Sea Initiative focus area. Their management for water quality and recharge is a great benefit for plants and wildlife in the region. The water district lands are among the most scenic in those towns. The Wells-Kennebunk-Kennebunkport Water District (KKW) is the most important landowner along Branch Brook and the Merriland River. KKW has systematically purchased land for more than 100 years to achieve their mission of providing clean water to their customers. They have taken the lead role in determining 100- and 200-day transport distances, and have based their land conservation on the best information available.

**Land Trust and Town Properties**

Local land trusts are very active, and have protected thousands of acres of land in the 11 towns. We work closely with those trusts, especially on the wildlife values of proposed acquisitions and stewardship. The Maine Natural Areas Program has combined the Service trust resources identified in the Important Habitats of Southern Maine (USFWS 2001) with plant and wildlife of state significance; this is the reference most frequently used by land trusts to determine habitat values.