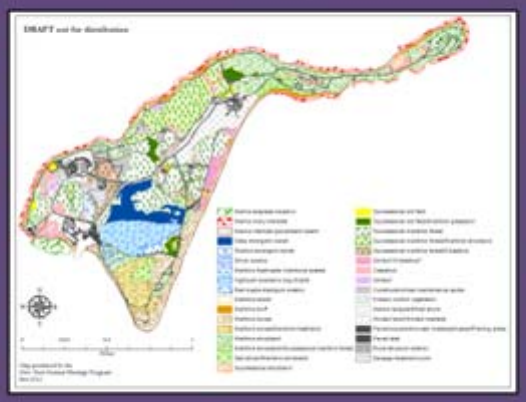
Biodiversity and ecological potential of Plum Island, New York





New York
Natural Heritage
Program

The New York Natural Heritage Program

The NY Natural Heritage Program is a partnership between the NYS Department of Environmental Conservation (NYS DEC) and The Nature Conservancy. Our mission is to facilitate conservation of rare animals, rare plants, and significant ecosystems. We accomplish this mission by combining thorough field inventories, scientific analyses, expert interpretation, and the most comprehensive database on New York's distinctive biodiversity to deliver the highest quality information for natural resource planning, protection, and management.

NY Natural Heritage was established in 1985 and is a contract unit housed within NYS DEC's Division of Fish, Wildlife & Marine Resources. The program is staffed by more than 25 scientists and specialists with expertise in ecology, zoology, botany, information management, and geographic information systems.

NY Natural Heritage maintains New York's most comprehensive database on the status and location of rare species and natural communities. We presently monitor 174 natural community types, 802 rare plant species, and 441 rare animal species across New York, keeping track of more than 12,500 locations where these species and communities have been recorded. The database also includes detailed information on the relative rareness of each species and community, the quality of their occurrences, and descriptions of sites. The information is used by public agencies, the environmental conservation community, developers, and others to aid in land-use decisions. Our data are essential for prioritizing those species and communities in need of protection and for guiding land-use and land-management decisions where these species and communities exist.

In addition to tracking recorded locations, NY Natural Heritage has developed models of the areas around these locations important for conserving biodiversity, and models of the distribution of suitable habitat for rare species across New York State.

NY Natural Heritage has developed two notable online resources: Conservation Guides include the biology, identification, habitat, and management of many of New York's rare species and natural community types; and NY Nature Explorer lists species and communities in a specified area of interest.

NY Natural Heritage also houses *i*MapInvasives, an online tool for invasive species reporting and data management.

In 1990, NY Natural Heritage published *Ecological Communities of New York State*, an all inclusive classification of natural and human-influenced communities. From 40,000-acre beech-maple mesic forests to 40-acre maritime beech forests, sea-level salt marshes to alpine meadows, our classification quickly became the primary source for natural community classification in New York and a fundamental reference for natural community classifications in the northeastern United States and southeastern Canada. This classification, which has been continually updated as we gather new field data, has also been incorporated into the National Vegetation Classification that is being developed and refined by NatureServe, The Nature Conservancy, and Natural Heritage Programs throughout the United States (including New York).

NY Natural Heritage is an active participant in NatureServe – the international network of biodiversity data centers. NatureServe's network of independent data centers collect and analyze data about the plants, animals, and ecological communities of the Western Hemisphere. Known as natural heritage programs or conservation data centers, these programs operate throughout all of the United States and Canada, and in many countries and territories of Latin America. These programs work with NatureServe to develop biodiversity data, maintain compatible standards for data management, and provide information about rare species and natural communities that is consistent across many geographic scales.

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Cover photographs (clockwise from upper left): Crossleaf milkwort (*Polygala cruciata* var. *aquilonia*) by Stephen M. Young; American Oystercatcher (*Haematopus pallidus*) by Don Sias; Maritime bluff by Julie A. Lundgren; Harbor seals (*Phoca vitulina*) by the Riverhead Foundation for Marine Research and Preservation; Seabeach knotweed (*Polygonum glaucum*) by Stephen M. Young; preliminary natural community map of Plum Island by Aissa L. Feldmann; Hairy-necked tiger beetle (*Cicindela hirticollis*) by Matthew D. Schlesinger.

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Executive summary

In this report we document the historical and current known biodiversity, including natural communities and plant and animal species, of Plum Island, New York. We also note potentially undiscovered rare species and the potential of the island to support additional species with management and restoration. We draw from published literature, museum specimens, recent surveys, and expert opinion to form a comprehensive ecological picture of the history of the island's biodiversity and its current status.

Plum Island lies in a small archipelago of peninsulas and islands stretching from Long Island's North Fork to Fishers Island and then to Connecticut and Rhode Island. The island is famously shaped like a pork chop and encompasses 840 acres, approximately the size of New York City's Central Park, and is owned by the U.S. Department of Homeland Security within the Town of Southold, Suffolk County. Plum Island is surrounded by four bodies of water that influence its offshore and onshore environment and biodiversity: Long Island Sound to the west and north, Block Island Sound to the east, Plum Gut to the immediate southwest, and Gardiners Bay further southwest.

The geology of Plum Island is a reflection of its glacial history, which has resulted in varied topography, 17 soil types, and a diverse flora and fauna. The island has had a long and varied cultural history, including use by Native American and colonial farmers, 1800s recreationists, and as a military installation whose infrastructure largely remains. In 1952 a biological laboratory was built and this use continues today as the Plum Island Animal Disease Center, operated jointly by the US Departments of Agriculture and Homeland Security. Its use as a highly secure government facility prevents anyone besides the staff and selected visitors from using the island in any other manner or disturbing its plants or animals.

A systematic survey of the plant communities on Plum Island has never been conducted. We present here a very detailed preliminary seamless natural community map for the island that should serve as the foundation for future ecological data collection. We documented 25 natural community types and 8 cultural community types on Plum Island, including four considered significant from a statewide perspective: maritime dunes, maritime beach, maritime bluff, and marine rocky intertidal. Transect and plot sampling are necessary next steps to revise and validate both the linework and the attributed classification.

The animal biodiversity of the island is poorly known, with the exception of the birdlife. Compiling data from multiple sources, we report that 187 species have been observed on the island, including 57 New York State Species of Greatest Conservation Need (SGCN). Sixty-five species are considered breeders, with 13 of these being SGCN. Notable birds include the Osprey, whose nests now number in the single digits but for which at one time Plum Island hosted the largest nesting colony in New York. The substantial multispecies heron rookery and gull colony, which thrived into the 1990s, are now gone, presumably due to the accidental introduction of raccoons. Piping Plover, American Oystercatcher, Northern Harrier, and Common Eider are some of the at-risk species known to breed currently on the island.

Scattered sightings constitute the known mammalian fauna of the island, which includes mice, voles, fox, muskrat, beaver, raccoon, and deer (which are killed by island personnel). The beaver sighting is significant because it highlights the potential importance of Plum Island as a stepping stone for the recolonization of and continued immigration to Long Island from New England by other mammals, such as river otter, fisher, and coyote. The island's herpetofauna is a big mystery, with three or four turtle species, garter snake, and green frog confirmed, and a great deal other rare species with potential, including mud turtle, tiger salamander, and the newly identified and rare species of leopard frog. Similarly, only a handful of surveys have been done for insects, with the

most notable finds being the seaside dragonlet and beach-dwelling hairy-necked tiger beetle. There is great potential for additional rare dragonflies, damselflies, and moths on the island. The federally listed American burying beetle is extant on nearby Block Island, the only extant location in the northeast not supported by management, and similar conditions may occur on Plum Island, although surveys have not been conducted there.

Plum Island's marine environment is highly productive for animals, with greater numbers of marine fish in the surrounding waters than in most other sites in the mid-Atlantic. Multiple species of cetaceans have been seen in nearby waters, including the critically endangered northern right whale, and the rocks off of Plum Island's shore are home to the largest seal haul-out site in New York. The eelgrass meadows off of Plum Island have potential to support foraging sea turtles, but survey data are lacking.

Plum Island's flora is well documented compared to other taxa. Botanists have recently collected 391 species within 246 genera and 89 families and along with historical records there is a total of approximately 420 species. Genera with the largest number of species collected were *Cyperus*, *Panicum*, and *Carex*. Native species are still a major component of the natural vegetation. Plum Island, with 16 recorded rare plant species, has one of the highest concentrations of rare plants in New York State, similar to the situation on Fishers Island, a short distance to the northeast. Both islands are part of the "outer lands" of the Ronkonkoma moraine islands east of Long Island and contain a variety of habitats that support rare plants that only occur on the coastal plain of New York. Only two of the sixteen rare plants recorded from Plum Island occur inland of the coastal plain. Although there is a high number of rare species on Plum Island, the populations are small compared to other populations of these species. The one exception is spring ladies-tresses, a rare orchid with a large population on the island.

Fourteen rare plants are extant, having been discovered since 1984. Six of these species have fewer than six populations in the state and are listed as endangered. Five species have fewer than 21 populations in the state and are listed as threatened. Three species have more than 20 populations in the state and are listed as rare. Six rare plants are considered historical since they have not been found in the previous 30 years. Three of the species (salt-marsh spikerush, mock bishop-weed, and Northern blazing star) were found in 1932, bushy rockrose in 1915, Atlantic white cedar sometime before 1915, and Scotch lovage in 1895. There is still habitat for five of the species and they still may yet be found. The stumps of Atlantic white cedar trees can still be seen in the northwest corner of the deep emergent marsh, but no live trees remain and we consider this species extirpated from the island. Several invasive plants are present, some with large populations that may require management attention.

Threats to Plum Island's native biodiversity include invasive species, the potential for residential development, climate change, and on- and offshore energy development such as wind and underwater turbines. Should the opportunity become available for ecological management and/or restoration, a consortium of stakeholders could contribute to a vision of a desired future condition for the island, which will direct appropriate action. In this report we briefly outline some possibilities to enhance the biodiversity value of the island, including restoration of marsh hydrology, eradication of raccoons, targeted removal of invasives, restoration (or establishment) of maritime grassland throughout the panhandle, continued minimal impacts to maritime and coastal communities, and dark skies compliance.

Introduction

Few publicly owned islands are as poorly known, misunderstood, and shrouded in mystery as Plum Island, New York, off the coast of the North Fork of Long Island (Figure 1). A former U.S. Army base, and operated as the Plum Island Animal Disease Center since 1954, the island has an uncertain future, as plans to relocate the Center to Kansas have prompted the Department of Homeland Security to plan the sale of the island. At the time of this writing, the Draft Environmental Impact Statement (DEIS) on the sale of the island has not been released, but a previous EIS (U.S. Department of Homeland Security 2008a) and other documents have not taken inventory of the full biodiversity value and potential of this island. Plum Island has been recognized previously for its potential importance to New York's and the nation's biodiversity. For instance, the island is part of the "Orient Point-Plum Island" Important Bird Area (Burger and Liner 2005) and the adjacent waterway known as Plum Gut is a Coastal Significant Fish and Wildlife Habitat (New York State Division of Coastal Resources 2009).

Given the uncertain future of this island, we document Plum Island's known biodiversity, inventory needs, and biotic potential with restoration in the following report. We draw from published literature, museum specimens, recent surveys, and expert opinion to form a comprehensive ecological picture of the history of the island's biodiversity and its current status. For taxa that are well known (e.g., vascular plants, birds) we provide information on the known species—tallies, notable species, and full lists for some taxa. For taxa that are not well surveyed, we supplement existing knowledge with discussions of the potential of the island to host rare species that could be documented with additional inventory work or that could be brought back with restoration.

Geography and geology

Plum Island lies in a small archipelago of peninsulas and islands stretching from Long Island's North Fork to Fishers Island and then to Connecticut and Rhode Island (Figure 1). The island is famously shaped like a pork chop and encompasses 840 acres, approximately the size of New York City's Central Park. Its total length is about 3 miles with the long narrow panhandle measuring about 300 feet wide. Land elevations vary from sea level to about 100 feet on a hill by the reservoir. The southern third of the island is characterized by low hills and depressions and a series of low beach ridges alternating with freshwater wetlands (Figure 2). The middle of the island features a central plain (where Fort Terry was developed) that divides hills to the southeast, ranging from 40 to about 75 feet high, from the northwestern ridge of irregular hills that rise to 100 feet in height. The eastern third of the island is a continuation of the northwestern ridge but narrows to a low stretch of land that terminates in a group of hills that rise up to 85 feet. The shoreline is characterized by wide sandy beaches in the south and east where the topography is low to a narrow shore of large boulders on the rest of the island at the base of low, to as much as 50 feet high, steep bluffs and cliffs where the topography is higher. Plum Island is owned by the U.S. Department of Homeland Security and lies within the Town of Southold, Suffolk County.

Plum Island is surrounded by four bodies of water that influence its offshore and onshore environment and biodiversity: Long Island Sound to the west and north, Block Island Sound to the east, Plum Gut to the immediate southwest, and Gardiners Bay further southwest. Around most of the island is a narrow shelf, a little wider to the east, with depths to about 20 feet. Beyond the shelf, depths are from 100 to 200 feet. The strait between the island and Orient Point, called Plum Gut, is narrow and deep with depths up to 188 feet and fast-running tides but no natural hazards. The strait between the island and Great Gull Island to the northeast is wider and shallower with depths from 3 feet around shoals to 25 feet toward the center. The ecology of other islands in the region, including

Great and Little Gull Islands, Gardiners Island, Fishers Island, Shelter Island, and Block Island (Rhode Island) are useful for comparison, although the biodiversity of many of these areas are similarly poorly known.

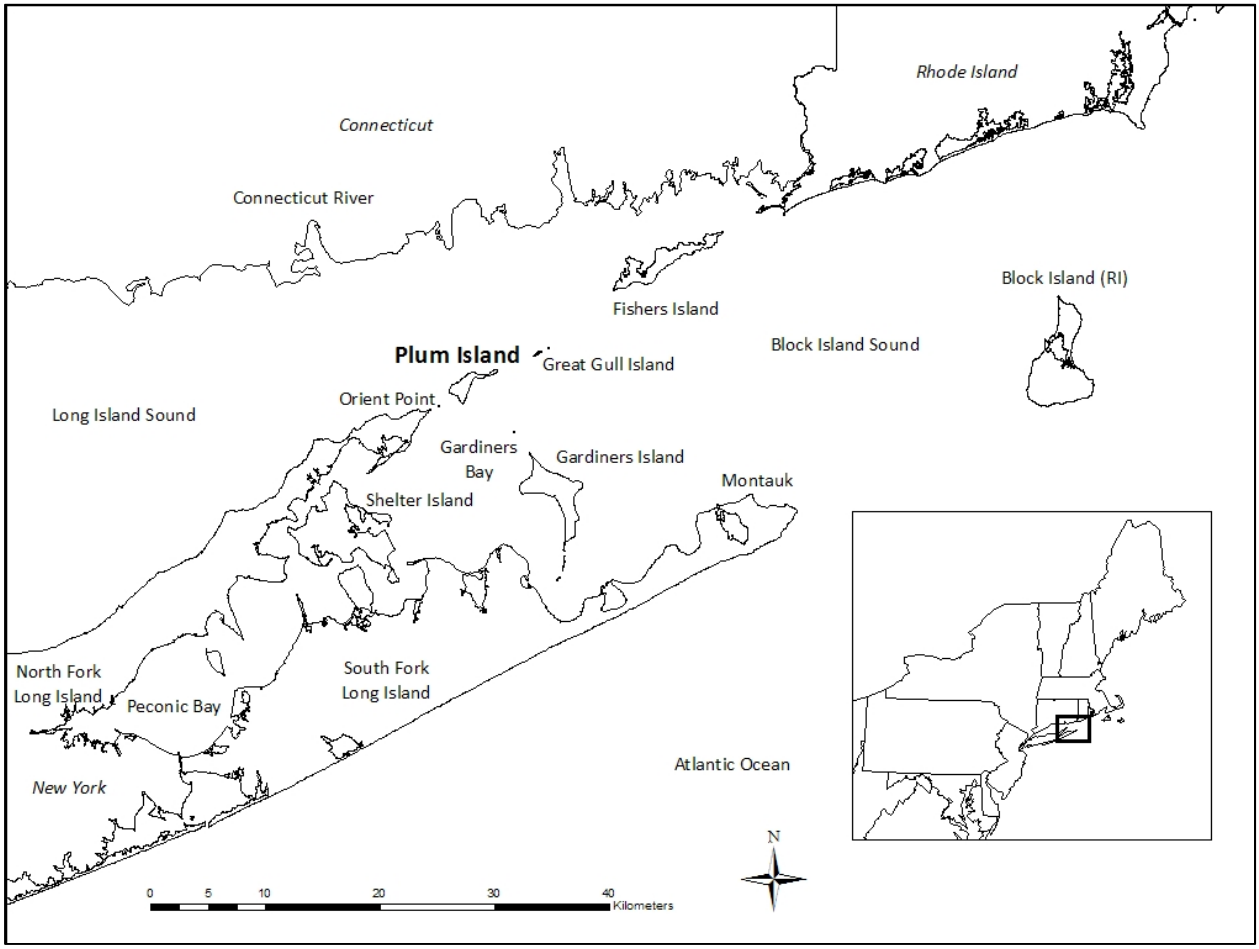

Figure 1. Plum Island with surrounding islands and points in mainland New York, Connecticut, and Rhode Island. Islands are within New York State unless otherwise noted. Inset: area of detail within the Northeast United States.

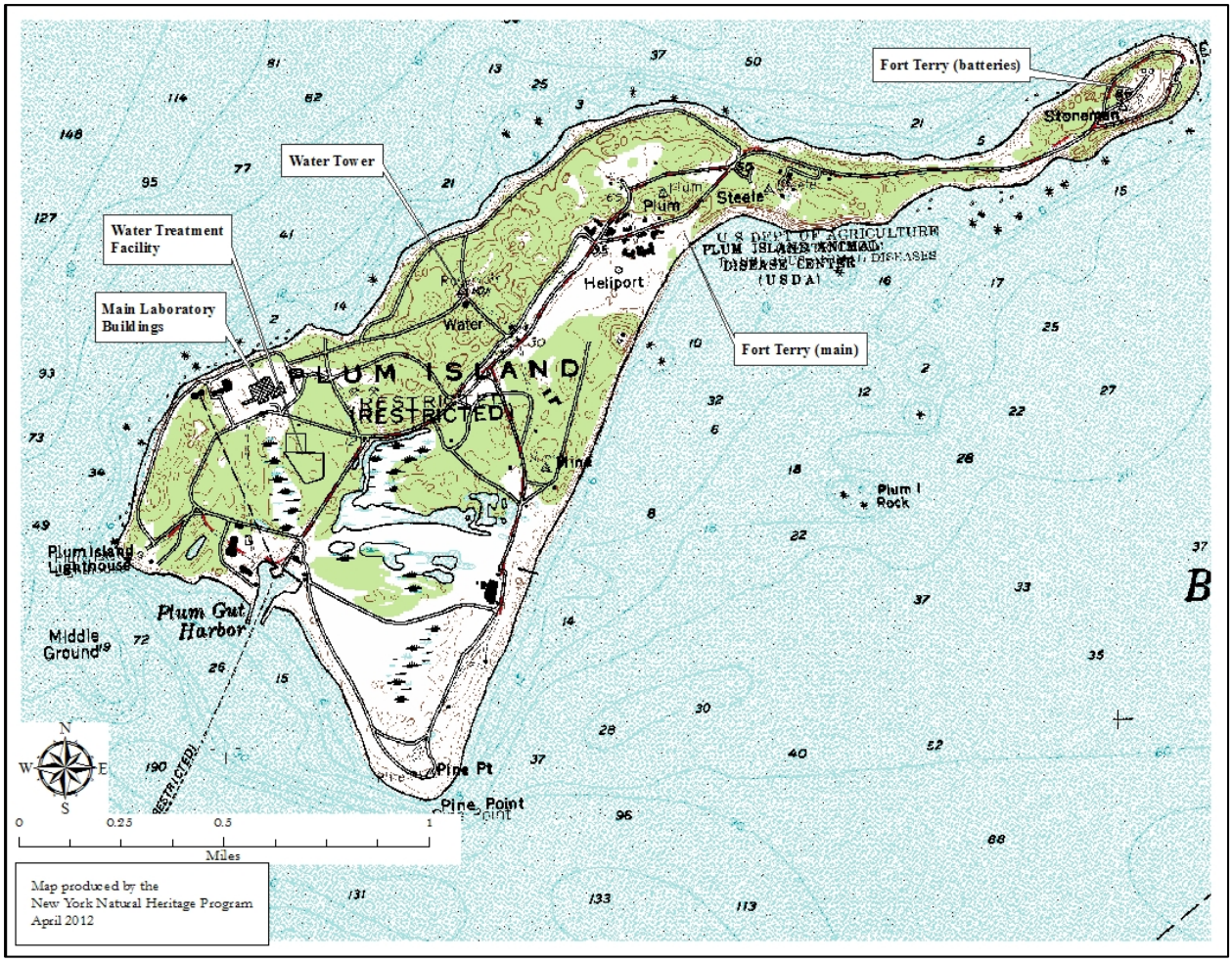

Figure 2. Plum Island, New York, with major features and human infrastructure.

The geology of Plum Island is a reflection of its glacial history, summarized here from Crandell (1962). During the Wisconsin ice age of the Pleistocene epoch the forward movement and backward melting of the continental glaciers were instrumental in forming the island. Morainal outwash and till were laid down over existing Late Cretaceous deposits of silt, sand and gravel that had been eroded into a hilly terrain over Precambrian bedrock. As the Wisconsin ice sheet advanced it pushed forward over the Plum Island area and Long Island carrying sand, gravel, and rocks from New York and New England over which it had passed. After it had reached its most southern extent it began to melt back around 21,750 years ago. During this retreat the forward motion of the ice at times equaled the rate of melting and the glacier paused and deposited two large moraines and outwash plains on Long Island. The southern moraine was the southern edge of the ice sheet and is called the Ronkonkoma Terminal Moraine. As the ice sheet retreated again it paused and created a second moraine called the Harbor Hill Moraine that runs along the northern half of Long Island forming the North Fork, most of Plum Island and the islands to the northeast.

The glacier first deposited thick layers of sand and gravel to form the island. Some of these layers were removed by an outwash channel at the southwestern end of the island where the laboratory is located, so this area is not as high and hilly as the rest of the island. A subsequent advance of the glacier deposited a layer of silt, sand, gravel, and boulders (glacial till) in depths of 5 to 40 or more feet thick, forming the hills of the northern two thirds of the island. This is where most of the present forests and shrublands grow. A meltwater channel eroded the till in the central

part of the island to form a northeastward-trending level topography where Fort Terry is located. After the final glacial deposits had been laid down, erosion from ocean waves carried the finer sand and gravels to the southern end of the island where they formed a series of low beach ridges, allowing freshwater swales and marshes to form in between. This is where the wetland vegetation of the island can be found and where deposition has formed the wider beaches with no boulders. Elsewhere, the erosion of the upper layers of glacial till resulted in large boulders rolling down the slopes to the beach (along with some of the fort's gun emplacements!) to form the rocky beaches and rocky intertidal shore. Along the eastern shore are several exposures of gray to gray-brown sandy to solid clay that may have been deposited by the glaciers or forced upward from pre-glacial deposits.

The varied topography, along with different types of glacial till and outwash that have been eroded into new features, have resulted in 17 soil types listed for the island by the Natural Resources Conservation Service (U.S. Department of Agriculture Natural Resources Conservation Service 1995): Atsion, Berryland, Bridgehampton, Carver, Deerfield, Haven, Montauk, Montauk Variant, Plymouth, Raynham, Riverhead, Scio, Sudbury, Wallington, Walpole, Wareham, and Whitman. Descriptions of the soil types can be found at https://soilseries.sc.egov.usda.gov/osdnamequery.asp. This large diversity of soils and features in such a small area has resulted in the diverse flora and fauna found there today.

Climate

Plum Island has a maritime temperate climate and is greatly influenced by the surrounding ocean. The heat-absorbing ocean waters moderate the temperatures that are typical in central Long Island and the mainland to the west. This moderation of temperatures tends to delay the growing season in the spring and prolong it in the fall. The average high in midsummer on Long Island is in the low 80s and the average low in midwinter is in the low 20s (See http://longisland.about.com/od/neighborhoods/a/Long-Island-Ny-Climate.htm). Average monthly precipitation averages from 3 to 5 inches in central Long Island with the lowest amount in July and the highest in March. Annual precipitation is about 45 inches. Plum Island is subject to a variety of storms. Spring and summer thunderstorms are a common occurrence and strong nor'easters can bring storm surges and high winds in the fall and winter. The NOAA website for historical hurricane tracks (See http://www.csc.noaa.gov/hurricanes) shows about 8 hurricanes and tropical storms passing within 50 miles of the island since records began. An unnamed storm tracked right between Plum Island and Orient Point in 1944, and the most recent major storm to come close to the island consisted of the remnants of hurricane Gordon in 2000. Even though hurricanes can be strong, the fall and winter nor'easters also have the high winds and waves that can influence the shoreline topography and vegetation (http://en.wikipedia.org/wiki/Noreaster).

History of human use

Plum Island has had a long and varied cultural history, which has had a dramatic impact on the animals and vegetation of such a small island. Prior to the arrival of European settlers, Native Americans probably used the island for fishing and hunting (R.A. Bramson, personal communication). The Pequot Indians grew corn there in the 1630s as a backup crop in case cornfields in Connecticut were burned by the English. In 1659 the island was sold by the Montauk Indians to Samuel Wyllys and for the next 238 years the island was used for farming and the grazing of sheep and cattle. By the mid-1700s there were three families living there and up to 40 or 50 people inhabited the island at times. In 1826 the US government bought three acres of land on the southern shore for a lighthouse that was constructed in 1827. In the late 1800s it was a popular place for fish camps of wealthy people and rustic buildings were built where they would stay. Others

might stay with the resident farmers or the lighthouse keeper. Luminaries such as Grover Cleveland visited during these times.

Most of the farmers sold their land by the end of the 1800s to Abraham S. Hewitt, former mayor of New London, Connecticut, who owned the entire island by 1890 (U.S. Department of Homeland Security 2010). His development plans for a summer resort never materialized and in 1898 the government bought the eastern half of the island to construct Fort Terry as a coastal defense for the Spanish-American war. They purchased the remainder of the island in 1901. The fort was active for the next 20 years and roads, buildings, and gun installations were built, mainly along the eastern shore. There was even a small railroad to carry equipment and ammunition between installations. In 1918 the fort changed to caretaker status and there was very little activity on the island for the next 23 years.

Beginning in 1941 the island was used as a base for World War II and activity increased again for the next five years. In 1946 the fort was decommissioned and there was little or no activity until 1952, when the US Army Chemical Corps began renovating Fort Terry's Building 257 for use as a biological lab to study foot-and-mouth disease. The use as a biological lab continues to this day. The buildings of the old Fort Terry have been vacated and new facilities have been constructed on the southwestern end of the island with a staff of about 300 people (U.S. Department of Homeland Security 2010). This has left much of the island in a semi-natural state except for the large mowed field and lawns of the Fort Terry parade ground and headquarters (see below), ferry dock facilities and buildings, sewer plant and pools, and various hazardous material disposal sites. A network of narrow, paved and unpaved roads connect these historical and modern facilities. Its use as a highly secure government facility prevents anyone besides the staff and selected visitors from using the island in any other manner or disturbing its plants or animals.

Documented and potential biodiversity

Natural communities

Mapping methods and preliminary natural community map

A systematic survey of the plant communities on Plum Island has never been conducted. A land cover map derived from the 2001 National Land Cover Database (Homer et al. 2004) is included in the Department of Homeland Security's (2008a) Final Environmental Impact Statement for the NBAF (Figure 3.2.2.1.1-1); but because the NLCD's classification is based on "unsupervised" (computer) interpretation of satellite data, it is extremely coarse and imprecise. The DHS report also includes New York State's Regulatory Freshwater Wetlands maps (Figure 3.8.2.1.2-1 - New York State Department of Environmental Conservation 2011) which have had only limited ground verification. The unpublished work of Eric Lamont and Richard Stalter , who compiled a list of plant communities and associated species while searching for rare plants on Plum Island (E. Lamont personal communication), is certainly the most exhaustive on-the-ground assessment of plant communities to date and is, in small part, incorporated into the narrative below.

We present here a very detailed preliminary seamless natural community map for the island (Figure 3) that should serve as the foundation for future ecological data collection. Detail views of the panhandle (Figure 4), center (Figure 5), and south/western (Figure 6) parts of the island are also included. Transect and plot sampling are necessary next steps to revise and validate both the linework and the attributed classification.

Polygons were digitized in ESRI's ArcMap 10.0 using 2007 digital color infrared aerial orthoimagery with 6-inch resolution (New York State 2008). Additional base layers that informed

the mapping included the USDA's Soil Survey Geographic Database (SSURGO2) for Suffolk County, New York (U.S. Department of Agriculture Natural Resources Conservation Service 1995) and USGS 7.5-minute topographic quadrangle maps (U.S. Geological Survey 1994). We also referred to images from Bing Maps (www.bing.com/maps) and Google Earth (http://www.google.com/earth/index.html).

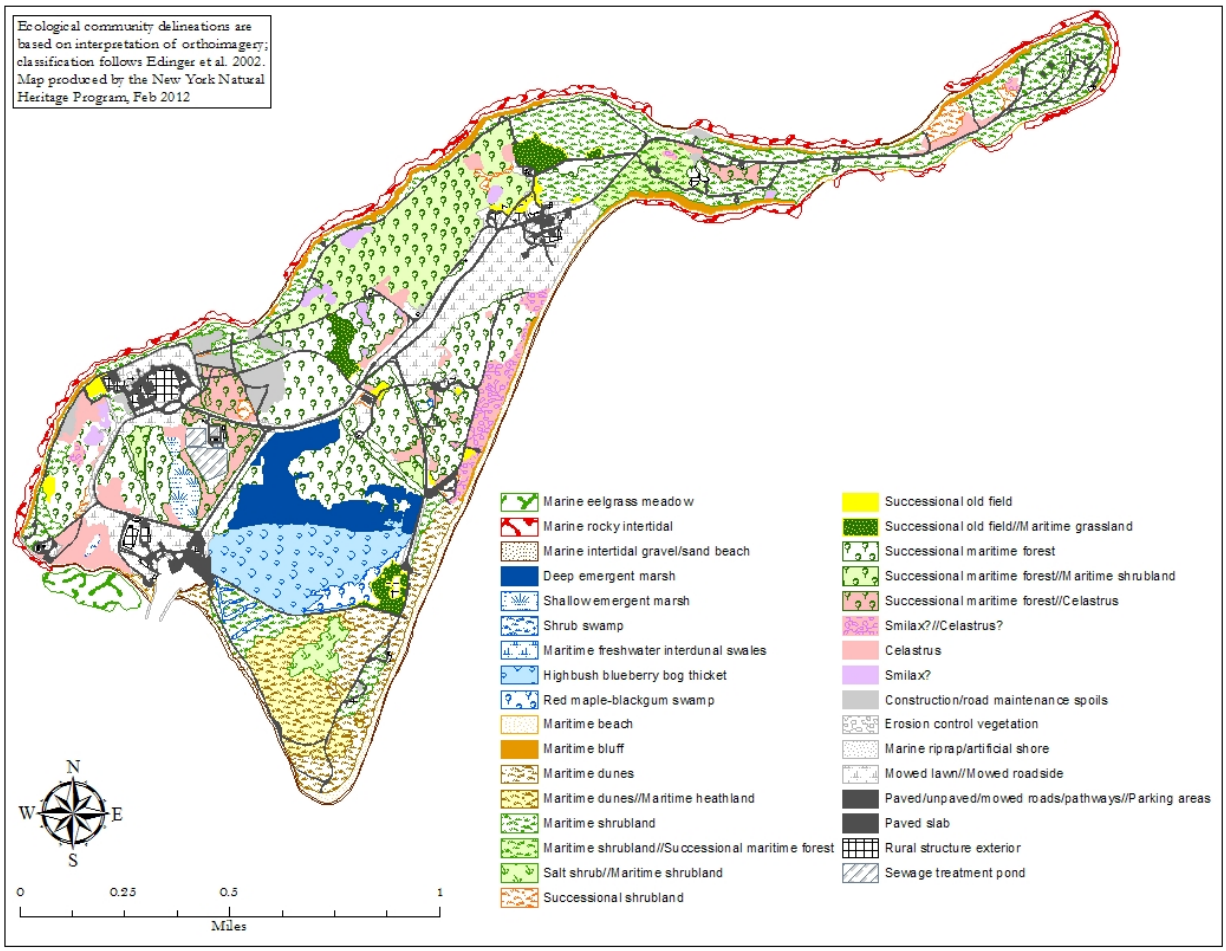

Figure 3. Natural and cultural communities of Plum Island, New York.

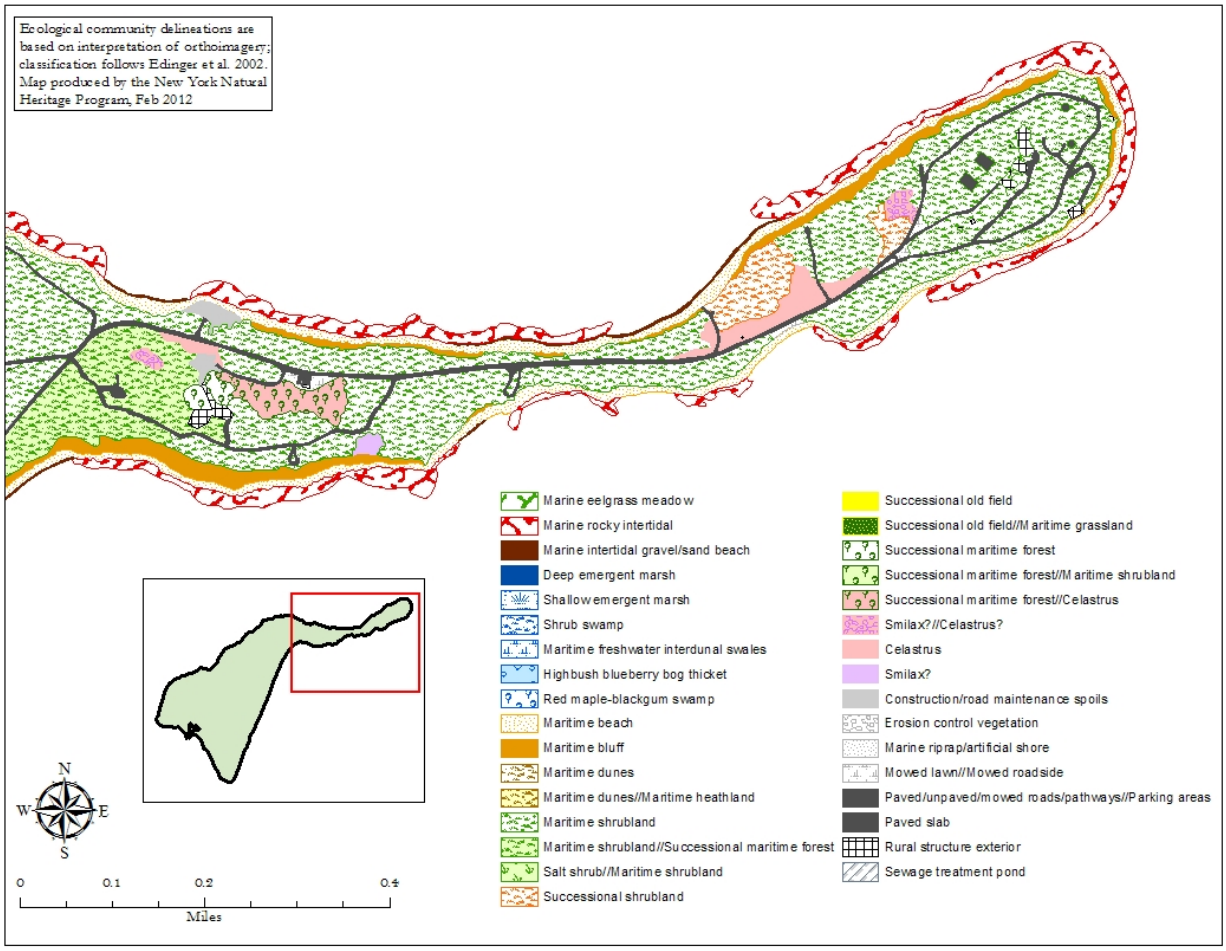

Figure 4. Natural communities of the panhandle of Plum Island, New York.

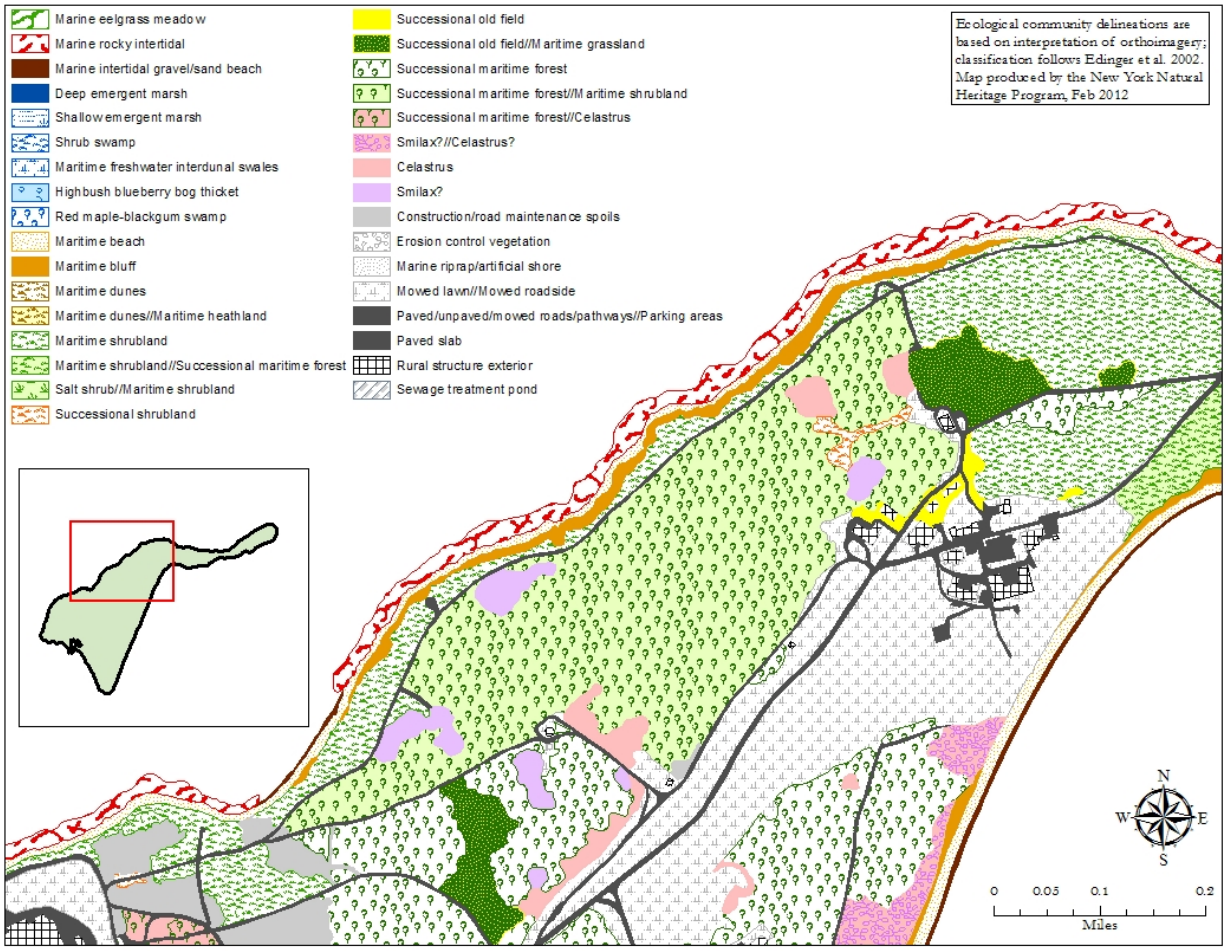

Figure 5. Natural communities of the center of Plum Island, New York.

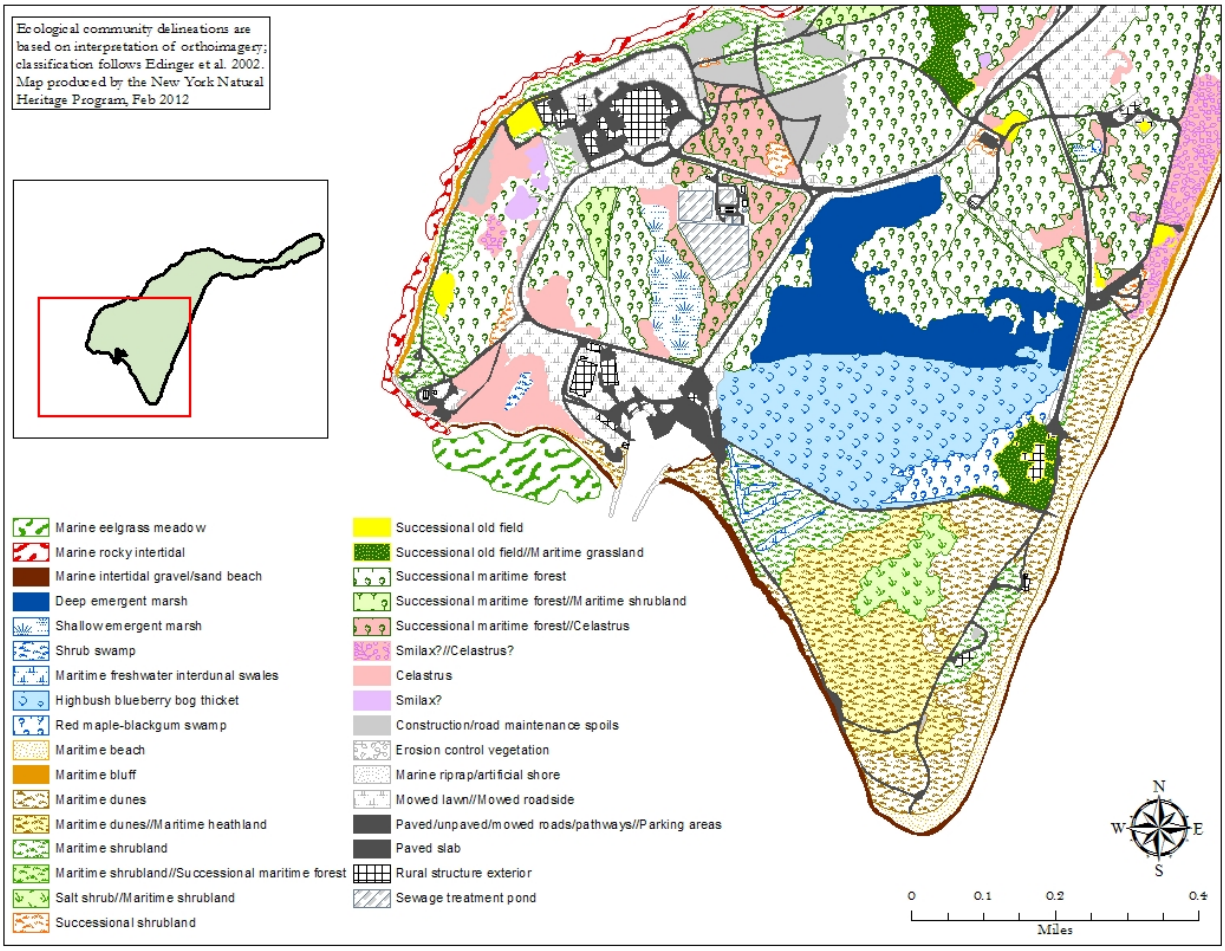

Figure 6. Natural communities of the southwestern portion of Plum Island, New York.

Because of the fine-scale resolution (6 inches) of the aerial images that were available for on-screen digitizing, polygons outlining community boundaries were mapped at a minimum scale of 1:900, with the intention of serving future land managers. For example, fairly substantial patches of what appears to be the highly invasive vine Oriental bittersweet (*Celastrus orbiculatus)* were delineated to help target remediation and restoration work. Not having recent stereo-pairs of photographs was our biggest limitation; while Bing Maps' bird's eye view provided some perspective, we had a difficult time distinguishing between tall shrubland and low maritime forest.

We attributed each polygon with the following data: primary and secondary community codes and community names (only primary names are presented in Figure 3 through Figure 6), area in acres, comments, and species composition, if known. For the most part, natural community nomenclature follows the NYNHP's existing community classification (Edinger et al. 2002), but when vegetation types or anthropogenic structures didn't fit existing types, placeholder names and codes were created (e.g., "*Smilax*?" (greenbriar) or "Subterranean structures"). Roads, pathways, and parking areas were merged, as were mowed lawns and mowed roadsides. In some cases, two primary community names were chosen for a polygon; this usually indicates a mosaic of the two types (for example, in the southwest tip of the island, maritime dunes and maritime heathland occur in a tight mosaic that is impractical to tease apart). Occasionally, it indicates a bit of uncertainty about the composition of the polygon, as when the label "*Smilax*?//*Celastrus*?" (greenbriar/bittersweet) or

"Successional old field//Maritime grassland" is applied. Rarely, a number of types occur in a particularly tight mosaic (as with maritime dunes, maritime heathland, maritime shrubland, and salt shrub at Pine Point); this example might be better classified at the Ecological System level, but in this case, we included the two shrubland types as secondary community names.

Plum Island's vegetation has been heavily impacted by human use since the mid-1600s, when areas were cleared for agriculture, through the early 20th century, when the military built a network of bunkers and other infrastructure to support Fort Terry, to the present day network of roads and facilities surrounding the USDA/DHS's Animal Disease Center. We mapped 25 'natural' communities and community complexes (Table 1) and 8 'cultural' types (Table 2) on the island (see Edinger et al. 2002 for details on community classification). The site is fragmented by over 12 miles of paved and unpaved roads and paths, numerous mowed fields, and infrastructure which, in part, explains the high number of polygons for some types.

Table 1. Natural community types mapped at Plum Island, their total acreage, and number of polygons.

Natural community name	Acres	Number of polygons
Maritime shrubland	124.4	35
Successional maritime forest	118.9	30
Successional maritime forest//Maritime shrubland	66.0	3
Highbush blueberry bog thicket	43.6	1
Maritime beach	38.3	3
Maritime dunes	35.5	9
Marine rocky intertidal	34.0	9
Maritime dunes//Maritime heathland	30.8	4
Deep emergent marsh	30.3	2
Celastrus	27.4	33
Successional maritime forest//*Celastrus*	15.8	9
Maritime bluff	14.8	12
Smilax?//*Celastrus*?	13.9	7
Successional old field//Maritime grassland	13.3	4
Maritime shrubland//Successional maritime forest	12.4	2
Marine eelgrass meadow	9.5	1
Shallow emergent marsh	7.5	2
Successional shrubland	7.5	11
Marine intertidal gravel/sand beach	6.8	7
Smilax?	6.5	9
Salt shrub//Maritime shrubland	6.3	1
Red maple-blackgum swamp	6.1	1
Successional old field	4.6	11
Maritime freshwater interdunal swales	1.8	2
Shrub swamp	0.8	2

Table 2. Cultural community types mapped at Plum Island, their total acreage, and number of polygons.

Cultural community name	Acres	Number of polygons
Mowed lawn//mowed roadside	93.1	72
Paved/unpaved/mowed roads/pathways//Parking areas	44.5	1
Construction/road maintenance spoils	14.5	16
Rural structure exterior	11.7	60
Sewage treatment pond	5.0	6
Marine riprap/artificial shore	1.0	3
Paved slab	0.4	4
Erosion control vegetation	0.1	1

Conservation Guides that summarize the statewide characteristics of most of the mapped natural communities are available at http://guides.nynhp.org/ and included in a separate document as Appendix C. Because detailed, local (Plum Island) vegetation descriptions will be based solely on best professional judgment and remote assessment until a significant amount of fieldwork has been undertaken, the floristic information in the Guides should be viewed as generalized and not specific to sites on the island. Detailed species-specific information in the following narrative was gathered by E. Lamont during his floristic surveys.

A broad description of the island's vegetation is included in the DHS's (2008a) FEIS and is excerpted [with additions in brackets] below:

> "Natural vegetation on the island is influenced by maritime processes that include high winds, salt spray, overwash, and dune formation and shifting. The island contains characteristic maritime communities that include beach, dune, and maritime shrub/forest. Additional communities include an extensive complex of freshwater herbaceous/shrub wetland communities on the southwestern portion of the island, and coastal hardwood forests on elevated moraine deposits that are protected from ocean salt spray and overwash. The [north] side of the island on Long Island Sound [and the southern panhandle on Block Island Sound] is actively eroding, resulting in vertical bluffs that are adjoined by unvegetated beaches consisting of sand and glacial till (gravel, cobble, and boulder). Consequently, the island lacks tidal marshes… that are characteristic of barrier islands and other moraine islands in Long Island Sound."

We found that maritime shrubland and successional maritime forest ("maritime shrub/forest") cover over 330 acres of the island (nearly 40% of the landscape). As a rule, maritime shrubland seems to be more common on the exposed, narrow eastern panhandle, while taller maritime forests dominate in the center of the island and just north and east of the large wetland complex in the southwest. More mature maritime (or coastal) forests are said to occur in high spots on the rolling terrain surrounding the water tower, in the northwest corner (west of the Animal Disease Center's main laboratory building) of the island, and adjacent to the deep emergent marsh north of Pine Point (E. Lamont, personal communication). More survey work is needed to document their composition and extent.

As mentioned above, maritime shrublands on and near the exposed edges of the island are wind- and salt-pruned and occasionally perch atop the steeply eroding maritime bluffs that tumble down to the rocky and sandy beaches below. In some areas, they are dominated by bayberry (*Myrica pensylvanica*) and beach plum (*Prunus maritima*) (E. Lamont, personal communication). In the

southwest corner of the island, at Pine Point, maritime shrublands are contained within the large (63-acre) maritime dune complex and also surround a series of what appear to be small (1.8 acres) maritime freshwater interdunal swales. In that area, groundsel tree (*Baccharis halimifolia*) is associated with the bayberry (E. Lamont, personal communication)

Both inland and near the island's perimeter, expanses of taller shrublands and maritime forests are punctuated by the sweeping lawns and building complexes associated with the Animal Disease Center. Successional old fields and what may be maritime grasslands occur in formerly cleared areas dominated by (non-lawn-forming) graminoids and forbs; these spaces, which are likely to provide habitat for grassland birds and other species, probably experience continued disturbance or mowing that prevents incursion by shrubs, woody vines, and tree species.

We mapped over 90 acres of freshwater wetlands, or palustrine communities, on the island. In addition to the small maritime freshwater interdunal swales mentioned above, there are two small shallow emergent marshes and two small patches of shrub swamp. At least one of the shallow emergent marshes (located just south of the Animal Disease Center's main lab building) is dominated by cattail (*Typha* spp.) with some swamp loosestrife (*Decodon verticillatus*) (E. Lamont, personal communication). If the loosestrife is dominant, the site will be re-classified as a shrub swamp. The shrub swamp east of the lighthouse is dominated by buttonbush (*Cephalanthus occidentalis*) (E. Lamont, personal communication); both the shallow emergent marsh and shrub swamp are common community types but do provide unique habitat for turtles, amphibians, and marsh birds on Plum Island.

The most obvious freshwater feature on the island is the large (74-acre) ponded wetland complex north of the dune system at Pine Point. There has been some discussion about the origin, natural or anthropogenic, of this uniquely striated marsh system. Because there is evidence of an old causeway ("Love Lane," currently visible as a narrow path) on one of the wider striations, it has been assumed that the wetland's structure is primarily human-caused (Lamont and Stalter 2011). However, Crandell (1962), in his treatment of the geology and groundwater of the island, noted that "low beach ridges that seldom reach more than 10 feet in altitude alternate with marshy depressions in the southwestern part of the island…" He goes on to say that "The older of these ridges…have almost east-west trends, but successively younger ridges approach north-south trends." This description perfectly matches the series of ridges seen in (aligned east-west) and just south of (running nearly north-south) the large wetland, and we suspect its origin to be as a natural, ancient dune-swale complex. Crandell does not mention the causeway, but does refer to some anthropogenic hydrological alterations on the site, saying, "…an artificial channel has been dredged to drain the swampy area in the southwestern part of the island and to control mosquito breeding. A sea gate is used to control the flow in this channel, and it has recently (1959) been kept closed to retain ponded rainwater." We did not see any evidence of this sea gate or artificial channel on the aerial imagery that we reviewed.

We classified the ponded northern half of the wetland as deep emergent marsh – a broad type that can be dominated by a variety of emergent and floating aquatic species. Ancient Atlantic white cedar (*Chamaecyparis thyoides*) stumps have been noted in this area of the marsh; they are presumed to be remnants of an old Coastal Plain Atlantic white cedar swamp, but no seedlings or trees are extant (E. Lamont, personal communication). The southern portion of the wetland that contains the series of possible old dune ridges, has been classified as highbush blueberry bog thicket, based on a brief species list from E. Lamont; it contains swamp azalea (*Rhododendron viscosum*), highbush blueberry (*Vaccinium corymbosum*), fetter-bush (*Leucothoe racemosa*), and spoon-leaved sundew (*Drosera intermedia*) with sedges, rushes, grasses, and forbs. This species-rich area is an important target for future surveys and adds fascinating diversity to the island's flora.

Our map extends into the waters surrounding Plum Island to capture marine intertidal and subtidal communities. The intertidal zone consists of a narrow strip of marine intertidal gravel/sand beach, essentially a continuation of the exposed (terrestrial) maritime beach community into the water. The community is exposed at low tide and submerged at high tide and is an important foraging area for shorebirds. Along some stretches of shoreline, the intertidal beach is replaced by a marine rocky intertidal community that is characterized by large rocks and boulders that are alternately submerged and exposed and are colonized by marine algae. Part of this rocky coast is notable at Plum Island as a seal haul-out site. Finally, a small (9.5-acre) patch of marine eelgrass meadow that was digitized by Tiner et al. (2007) is included on our map. Underwater surveys should be conducted to search for more eelgrass and to thoroughly assess the rocky intertidal community.

Significant natural communities

Four significant natural community occurrences have been documented at Plum Island (Figure 7). We have some quantitative field data associated with only one of the four – Maritime dunes – and the others were identified through aerial imagery interpretation during the course of our vegetation mapping.

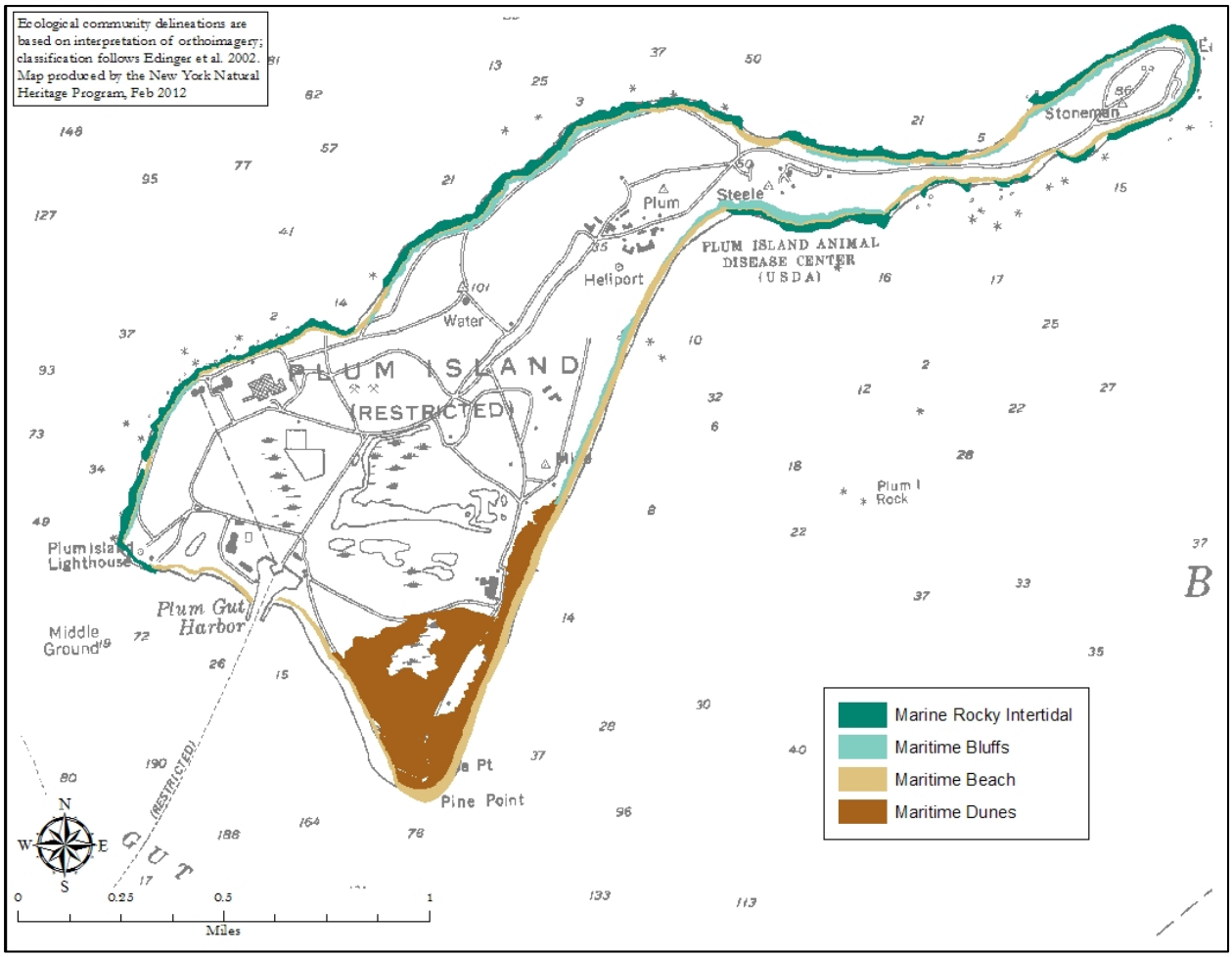

Figure 7. Significant natural communities of Plum Island, New York.

Maritime dunes. The maritime dune system at Pine Point is about 63 acres, making it average to small for New York. It is mapped as 6 polygons ranging in size from 0.1 acre to about 37 acres;

because the polygons are separated by narrow, unvegetated sand paths, they are essentially continuous. In recent (2007) aerial imagery, the dune system appeared to be a tight mosaic of a few community types: maritime dunes, maritime heathlands, maritime shrubland, and possibly salt shrub (see community conservation guides in Appendix C). In 1989, the date of our field data, the surveyed areas of the dunes were strongly dominated by American beachgrass (*Ammophila breviligulata*), which is characteristic for active maritime dunes in New York. Other documented herbs were Canadian horseweed (*Conyza canadensis*), seaside goldenrod (*Solidago sempervirens*), grass-leaved goldenrod (*Euthamia caroliniana*), beach pinweed (*Lechea maritima* var. *maritima*), switchgrass (*Panicum virgatum*), cordgrass (*Spartina pectinata* or *S.patens?*), and fragrant cudweed (*Pseudognaphalium obtusifolium*). Patches of shrubs were primarily composed of sassafras (*Sassafras albidum*), winged sumac (*Rhus copallinum*), and bayberry. The community was essentially free of invasive exotic species, despite their presence in disturbed areas along the old roads. In 2012, E. Lamont (unpublished data) noted American beachgrass, sand-heather (*Hudsonia tomentosa*), beach pinweed, poison ivy (*Toxicodendron radicans*), winged sumac, beach plum, groundsel tree, and red cedar (*Juniperus virginiana*). Additional survey work should document the composition of the communities within the dune system, investigate the narrow maritime freshwater interdunal swales that lie to the west of the dunes, and survey the polygon that is labeled 'Salt shrub//Maritime shrubland' on the map. That area is mapped as a wetland on the NYS Regulatory Wetland maps but does not appear wet in recent photos. It could be shrubby, brackish swale containing a salt shrub community.

Maritime beach. The maritime beach on Plum Island is, on average, about 10-15 m wide and extends around the majority of the perimeter of the island in a nearly continuous band. It continues for over 11.5 km and covers about 45 acres, making it average-sized for New York. This occurrence has not been surveyed in the field, but its signature is clear on aerial photographs. It consists of a combination of rocky and sandy beach, in seemingly equal proportions, but with more rocky beach on the northern shore. Driftwood and wrack are visible; again, more frequently on the northern shore. Where the beach abuts steep maritime bluffs, boulders can be seen on the beach at the base of the eroding surface. At least three rare species have been documented on the beach, including seabeach knotweed (*Polygonum glaucum*), Piping Plover (*Charadrius melodus*), and the Hairy-necked Tiger Beetle (*Cicindela hirticollis*). Adjacent natural communities include marine rocky intertidal, maritime bluff, maritime dunes, and maritime shrubland.

Maritime bluff. The maritime bluff community was calculated to be 44 acres (a very large occurrence for New York), which is "actual acres," and takes slope into consideration. This acreage may overestimate its size, as the mapped area is likely to contain the tapered edges of the bluffs. These edges would probably be shorter than 10 feet tall, which is the minimum height requirement for the community. This occurrence has not been surveyed in the field, but its signature is clear on aerial photographs from 2007. It consists of a series of steeply sloping (estimated to be about 70 degrees on average), sparsely vegetated, actively slumping bluffs that range in height from 10 to 50 or 60 feet and are composed of unconsolidated glacial till and outwash. The occurrence is mapped as 12 linear patches that range in length from about 60 m to just over 1 km. Adjacent natural communities include sandy and rocky maritime beach, windblown blufftop maritime shrubland, and successional maritime forest.

Marine rocky intertidal. This occurrence consists of 34 acres of marine rocky intertidal (large for New York) mapped in nine patches that range in size from about 0.5 acre to 10.5 acres. The community has not been surveyed in the field, but its signature is clear on CIR aerial photographs as a series of bright red patches of marine macroalgae that occur on the tidally washed rocky shores surrounding Plum Island, extending out to the lowest tide level. Mapped patches range in width from about 5 to 50 meters. Adjacent natural communities include maritime beach and marine deepwater communities, and there is at least one nearby patch of marine eelgrass meadow.

Animals

"The island has no wildlife, and no animal leaves Plum Island alive." – Wall Street Journal, January 8, 2002 (Dugan 2002)

Because Plum Island has not had a comprehensive biodiversity inventory, and published information on many taxa was not readily available, we compiled information from a variety of sources including published articles in peer-reviewed journals, gray literature, and personal communications. For taxa that had not been inventoried on the island, we compiled information on surrounding islands and mainland Long Island to inform a list of the potential species (or simply potential at-risk species, depending upon the taxon) of Plum Island.

Conservation guides for all NYNYP-tracked rare animals recorded from Plum Island are available at http://guides.nynhp.org/ and included in a separate document as Appendix C.

Terrestrial mammals

Very little survey effort has been expended for terrestrial mammals on Plum Island. Connor (1971) noted the white-footed mouse (*Peromyscus leucopus*) and meadow vole (*Microtus pennsylvanicus*) as the only native rodents collected from Plum Island. The invasive Norway rat (*Rattus norvegicus*) was also reported. A trapping survey of small mammals for disease-carrying insects in the late 1970s (White and White 1981) found only the white-footed mouse and meadow vole in 500 trap-nights. The researchers incidentally noted house cats and bats (species unknown) on the island. However, it is well known that many native mammals have been removed from the island by USDA and DHS personnel, concerned about the potential for the spread of disease. Primarily these have included white-tailed deer (*Odocoileus virginianus*), which swim there from the mainland, and raccoon (*Procyon lotor*), which apparently colonized the island in about 1995, facilitated by the transport of construction debris (K. Preusser, USDA, personal communication). Biologists from USDA also noted the presence of muskrat (*Ondatra zibethicus*), fox (species unknown), and, in approximately 2003, beaver (*Castor canadensis)* (L. Humberg, K. Preusser, and M. Lowney, USDA, personal communication).

The detection of beaver sign is significant because beaver have rarely been documented otherwise on Long Island since the colonial period (Connor 1971). A beaver arrived in the Bronx in 2007 to great fanfare after a substantial restoration effort; some speculated that the beaver could have come across Long Island Sound (O'Connor 2007). Further, beaver are now known from East Hampton, New York, to the south of Plum Island (J. Janssen, personal communication). Thus, Plum Island has potential to be an important stepping stone for beaver, and possibly other animals, to recolonize Long Island. The river otter (*Lontra canadensis*) was periodically considered extirpated from Long Island despite scattered sightings (De Kay 1842, Connor 1971), but there now appears to be a small population. Connor (1971) proposed that otters sighted on the east end of Long Island in the 1950s may have swum across the Long Island Sound from Connecticut. The route from Connecticut with the shortest open-water crossing (7.25 km, close to the maximum reported for the species [Blundell et al. 2002]) would take in the archipelago of New York islands including Fisher's Island, Great Gull Island, and Plum Island. Finally, both coyote (*Canis latrans*) and fisher (*Martes pennanti*) have been reported from Fishers Island (L. Klahre, personal communication), and thus may be next to recolonize mainland Long Island, potentially with Plum Island as a stepping stone.

Bats have become one of the greatest conservation concerns in the northeast U.S., with white-nose syndrome having devastated many cave-dwelling bat species (Blehert et al. 2009) and fatalities at wind turbines causing concern especially for migratory tree bats (Cryan and Brown 2007,

Cryan and Barclay 2009). No surveys of bats have been conducted on Plum Island, yet there is potential for the island to be an important stopover and roosting location. While little information is available on bat use of islands in this region, bats are known to migrate along the coast and over the ocean and to stopover on islands (Cryan and Brown 2007, Boyden 2012, Hooton and Costello 2012). Further, the island's many abandoned military bunkers have the potential to provide habitat for roosting big brown bats (*Eptesicus fuscus*) and perhaps other species as well, as has been documented in other locations (e.g., Baranauskas 2001, Masinga et al. 2009). The U.S. Fish and Wildlife Service is assessing the potential of a captive management program as part of an overall strategy to combat WNS, in which bunkers and other human-made structures would be treated against the fungus and house captive bats year round (Traylor-Holzer et al. 2010).

Plum Island harbors potential habitat for New England cottontail (*Sylvilagus transitionalis*), a candidate for federal listing that historically occurred on Long Island but that has not been documented there since the 1930s (Connor 1971). Currently, no rabbits, not even the prolific eastern cottontail (*Sylvilagus floidanus*), are known from Plum Island despite suitable cover and infrared surveys by USDA (K. Preusser, personal communication). Besides pitch pine oak barrens and high salt marsh, which are not known from Plum Island, coastal habitat for New England cottontails also includes coastal shrublands that might be similar to the salt shrub and maritime shrubland communities occurring on Plum Island. Inland, they have been found in successional old fields, successional shrubland, and they may use highbush blueberry bogs, shrub swamp, and *Smilax* and *Celastrus* thickets (http://www.newenglandcottontail.org/), which are all vegetative types occurring on Plum Island. Pending further investigation into whether the vegetative communities on Plum Island are sufficient to support cottontails and sustainable in their presence, Plum Island could be a particularly effective (re)introduction site because of the absence of the competing eastern cottontail and isolation from the mainland increasing potential for the control of deer and invasives.

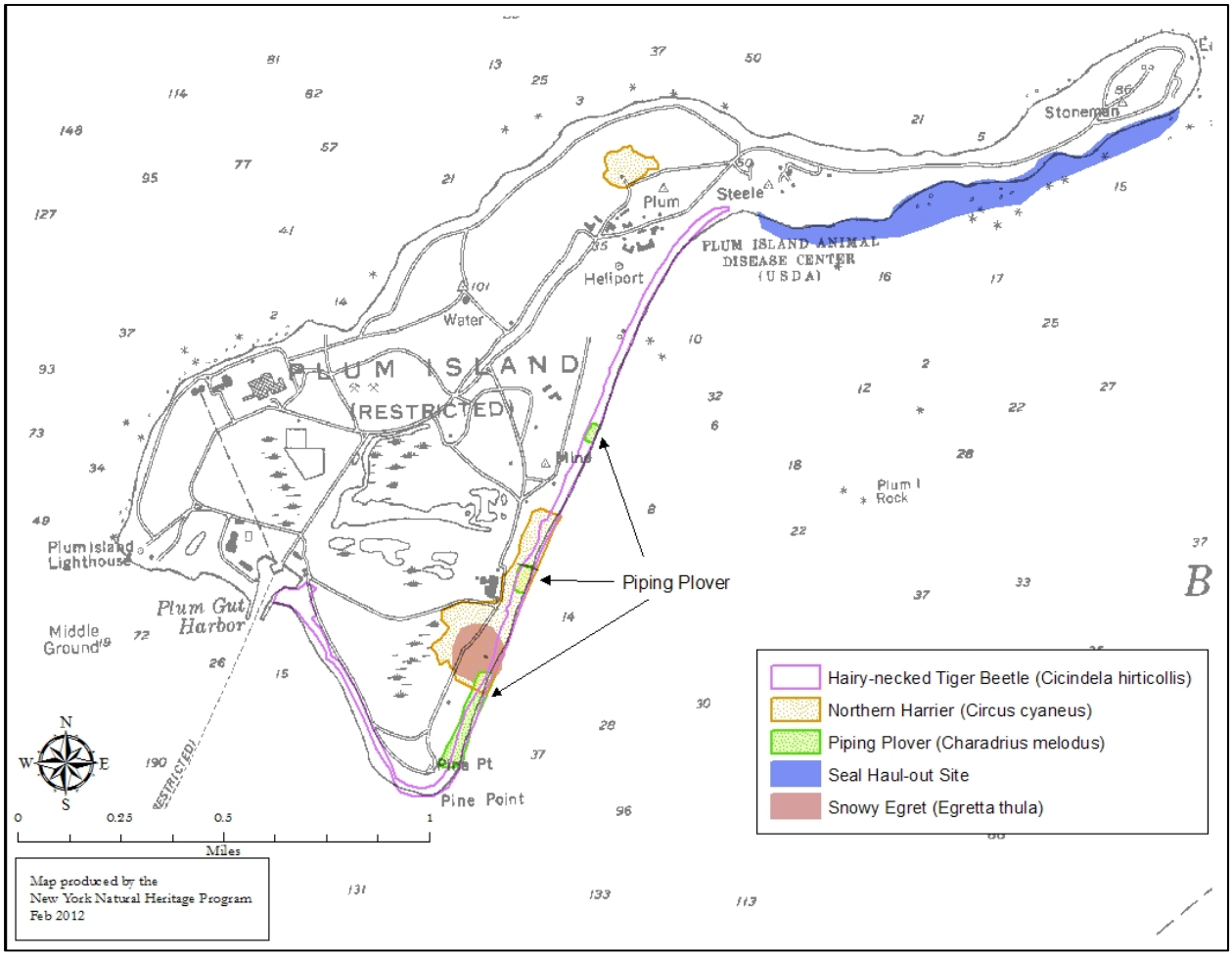

Figure 8. Animal element occurrences on Plum Island, New York.

Marine mammals

Plum Island is known as the home of the largest winter seal haul-out site in New York State and among the largest in southern New England (DiGiovanni Jr. et al. 2011)(Figure 8). Pinniped surveys by the Riverhead Foundation for Marine Resarch and Preservation are conducted during a two-hour window on each side of low tide, while aerial surveys are flown in a fixed high-wing aircraft at an altitude of 600 feet. During the first half of the last decade, the mean number of seals observed around Plum Island was 100 animals. Over 600 harbor seals (*Phoca vitulina*) have been detected on the rocks off the south side of the island via regular flyovers by the Riverhead Foundation for Marine Preservation and Research (Figure 9; Figure 10). Notably, the recorded number of harbor seals has increased dramatically in their surveys over the last 7 years (Figure 9). Historical data are sparse, although Connor (1971) highlighted a 1933 report of 50 seals and ongoing "fairly large numbers" of seals using the island.

Numbers of seals observed need to be considered in terms of the regional population, which is considered to be southern New England and eastern Long Island, NY. Animals may move among haul-out sites in a metapopulation-type dynamic without overall numbers changing at a regional scale. However, at the Fisher's Island haul-out site, just 10 miles east of Plum Island, observations went from 68 harbor seals in 2005 to 423 in 2011 (DiGiovanni Jr. et al. 2011). These data indicate that the population of harbor seals on Plum Island and the surrounding haul-out sites is increasing.

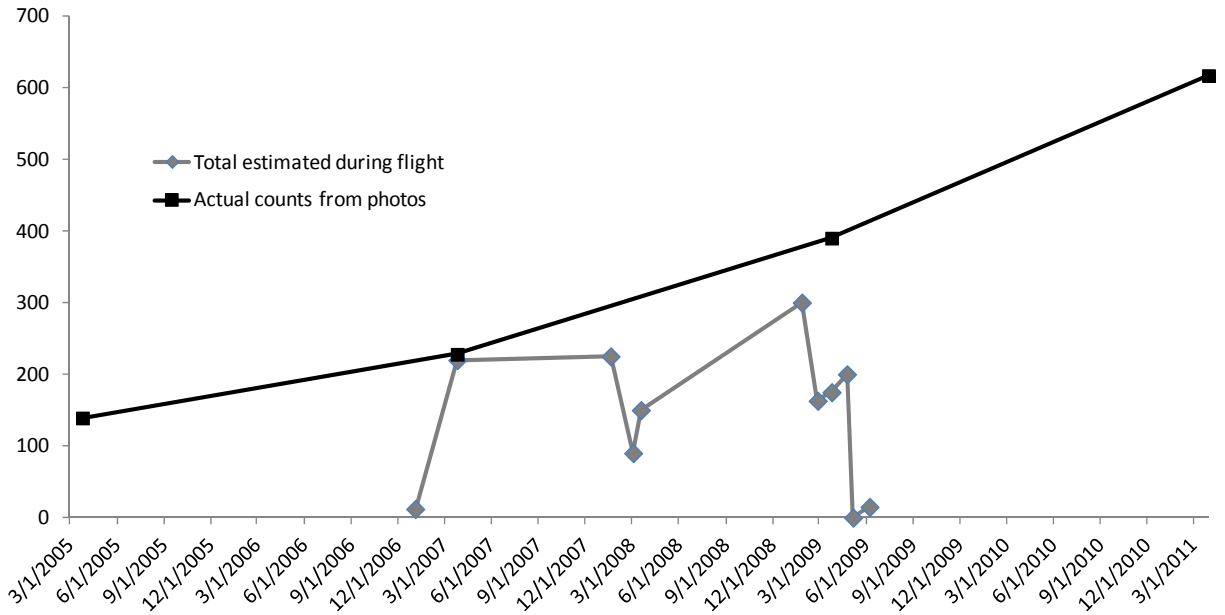

Figure 9. Counts of harbor seals using two methods from 2005 to 2012 at Plum Island, New York. Points indicate survey dates. Data courtesy of the Riverhead Foundation for Marine Research and Preservation. Increasing numbers annually are evident from the photo counts, while seasonal variation is evident from the flight tallies.

As late as 1971, no reports of gray seals (*Halichoerus grypus*) were known from Long Island (Connor 1971). They have recently increased dramatically in the region and are now common on nearby Little Gull Island (DiGiovanni Jr. et al. 2009). They have been seen in the water near the seal haul-out site on Plum Island in summer, and 5 were seen during the 2011 Christmas Bird Count (R. Digiovanni Jr., ML. Lamont, and M. Schlesinger, unpublished data). Mixed groups of gray and harbor seals have also been observed (R. DiGiovanni Jr., unpublished data).

Figure 10. Harbor seals (*Phoca vitulina*) hauled out on the south shore of Plum Island, New York in March 2011. Photograph courtesy of The Riverhead Foundation for Marine Research and Preservation.

Sadove and Cardinale (1993) compiled decades of survey results, opportunistic sightings, and strandings to document the distributions of marine mammals in the New York area. Several of these species were documented in the Peconic Bay (southwest of Plum Island between the two "forks" of Long Island; Figure 1), Long Island Sound, and Block Island Sound, surrounding Plum Island (Table 3). Of note are recent sightings of the Endangered northern right whale (*Eubalaena glacialis*) at the mouth of Long Island Sound and near Fishers Island in 2008 and 2010 (Khan et al. 2010). Over 100 common dolphins (*Delphinus delphis*) were sighted off the north side of Plum Island and in Plum Gut in January 2006 (ML. Lamont, unpublished).

Table 3. Marine mammals documented in the waters near Plum Island, New York. From Sadove and Cardinale (1993), Connor (1971), and R. DiGiovanni Jr, unpublished data.

Common name	Scientific name	S-rank*	Location
Northern right whale	*Eubalaena glacialis*	SNA‡	LI Sound, Plum Gut
Humpback whale	*Megaptera novaeangliae*	SNA‡	Montauk
Beluga	*Dephinapterus leucas*	SNA	LI Sound
Bottlenose dolphin	*Tursiops truncatus*	S3	LI Sound, Plum Gut
Common dolphin	*Delphinus delphis*	S4	Plum Island, Gardiner's Bay, Robins Island, Great Peconic Bay, Shelter Island, Gardiner's Island, Orient
Harbor porpoise	*Phocoena phocoena*	S4‡	LI Sound, Plum Gut, Peconic Bay
Harbor seal	*Phoca vitulina*	S3	Haul-outs on Plum, Gulls, Gardiner's, Montauk, Fisher's, Shelter

*Definitions of Natural Heritage S-ranks are in Appendix A.
‡Species of Greatest Conservation Need

Birds

Information on the bird fauna of the island came primarily from regular surveys by Audubon New York. Additional information came from Christmas Bird counts, avian literature, and anecdotal observations from experts. We have documented 187 species of birds using Plum Island across seasons and years, including 57 New York State Species of Greatest Conservation Need (SGCN; New York State Department of Environmental Conservation 2005; Appendix B). Scientific names for all birds mentioned in the text are in Appendix B.

The 2000-2005 Breeding Bird Atlas (McGowan and Corwin 2008) documented 55 species in the two atlas blocks intersecting Plum Island. Block 7356C, which covered the eastern portion of the island, had 50 species, with 45 confirmed or probable breeders. Block 7256D, which covered the western portion of the island and Orient Point on mainland Long Island, had 39 species, with 35 of them confirmed or probable breeders. Both blocks had lower than average species totals for the Coastal Lowlands ecozone (McGowan and Corwin 2008), but also considerably less land area available for surveying.

Regular surveys of Plum Island's birds have been conducted by Audubon New York since spring 2006. In the following summaries we include surveys through January 2012, although three new species that were added since are included in the grand total and the species list in Appendix B. The island had been surveyed 37 times as of January 2012: 9 in spring, 11 in summer, 11 in fall, and 6 in winter. Surveyors have detected 173 species over the six years through a combination of point surveys, walking surveys, and incidental sightings (Appendix B). Numbers of species detected reached peaks in May (maximum recorded count of 76 species) and September (65 species), with richness in the breeding season averaging around 50 species and wintering richness varying between

30 and 40 species (Figure 11). The most common species (detected on >90% of weeks) were ones typical of northeastern coastal habitats: American Robin, American Crow, Black-capped Chickadee, Carolina Wren, European Starling, Herring Gull, Northern Mockingbird, Blue Jay, Red-tailed Hawk, Great Black-backed Gull, Song Sparrow, Northern Cardinal, and Canada Goose.

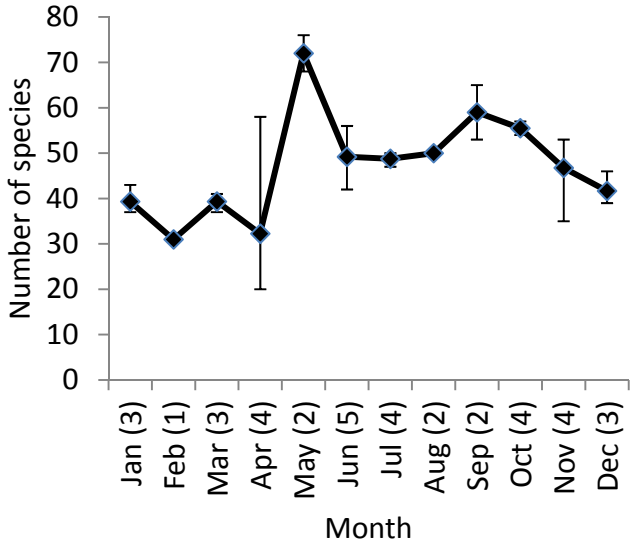

Figure 11. Average monthly numbers of bird species detected on walking surveys, point-based surveys, and day lists by Audubon New York from April 2006 to January 2012. Bars represent minimum and maximum species numbers. The number in parentheses below each month is the number of surveys that have been conducted in that month, across years.

Sixty-five species have been documented as "confirmed" or "probable" current-day breeders (following guidelines in McGowan and Corwin 2008), although four of the gulls and terns included in that total were likely breeding on nearby islands. The breeding bird fauna has included 13 New York State SGCN (Appendix B). Rare and notable species are discussed below.

Colonial waterbirds and waders. Plum Island's once substantial populations of breeding herons and egrets have disappeared in the past few decades. Plum Island was first documented as a major heron rookery and seabird breeding colony in the 1970s (Buckley and Buckley 1980), when up to 26 pairs of Great Egret, 135 pairs of Snowy Egret, 45 pairs of Black-crowned Night-heron, 10 pairs of Glossy Ibis, two pairs of Little Blue Heron, and one pair of Tricolored Heron were recorded (Figure 12). (Note that Allen [1892] reported that a night-heron [species not given, but presumably black-crowned] colony was destroyed by the island's landowners in the 1880s to stop outside hunters from shooting at osprey that frequented the colony.) In the late 1970s Plum Island contained the largest colony of many of these species outside of the substantial heron rookeries of Nassau County (Buckley and Buckley 1980). Snowy Egret had the largest breeding population of any species, in the scrub-shrub wetlands near the southern tip of the island; it has not been documented breeding since 1995 (New York Natural Heritage Program 2011) or even present on the island in the last six years (Appendix B). Glossy Ibis were also once numerous but declined substantially; at last count, this species has bred in only 29 locations in New York, with only eight of those sites active in 2007 (New York Natural Heritage Program 2012). They were documented as probable breeders on Plum Island in 2007 and 2009. Great Egret and Black-crowned Night Heron populations similarly have crashed in recent years, with only the Double-crested Cormorant increasing in breeding population (Figure 12). Tricolored and Little Blue Heron, each with just a handful of known breeding locations in New York, have bred on Plum Island off and on, although neither has been documented since 2001.

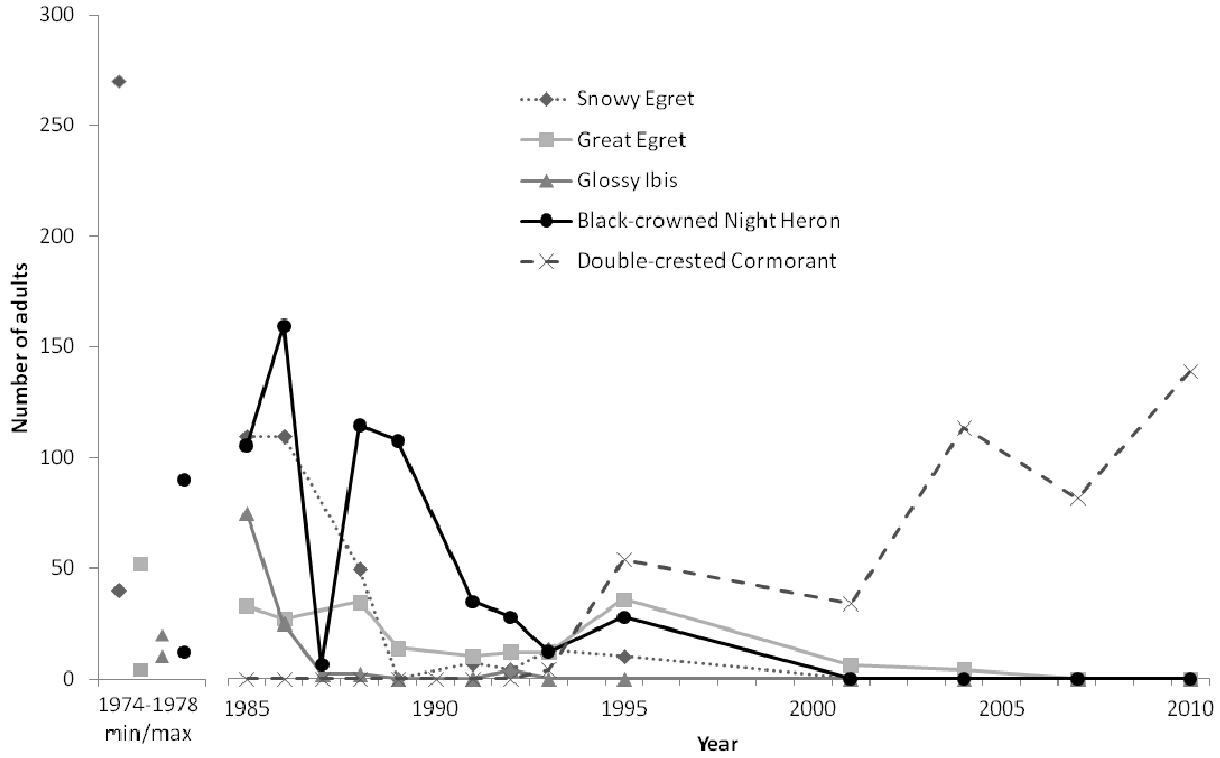

Figure 12. Number of adults of five species of colonial waterbirds breeding on Plum Island from the 1970s (given as minima and maxima from 1974 through 1978, as per Buckley and Buckley [1980]) and 1985 through 2010. When number of pairs was reported, we doubled that value to yield a conservative estimate of the number of adults.

The decline and eventual disappearance of the multispecies heronry on Plum Island can be convincingly traced to the introduction of raccoons in the mid-1990s. Raccoons are notorious nest predators and their introduction to islands they previously unoccupied has proven highly detrimental to the formerly insulated prey on those islands (Roemer et al. 2009).

P. Spitzer (unpublished) documented a breeding Least Bittern in the large emergent marsh in the 1970s. The Least Bittern is listed as Threatened by New York State. This species has not been reported since.

Plum Island used to be home to a substantial gull colony as well. In the 1970s Buckley and Buckley (1980) counted up to 1000 pairs of Herring Gull and 75 pairs of Great Black-backed Gull (Figure 13). While both species have been documented during the breeding season (Appendix B), the Long Island Colonial Waterbird Survey has not documented any breeding gulls in recent years (Figure 13). Although some species had declined since recorded maxima in the 1970s and 1980s, the sharpest declines, often to zero, happened after the apparent 1995 arrival of raccoons, which are common predators of colonial waterbirds (e.g., Ellis et al. 2007).

Although the Roseate Tern, federally and state listed as Endangered, and Common Tern (Figure 14), state listed as Threatened, do not appear to breed on the island, the island's shores provide foraging and resting habitat for these species, which are easily seen in the summer months. Plum Gut, the deep channel between Plum Island and Orient Point to the west, is known as a nutrient-rich and important foraging area for both terns (Burger and Liner 2005). At least one historical reference makes note of a former tern colony on the island (Bayles 1963).

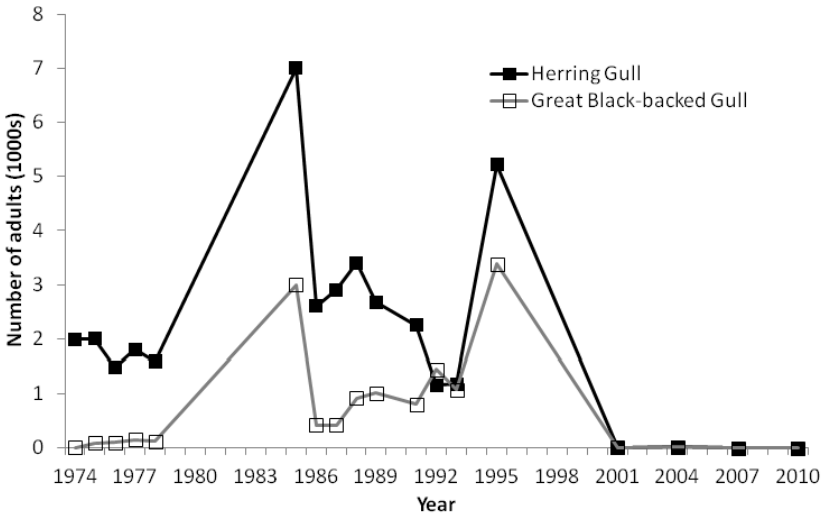

Figure 13. Number of adults of Herring and Great Black-backed Gull breeding on Plum Island from the 1970s (Buckley and Buckley 1980) and from 1985 through 2010 (NYSDEC). When number of pairs was reported, we doubled that value to yield a conservative estimate of the number of adults.

The Piping Plover, federally listed as threatened, has attempted to breed on the east-facing portion of the southern shore of Plum Island several times in the last decade. It apparently has never been common on the island; through 2011, only one or two nesting pairs have been documented in any given breeding season and nesting has only occasionally been successful (M. Gibbons, personal communication). Still, the presence of this species, like that of the hairy-necked tiger beetle (below), indicates a reasonably intact beach with little human disturbance.

Figure 14. Common terns (*Sterna hirundo*) off the shore of Plum Island, New York. Photograph by Annette DeGiovine Oliveira and Sally Newbert.

Waterfowl and shorebirds. In addition to hosting breeding populations of Canada Goose, American Black Duck, and Mallard, Plum Island apparently has breeding Common Eider, which if confirmed would constitute only the second breeding record for New York State, after nearby Fisher's Island (McGowan and Corwin 2008). The island and its surrounding waters also provide habitat for many species of wintering waterfowl (Appendix B). American Oystercatcher, a New York State SGCN, has been reported breeding on Plum Island somewhat erratically, with numbers of pairs reported ranging from 0 to 5 since 1985.

Raptors. Plum Island once contained one of the largest colonies, if not the largest colony, of breeding Osprey on the eastern seaboard. Allen (1892) reported nests numbering in the hundreds as of 1879, but extensive clearing in the late 1800s dramatically reduced the number of nests (Allen 1892, Latham 1959, Spitzer and Poole 1980), with most Osprey moving to nearby

Gardiners Island. The population at Gardiners Island subsequently declined from over 300 nests in 1940 to 38 nests in 1970, resulting from increasing use of DDT and other pesticides over that time period (Spitzer and Poole 1980). The NYSDEC began regular monitoring of Osprey nests on Long Island in 1976 and have continued with varying coverage for 35 years (Table 4; Figure 15). On Plum Island, as on Gardiners, numbers of active nests and young produced rose in the 1980s before declining again in the mid-1990s (Figure 15), despite an overall increasing trend statewide (McGowan and Corwin 2008). A decline in important prey fish, namely menhaden and winter flounder, is suspected (P. Spitzer, personal communication; C. Safina, personal communication) The Osprey is currently listed as a state species of Special Concern, and Plum Island continues to provide reliable nesting habitat for this charismatic bird. Bald Eagles, state listed as Threatened, have been sighted on the island on several occasions and in several seasons (White and White 1981, ML Lamont, unpublished).

Table 4. Osprey monitoring results from Plum Island and nearby Fishers Island, Gardiners Island, and Orient (North Fork of Long Island). Nest and young numbers are averages from 1976-2010. Data courtesy of NYSDEC and The Nature Conservancy.

	Fishers	Gardiners	Orient	Plum
Number of active nests	6.17	41.29	18.72	10.39
Percent of active nests successful	68.0%	54.3%	64.2%	59.7%
Number of years of nest data	29	34	29	33
Number of years with productivity data	28	32	28	29
Number of young per active nest	1.25	0.85	1.21	1.10

Plum Island has had nesting Northern Harrier, state listed as Threatened, as recently as 2004 (New York Natural Heritage Program 2011), in grassy openings in the southern and north-central portions of the island. They have not since been documented nesting to our knowledge, although they are regularly seen in small numbers in most months of the year.

USDA biologists detected Barn Owls near the "parade grounds"—the area of grassland near Fort Terry in about the center of the island (K. Preusser, USDA, personal communication). Barn Owls are known to breed in only 14 locations statewide (McGowan and Corwin 2008, New York Natural Heritage Program 2011), which makes this finding significant. No Barn Owls (or any owls, for that matter) have been documented in Audubon New York's surveys, owing to the lack of access for nocturnal surveys. Abandoned buildings and bunkers may provide good nesting habitat for Barn Owls, although it is possible that the species has disappeared from the island, mirroring the statewide decline (McGowan and Corwin 2008). Adding nesting platforms in the bunkers may improve habitat for Barn Owl, Eastern Phoebe, and possibly Black Vulture, which are increasing in the state. Northern Saw-whet Owls were also reported by USDA biologists.

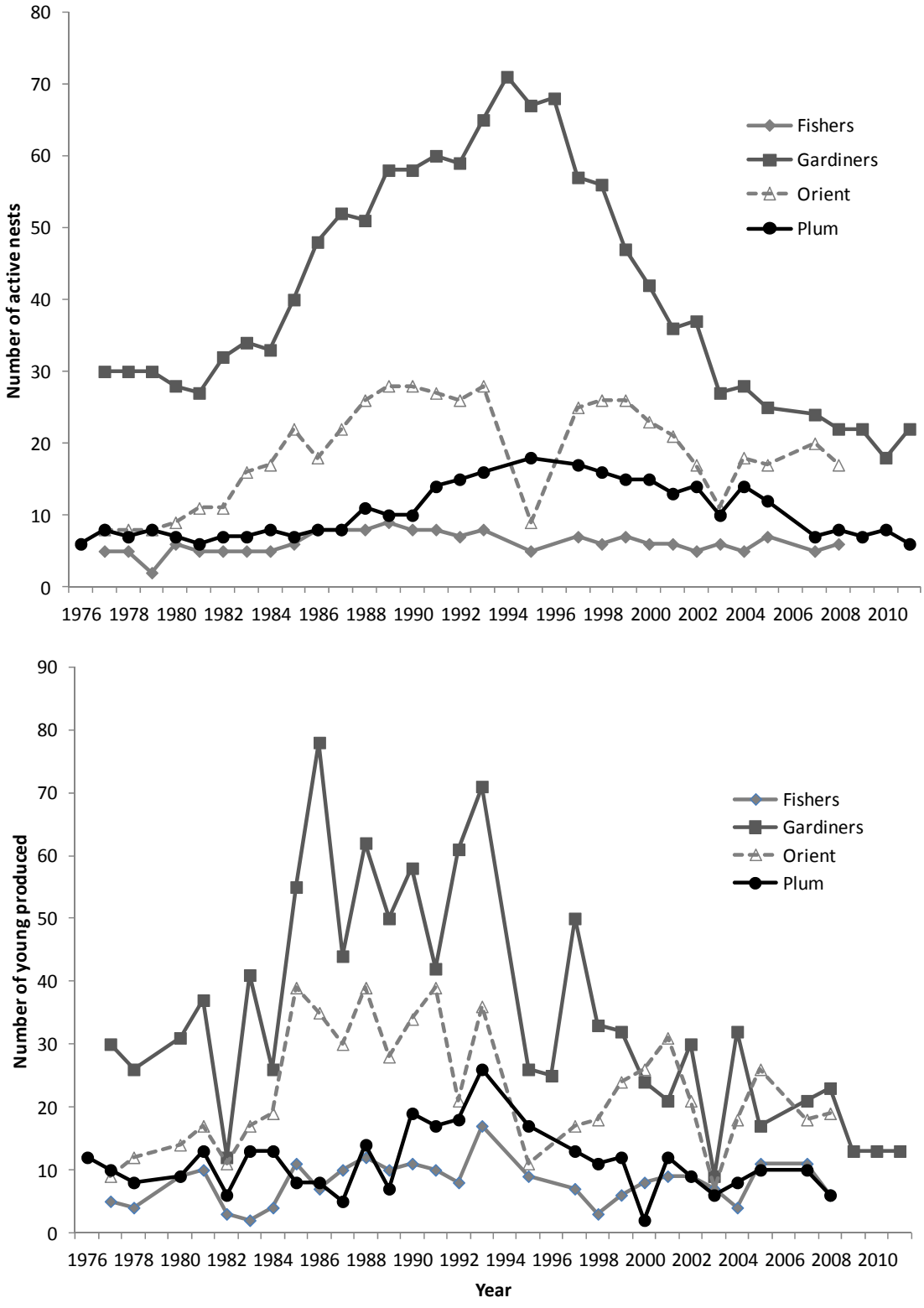

Figure 15. Numbers of active nests (top) and young produced (bottom) of Osprey on Plum Island and nearby Fishers Island, Gardiners Island, and Orient on the North Fork of mainland Long Island. Data courtesy of NYSDEC and The Nature Conservancy.

Passerines. The island contains an active nesting colony of Bank Swallow, a species on the decline in New York (McGowan and Corwin 2008). As many as 287 individuals have been counted in the summer. In addition, Tree Swallows visit the island in huge numbers in late summer, with 5,735 individuals estimated on one September survey.

The significance of Plum Island's position within the Atlantic Flyway and its potential value a stopover after an ocean crossing for passerines need further exploration. Winergy (now Deepwater Wind) conducted radar surveys in spring and fall of 2008 but the raw data remain unanalyzed. Audubon New York has documented thousands of passerines on the island in spring and fall (for example, 69 Yellow Warblers on a single survey in May, 136 Yellow-rumped Warblers and 153 White-throated Sparrows on single surveys in October, 193 Dark-eyed Juncos and 700 American Robins on single surveys in November), an indicator of the island's value to migrating songbirds. Nineteen species of warblers have been documented to date. However, additional survey effort is needed, especially surveys timed with storm fronts, to describe adequately the abundance and richness of migrants using the island.

Reptiles and amphibians

Very little herpetological survey has been conducted on Plum Island, so here we document the known fauna and the potential based on records from the surrounding islands and mainland. Scientific names are given in the tables.

Reptiles. Several species of turtles and one snake constitute the known reptilian fauna of the island. White and White (1981) reported "a few garter snakes and numerous box and spotted turtles," in 1995 a NYSDEC biologist reported painted and snapping turtles from the sewage treatment pond (NYSDEC 2009), and the same species were reported in the 2000s (ML. Lamont, J. Sepenoski, unpublished). A 2010 survey (T. Green, unpublished) found signs of painted and box turtles. In 2011 a garter snake was reported. The 2008 final environmental impact statement for upgrades to the facility (U.S. Department of Homeland Security 2008a) noted that diamondback terrapins were "common" on the island, but we have found no other documentation of this.

The island has potential for many additional species of reptiles. The NYSDEC amphibian and reptile atlas database (NYSDEC 2009) records species by a grid of 7.5-minute topographic quadrangle ("quad") maps. The eight topographic quads surrounding Plum Island (Gardiner's Island East, Gardiner's Island West, Greenport, Montauk Point, Mystic [Connecticut], New London [Connecticut], Orient, and Plum Island)—a radius of approximately 15 to 25 km—include Great and Little Gull islands, Shelter Island, Gardiner's Island, Fisher's Island, and mainland locations including Orient Point and Montauk. A query of these quads yielded nine recorded species of snakes, nine species of terrestrial and freshwater turtles, and five species of sea turtles (Table 5), which must inform the potential fauna of Plum Island.

The occurrence of several of these species would be significant. The eastern mud turtle, for example, is the rarest turtle in New York, known from only a handful of locations on Long Island , including nearby Robins Island (New York Natural Heritage Program 2011). Habitat for mud turtles includes freshwater and brackish wetlands, the latter of which are used particularly on Long Island (Gibbs et al. 2007). It is unknown if the wetlands on Plum Island are suitable for these turtles, and the species' ability to disperse to Plum Island from Long Island following Plum Island's isolation is unknown (see below under Amphibians). Spotted turtle is another SGCN that could occur in the freshwater wetlands on the island. Wood turtle, another SGCN, is less likely given its typical stream habitat (Gibbs et al. 2007). Eastern hognose snake, another SGCN and state species of Special Concern, which occurs on sandy soils on Long Island (Gibbs et al. 2007), is a possibility; however, its chief prey, toads (Gibbs et al. 2007), have not been documented on the island to date.

Table 5. Snakes and turtles with potential for occurring on Plum Island, New York, or in the nearby waters, based on their occurrence in the seven USGS topographic quads surrounding the island (NYSDEC 2009). Those already reported from Plum Island are noted.

Common name	Scientific name	S-rank	Reported from Plum Island
Snakes			
Common gartersnake	*Thamnophis sirtalis*	S5	Y
Eastern hognose snake	*Heterodon platirhinos*	S3‡	
Eastern milksnake	*Lampropeltis t. triangulum*	S5	
Eastern ribbonsnake	*Thamnophis s. sauritus*	S4‡	
Northern black racer	*Coluber c. constrictor*	S4‡	
Northern brownsnake	*Storeria d. dekayi*	S5	
Northern ringneck snake	*Diadophis punctatus edwardsii*	S5	
Northern watersnake	*Nerodia s. sipedon*	S5	
Smooth greensnake	*Liochlorophis vernalis*	S4‡	
Turtles			
Common musk turtle	*Sternotherus odoratus*	S5	
Common snapping turtle	*Chelydra s. serpentine*	S5	Y
Eastern box turtle	*Terrapene c. carolina*	S3‡	Y
Eastern mud turtle	*Kinosternon s. subrubrum*	S1‡	
Eastern painted turtle	*Chrysemys p. picta*	S5	Y
Northern diamondback terrapin	*Malaclemys t. terrapin*	S3‡	Y
Red-eared slider	*Trachemys scripta elegans*	SNA	
Spotted turtle	*Clemmys guttata*	S3‡	Y
Wood turtle	*Glyptemys insculpta*	S3‡	
Atlantic hawksbill	*Eretmochelys i. imbricate*	SNA‡	
Atlantic ridley	*Lepidochelys kempii*	S1N‡	
Green turtle	*Chelonia mydas*	S1N‡	
Leatherback	*Dermochelys coriacea*	S1N ‡	
Loggerhead	*Caretta caretta*	S1N‡	

‡Species of Greatest Conservation Need

Five species of sea turtles, all federally listed, have potential to be found in the waters surrounding Plum Island (Table 5) (Morreale et al. 1992, NYSDEC 2009), but no information is available indicating their use of waters immediately adjacent to Plum Island. One of the only studies on sea turtle movements in the area (Morreale and Standora 1993) documented turtles around Orient Point but not Plum Island, although it is unclear whether the researchers had access to the island. Sea turtles frequent eelgrass meadows (also known as "seagrass beds"), where they forage primarily on crabs (Burke et al. 1993). A field assessment is needed to determine whether the eelgrass meadow in Plum Gut Harbor (Figure 3; Figure 6) could provide the prey density and low human disturbance (Hazel et al. 2007) that would constitute suitable habitat for sea turtles. It is worth noting that with a warming climate we can expect greater numbers of sea turtles moving northward (Hawkes et al. 2009) into Long Island's waters.

Amphibians. In 1964 the naturalist Roy Latham reported the green frog as "common" (NYSDEC 2009); that sighting constitutes the only amphibian documented on the island to date. Nearby islands and the mainland support or have supported 10 species of frogs and eight species of

salamanders (Table 6). Some species, if detected on Plum Island, would be especially noteworthy, but it is unknown if Plum Island's wetlands and ponds are suitable for these species. Leopard frogs have apparently disappeared from Long Island, and Long Island's leopards are now believed to have belonged to a newly described (and as yet unnamed) species that appears to be of significant conservation concern (Newman et al. 2012). A leopard frog was collected on Gardiners Island and noted as "common" by Roy Latham in 1922 (NYSDEC 2009). Northern cricket frogs have likewise been extirpated from Long Island for unknown reasons. They were known historically from the town of Southold (New York Natural Heritage Program 2011). The eastern spadefoot is a cryptic toad of sandy substrates that is known from a handful of localities on Long Island, including nearby Southampton, East Hampton, and Shelter Island (NYSDEC 2009). Finally, the eastern tiger salamander, which is state-listed as Endangered, occurs in coastal plain ponds. It was documented as close as Shelter Island by Roy Latham in 1944 (NYSDEC 2009). It has declined from destruction of breeding habitat and forest fragmentation.

The glacial history of the region might offer clues as to whether some of these Long Island amphibian and reptile rarities might occur on Plum Island. It is useful to remind ourselves that herpetofauna were extirpated from glaciated regions during the Pleistocene, and thus the modern herpetofauna consists solely of what has established or recolonized in the last 10-12,000 years. Plum Island itself was not isolated from the mainland until approximately 6,000 ybp and many of the more southern species like tiger salamander and eastern spadefoot toad had not yet arrived in the region (C. Raithel, personal communication). Still, animals do disperse across unsuitable terrain, with and without the help of humans, so the presence of these rarities cannot be ruled out.

The low diversity of documented amphibians could also be a result of salinity in the freshwater marsh resulting from overwash during storms. The degree to which overwash affects freshwater salinity is undoubtedly site- and storm-specific. Many amphibians are known to be sensitive to increased salinity but studies have been equivocal in their documentation of this (see Gunzburger et al. 2010). On an island where chances for recolonization are slimmer, storm surges may have longer-lasting effects than have been documented in other locations.

Table 6. Frogs and salamanders reported from the seven USGS topographic quads surrounding Plum Island, New York. Only the green frog has been reported from Plum Island.

Common name	Scientific name	S-rank
Frogs		
Bullfrog	*Rana catesbeiana*	S5
Eastern spadefoot	*Scaphiopus holbrookii*	S2S3‡
Fowler's toad	*Bufo fowleri*	S4‡
Gray treefrog	*Hyla versicolor*	S5
Green frog	*Rana clamitans*	S5
Leopard frog	*Rana* sp. nov.	*
Northern cricket frog	*Acris crepitans*	S1‡
Northern spring peeper	*Pseudacris crucifer*	S5
Pickerel frog	*Rana palustris*	S5
Wood frog	*Rana sylvatica*	S5
Salamanders		
Blue-spotted salamander	*Ambystoma laterale*	S4‡
Eastern tiger salamander	*Ambystoma tigrinum*	S1S2‡
Four-toed salamander	*Hemidactylium scutatum*	S5‡
Jefferson salamander	*Ambystoma jeffersonianum*	S4‡
Marbled salamander	*Ambystoma opacum*	S3‡
Northern redback salamander	*Plethodon cinereus*	S5
Red-spotted newt	*Notophthalmus viridescens*	S5
Spotted salamander	*Ambystoma maculatum*	S5

‡Species of Greatest Conservation Need
*Long Island's leopard frogs are now considered a new species (Newman et al. 2012). *Rana sphenocephala*, the species formerly assigned to Long Island's leopard frogs, is an SGCN ranked S1S2.

Fish

Marine fish. No systematic survey of the waters surrounding Plum Island has been conducted to our knowledge, so we draw on data from the surrounding region to inform the likely fish fauna of Plum Island.

Plum Island sits in a highly productive marine environment, as evidenced by the diversity of species of fish and invertebrates recorded in nearby estuaries. Stone et al. (1994; see also http://ccma.nos.noaa.gov/ecosystems/estuaries/elmr.aspx) reported on fish and invertebrates collected in Mid-Atlantic estuaries from the late 1980s and 1990s. Three sample sites near Plum Island —Long Island Sound, Gardiners Bay, and the Connecticut River (Figure 1)—had among the highest species richness of adult fish and invertebrates of the 16 sites sampled, in all salinity zones (Figure 16). The same pattern held true for other life stages (Stone et al. 1994).

Nine years of surveys in Peconic Bay to the southwest of Plum Island, between the two "forks" of Long Island (Figure 1) yielded 74 species of marine fish in 41 families, with six species—bay anchovy, winter flounder, weakfish, windowpane, Atlantic silverside, and scup—comprising most of the individuals caught (Weber et al. 1998).

Notable species found in these surveys include shortnose sturgeon (*Acipenser brevirostrum*), federally and state listed as Endangered, and Atlantic sturgeon (*Acipenser oxyrinchus*), federally listed as Endangered. In addition, 26 species in the surrounding bays and estuaries are considered SGCN (New York State Department of Environmental Conservation 2005) (Table 7).

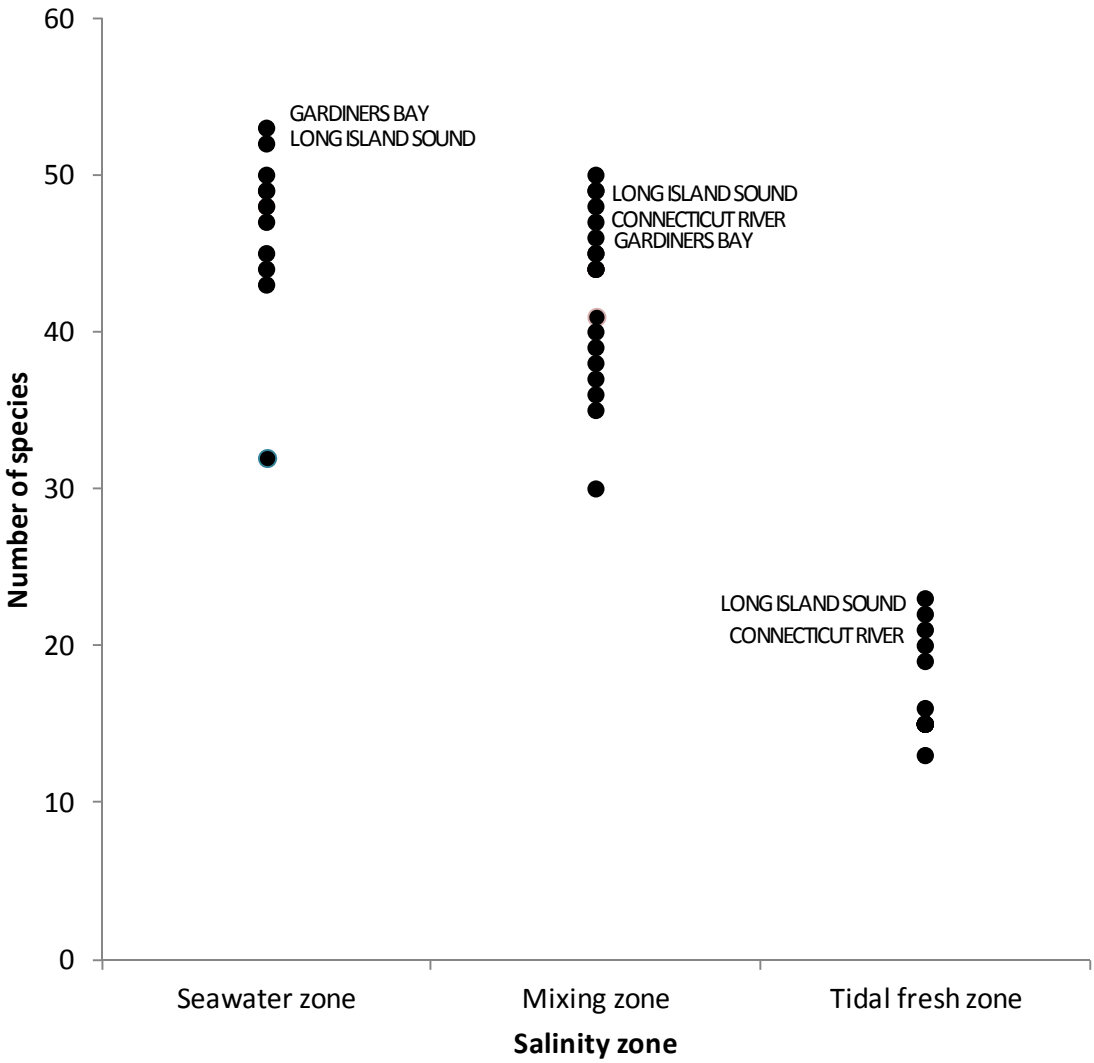

Figure 16. Numbers of species of adult fishes and invertebrates detected in Mid-Atlantic estuaries, 1985-2000. Three sample sites surrounding Plum Island, New York are labeled. Data are from http://ccma.nos.noaa.gov/ecosystems/estuaries/elmr_metadata_feb2011.txt and Stone et al. (1994).

Table 7. Marine fish documented from Long Island Sound, Gardiners Bay, Peconic Bay, and the Connecticut River estuary in the 1980s and 1990s that are considered Species of Greatest Conservation Need. S-ranks do not reflect the current state of knowledge for this group and are therefore not reported.

Common name	Scientific name
Alewife	*Alosa pseudoharengus*
American eel	*Anguilla rostrata*
American shad	*Alosa sapidissima*
Atlantic salmon	*Salmo salar*
Atlantic silverside	*Menidia menidia*
Atlantic tomcod	*Microgadus tomcod*
Barndoor skate	*Dipturus laevis*

Common name	Scientific name
Bay anchovy	*Anchoa mitchilli*
Blueback herring	*Alosa aestivalis*
Clearnose skate	*Raja eglanteria*
Common pipefish	*Syngnathus fuscus*
Cownose ray	*Rhinoptera bonasus*
Cunner	*Tautogolabrus adspersus*
Fourspine stickleback	*Apeltes quadricus*

Common name	Scientific name
Lined seahorse	*Hippocampus erectus*
Little skate	*Leucoraja erinacea*
Menhaden	*Brevoortia tyrannus*
Northern puffer	*Sphoeroides maculatus*
Oyster toadfish	*Opsanus tau*
Rainbow smelt	*Osmerus mordax*
Roughtail stingray	*Dasyatis centroura*
Sandbar shark	*Carcharhinus plumbeus*

Common name	Scientific name
Tautog	*Tautoga onitis*
Threespine stickleback	*Gasterosteus aculeatus*
Winter flounder	*Pseudopleuronectes americanus*
Winter skate	*Leucoraja ocellata*

Freshwater fish. No surveys of Plum Island's freshwater fish fauna have been conducted to our knowledge, nor are data on freshwater fish available for nearby islands and the mainland. Without more information on the microhabitats and water quality in the emergent marsh, it is difficult to predict what freshwater fish species might occur there. Seventy-nine species have been detected in NYSDEC's freshwater and estuarine surveys throughout Long Island (NYSDEC 2012).

Invertebrates

The insect fauna of Plum Island is poorly known. Here we highlight known and potential species from some major groups—Odonata (dragonflies and damselflies), Lepidoptera (butterflies and moths), and Coleoptera (beetles). Little is known about other groups.

Dragonflies and damselflies. No historical records of odonates have been located for Plum Island (N. Donnelly, personal communication), and no surveys were conducted there for the recent five-year atlas of New York's dragonflies and damselflies (White et al. 2010). An August, 2005 visit (ML. Lamont, unpublished) produced five species (Table 8), including one (seaside dragonlet) that is rare in the state, but clearly the odonate fauna is undersampled. Suffolk County, with its mix of coastal marine and freshwater ecosystems, is one of the richest in species in the state, with 96 species documented through 2009 (White et al. 2010). Plum Island has the potential for several rare species that are known from nearby islands or the mainland (Table 9).

Table 8. Dragonflies and damselflies recorded from Plum Island, New York in 2005. Courtesy of ML. Lamont.

Common name	Scientific name	S-rank
Northern bluet	*Enallagma annexum*	S4
Seaside dragonlet	*Erythrodiplax berenice*	S2
Black saddlebags	*Tramea lacerata*	S5
Blue corporal	*Ladona deplanata*	S4
Common whitetail	*Plathemis lydia*	S5

Table 9. Rare dragonflies and damselflies with the potential to occur on Plum Island, New York.

Common name	Scientific name	S-rank	State listing
Atlantic Bluet	*Enallagma doubledayi*	S1S2	
Banded Pennant	*Celithemis fasciata*	S3	
Bar-winged Skimmer	*Libellula axilena*	SNA	
Blackwater Bluet	*Enallagma weewa*	S1	

Common name	Scientific name	S-rank	State listing
Blue Corporal	*Ladona deplanata*	S4	
Citrine Forktail	*Ischnura hastata*	S3	
Comet Darner	*Anax longipes*	S2S3	
Common Sanddragon	*Progomphus obscurus*	S1	SC
Double-ringed Pennant	*Celithemis verna*	S1	
Four-spotted Pennant	*Brachymesia gravida*	S1	
Golden-winged Skimmer	*Libellula auripennis*	S1	
Great Spreadwing	*Archilestes grandis*	SNA	
Lilypad Forktail	*Ischnura kellicotti*	S3	
Little Bluet	*Enallagma minusculum*	S1	T
Mantled Baskettail	*Epitheca semiaquea*	S2	
Martha's Pennant	*Celithemis martha*	S2	
Mottled Darner	*Aeshna clepsydra*	S4	
Needham's Skimmer	*Libellula needhami*	S3	
New England Bluet	*Enallagma laterale*	S3	
Petite Emerald	*Dorocordulia lepida*	S3	
Pine Barrens Bluet	*Enallagma recurvatum*	S1	T
Rambur's Forktail	*Ischnura ramburii*	S2S3	
Scarlet Bluet	*Enallagma pictum*	S2	T
Southern Sprite	*Nehalennia integricollis*	S1	SC
Yellow-sided Skimmer	*Libellula flavida*	S1	

Beetles. In 2009, as part of a statewide status assessment of rare tiger beetles, New York Natural Heritage Program contractor Jonathan Mawdsley surveyed the beach of Plum Island from Fort Terry to Plum Gut Harbor for rare beach tiger beetles. He did not detect the beach-dwelling northeastern beach tiger beetle (*Cicndela dorsalis dorsalis*), which is federally listed as Threatened. However, the largest population documented in New York to date of the hairy-necked tiger beetle (*Cicindela hirticollis*) was confirmed. An historical record was based on a 1949 specimen housed at the American Museum of Natural History. The presence of the hairy-necked tiger beetle indicates intact beach structure and little vehicle traffic on this stretch of beach—vehicles compact the beetle's larval burrows and crush larvae, and are considered responsible for the decline of this species elsewhere on Long Island (Schlesinger and Novak 2011).

Plum Island is a prime location for the potential discovery or reintroduction of the American burying beetle (*Nicrophorus americanus*), federally listed as Endangered. This species is known historically from the town of Southold, at least as close as Orient, and from Montauk Point (New York Natural Heritage Program 2011)—the two closest points on mainland Long Island. Further, the only known extant population in the eastern U.S. occurs on Block Island, Rhode Island, 46 kilometers away. On Block Island, the American burying beetle occurs in "a post-agricultural maritime scrub plant community" (Raithel 1991), which could easily describe some of Plum Island's natural communities. Further, Plum Island's low abundance of mid-level predators and scavengers suggests that burying beetles would experience lower competition for carrion there, a situation which facilitates their persistence on Block Island (Raithel 2002, Sikes and Raithel 2002). No surveys for American burying beetle have been conducted to our knowledge on Plum Island, nor are any mentioned in the 5-year review of the species' status (U.S. Fish and Wildlife Service 2008).

Butterflies and moths. Our knowledge of the leptidopteran fauna of the island is limited to observations of nine butterfly species from August 2005 (ML. Lamont, unpublished; Table 10). Undoubtedly the potential exists for many more butterflies. We have not located any records of moths for the island; however, based on the island's geographic setting, known natural communities (Figure 3), and known flora (Lamont et al. unpublished), we estimate that the island has the potential for 43 species of moths listed by the New York Natural Heritage Program as rare (Table 11). Our list contains NYNHP-listed species most likely to occur on the island, but there are potentially a dozen other species in each category that might occur on the island should the host plants be found, including several species of *Papaipema*. The habitats most likely to contain rare species are the dune backs, especially in fresh-water swales, and freshwater wetlands. We have listed the host plants of the species we have identified as potentially occurring on Plum Island in Table 11.

Finally there are several species of moths that may occur on the Plum Island that are not currently recognized as rare but appear to meet the criteria for rarity, including *Episemasia solitaria*, *Tacparia zalissaria*, *Paonias astylus*, *Neoligia semicana*, *Meropleon ambifusca*, *Meropleon diversicolor*, *Amolita roseola*, and *Epiglaea apiata*. And several species of "micro" moths in the families Pyralidae and Tortricidae that are either rare or have limited ranges are likely to occur on the island, including *Phaneta clavana*, *Phaneta annetteana*. *Eucosma lathami*, *Crambus satrapellus*, *Haimbachia albescens*, *Pima albiplagiatella* and *Peoria bipartitella*. Several of these are particularly interesting because they have disjunct ranges, occurring in the Great Plains and along the eastern seaboard (Metzler et al. 2005).

Table 10. Butterflies recorded from Plum Island, New York in 2005. Courtesy of ML. Lamont.

Common name	Scientific name	S-rank
Cabbage butterfly	*Pieris rapae*	SNA
Orange sulphur	*Colias eurytheme*	S5
Eastern tailed blue	*Everes comyntas*	S5
Painted lady	*Vanessa cardui*	S5
Red admiral	*Vanessa atalanta*	S5
Monarch	*Danaus plexippus*	S5
Silver-spotted skipper	*Epargyreus clarus*	S5
European skipper	*Thymelicus lineola*	SNA
Hobomok skipper	*Poanes hobomok*	S5

Table 11. Moth species designated as rare by the New York Natural Heritage Program with the potential to occur on Plum Island, New York.

Species	S-rank	Host plant
Abagrotis nefascia	S1S3	*Amelanchier*
Acronicta albarufa	S1	*Quercus*
Agrotis stigmosa	SU	*Achillea millefolium*
Apamea burgessi	SU	Unknown; grasslands
Apamea inordinate	S1	Unknown; grasslands
Apamea lintneri	SU	*Arenaria*
Cisthene packardii	SU	Lichens
Citheronia regalis	S1	*Sumac*, *Prunus*
Dargida rubripennis	SU	*Panicum virgatum*
Derrima stellata	SNA	Unknown

Species	S-rank	Host plant
Dichagyris acclivis	S2S3	*Panicum virgatum*
Doryodes grandipennis	SU	*Spartina patens*
Drasteria graphica	SU	*Hudsonia*
Euchlaena madusaria	S1	*Vaccinium*
Eucoptocnemis fimbriaris	S1	Unknown
Eumacaria madopata	S2S4	*Prunus*
Euxoa pleuritica	S2S3	Unknown
Euxoa violaris	SU	Unknown; sandy areas
Fagitana littera	S2S3	*Thylypterus palustris*
Feltia manifesta	SU	Unknown; sandy areas
Hypomecis umbrosaria	SU	*Quercus*
Ilecta intractata	SNA	Unknown
Lagoa crispate	SU	Many woody plants
Leucania extinct	SNA	Unknown: wetland grasses
Marimatha nigrofimbria	SH	*Digitaria sanguinalis*
Metalectra richardsi	SU	Unknown; presumably fungus
Metaxaglaea semitaria	SU	*Vaccinium*
Mocis texana	SU	Grasses
Oligia bridghami	SU	Unknown
Parasa chloris	SU	Many woody plants, especially *Quercus*
Parasa indetermina	SH	Many woody plants
Psaphida thaxteriana	SH	*Quercus*
Renia nemoralis	SU	Unknown; presumably dead leaves
Schinia spinosae	SU	*Aster novae-angliae*
Schinia tuburculum	S2	*Pityopsis falcate*
Schizura apicalis	SU	*Vaccinium*, *Populus*, *Quercus ilicifolia*, *Viburnum*
Sericaglaea signata	SH	*Prunus*, *Quercus*
Sideridis maryx	S2S3	Unknown
Sphinx drupiferarum	SU	*Prunus*
Sphinx gordius	S1S3	*Vaccinium*, *Gaylusaccia*, *Comptonia*
Sympistis perscripta	S1	*Linaria canadensis*
Sympistis riparia	SU	Unknown; sandy areas
Virbia aurantiaca	SU	Various forbs

Other insects. White and White (1981) sampled Plum Island for insects known to act as vectors for disease. They detected 22 species of Culicidae (mosquitoes), including species known to breed in woodland pools, salt marshes, freshwater swamps, tree holes, and rock holes, some of which they conclude must have blown in from breeding locations in Orient Point or Gardiner's Island. They also detected the dipteran families Ceratopogonidae (biting midges), Tabanidae (horse and deer flies), Muscidae (house flies and kin), Sarcophagidae (flesh flies), Calliphoridae (blow flies), Cuterebridae (bot flies), as well as the orders Mallophaga (chewing lice), Siphonaptera (fleas), and Acarina (mites). For none of these groups have the commonness or rarity of individual species been studied sufficiently to warrant tracking by NY Natural Heritage.

Marine invertebrates. Nothing is known about Plum Island's marine invertebrates. The marine rocky intertidal community is rare in New York (10 mapped occurrences) and has a distinct suite of associated invertebrates; the community on Plum Island has not been inventoried. Seven

invertebrate SGCN have been documented in surrounding waters (Stone et al. 1994, Weber et al. 1998): American lobster (*Homarus americanus*), bay scallop (*Argopecten irradians*), blue crab (*Callinectes sapidus*), blue mussel (*Mytilus edulis*), hard clam (*Mercenaria mercenaria*), horseshoe crab (*Limulus polyphemus*) and oyster (*Crassostrea virginica*). Of particular interest is whether Plum Island provides habitat for spawning horseshoe crab, an important prey item for sea turtles and migrating shorebirds (Karpanty et al. 2006).

Plants

History of plant collection

Vascular plants. The first botanist to record plants from Plum Island was Charles B. Graves, a noted botanist from Connecticut. He reported the state rare Scotch lovage (*Ligusticum scothicum*) from the north shore of the island in 1895 (Graves 1896). In 1915 Norman Taylor, curator of plants at the Brooklyn Botanic Garden, made plant collections on Plum Island, three of them state rare, and deposited them at Brooklyn but he never published the collections he made. Kaleb P. Jansson, a plant collector from Groton, Connecticut, collected 32 plants, three of them state rare, on Plum Island in 1932 and they are deposited at the Graves Herbarium at the University of Connecticut. From 1932 to 1984 there is no additional information on the flora of the island. Bob Zaremba, a botanist from the New York Natural Heritage Program, visited the island in 1984 and observed the rare creeping spikerush (*Eleocharis fallax*) in a dry pond near the wastewater treatment plant but no other plants were noted. In November of 1989 New York Natural Heritage Program botanist Peter Zika and botanist Jerry Jenkins visited the island to look for rare plants. While no rare plants were found they did compile a list of 66 plant species they observed during their daylong stay.

In 2002 Long Island botanists Eric Lamont and Richard Stalter (unpublished data) began a 7-year study of the flora of Plum Island. They collected 391 species within 246 genera and 89 families and along with historical records there is a total of approximately 420 species. Genera with the largest number of species collected were *Cyperus*, *Panicum*, and *Carex*. They noted that native species are still a major component of the natural vegetation.

Bryophytes. We could find no evidence of herbarium studies or recent collections of this group of plants on Plum Island. Roy Latham, a noted naturalist from Orient, published a list of bryophytes from the Town of Southold and Gardiners Island from 1914 through 1925 (Burnham and Latham 1914a, 1914b, 1917, 1921a, 1921b, 1923a, 1923b, 1924, 1925) and it would be expected that many of the species on Plum Island would be on that list.

Algae. The history of the collection of marine algae around Plum Island is unknown. There have been no herbarium studies or recent collections of this group of plants (L. Liddle, personal communication). About 20 years ago *Laminaria* and other large species were observed during a dive in Plum Gut.

Fungi. Though fungi are not plants, we treat them here. No studies or collections of the fungi of Plum Island exist (M. Horman, personal communication). Roy Latham, a noted naturalist from Orient, published a list of fungi from the Town of Southold and Gardiners Island from 1914 through 1925 (Burnham and Latham 1914a, 1914b, 1917, 1921a, 1921b, 1923a, 1923b, 1924, 1925) and it would be expected that many of the species on Plum Island would be on that list.

Plum Island flora

The plants of Plum Island can be considered part of the flora of the Atlantic coastal plain of New York. It is probably similar to the other vegetation in nearby Orient and Fishers Island but no scientific comparisons have been made. Since the island has been heavily disturbed in the last 300 years many new exotic plants have been introduced and a few of them have become invasive

monocultures in some parts of the island. For over 200 years the island was farmed and grazed and probably dominated by grassland species with few shrubs and trees. The wetlands on the southeast corner of the island and the gravelly knob on the northwest side of the island may have preserved larger woody plants where farming and grazing was not possible. The construction and operation of Fort Terry, beginning in 1898, completely changed the human management of the island and the vegetation probably started to change again as farming and grazing ceased and new installations were built. In 1918 the fort reverted to caretaker status and except for its use for five years as a base in World War II, there was far less disturbance. More woody plants probably began to grow into cleared areas although the parade ground grassland continued to be mowed at the old Fort Terry. After World War II the decommissioning of the fort and the construction of the USDA facility had some impact on the vegetation (purple loosestrife was introduced) but much of the island has been kept in a natural state since then.

Rare, protected, and otherwise noteworthy plants

Plum Island, with 16 recorded rare plant species (Table 12; Table 13), has one of the highest concentrations of rare plants in New York State, similar to the situation on Fishers Island, a short distance to the northeast (Fishers Island has the highest concentration in the state with 27 species). Both islands are part of the "outer lands" of the Ronkonkoma moraine islands east of Long Island and contain a variety of habitats that support rare plants that only occur on the coastal plain of New York. Other large tracts of natural area on Long Island, surrounded by development, often have a large number of rare plants as well. Fishers Island contains nine of the same rare plants as Plum Island and another adjacent natural area, Orient Beach State Park, contains five of the same rare species (New York Natural Heritage Program 2011). This demonstrates the similarity of the floras of these adjacent natural areas. Only two of the sixteen rare plants recorded from Plum Island occur inland of the coastal plain. Although there is a high number of rare species on Plum Island, the populations are small compared to other populations of these species. The one exception is spring ladies-tresses, a rare orchid with a large population on the island.

Conservation guides for all NYNYP-tracked rare plants recorded from Plum Island are available at http://guides.nynhp.org/ and included in a separate document as Appendix C.

Fourteen rare plants are extant, having been discovered since 1984 (Table 12; Figure 17). Six of these species have fewer than six populations in the state and are listed as endangered. Five species have fewer than 21 populations in the state and are listed as threatened. Three species have more than 20 but fewer than 50 populations in the state and are listed as rare.

Six rare plants are considered historical since they have not been found in the previous 30 years (Table 13; Figure 18). Three of the species (salt-marsh spikerush, mock bishop-weed, and Northern blazing star) were found in 1932, bushy rockrose in 1915, Atlantic white cedar sometime before 1915, and Scotch lovage in 1895. There is still habitat for five of the species and they still may yet be found. The stumps of Atlantic white cedar trees can still be seen in the northwest corner of the deep emergent marsh, but no live trees remain and we consider this species extirpated from the island. All rare species are on the state protected list with the ranks endangered, threatened, or rare.

Another category of protection, exploitably vulnerable, covers those native plants that are usually showy and likely to be picked or dug up although they are not rare in the state. They include ferns, orchids, shrubs, and other showy wildflowers. There are fifteen plant species in this category on the island (Table 14).

Two species, *Asclepias verticillata* (whorled milkweed) and *Lobelia spicata* (pale-spiked lobelia), although common in New York State, are rare on the coastal plain and were collected during the most recent surveys by Lamont and Stalter (E. Lamont, personal communication).

Table 12. Existing rare plants recorded from Plum Island, New York.

Common name	Scientific name	S-rank	State listing
Marsh Straw Sedge	*Carex hormathodes*	S2S3	T
Fernald's Sedge	*Carex merritt-fernaldii*	S2S3	T
Red-rooted Flatsedge	*Cyperus erythrorhizos*	S3	R
Great Plains Flatsedge	*Cyperus lupulinus* ssp. *lupulinus*	S1	T
Coast Flatsedge	*Cyperus polystachyos* var. *texensis*	S1S2	E
Retrorse Flatsedge	*Cyperus retrorsus* ssp. *retrorsus*	S1	E
Velvet Panic Grass	*Dichanthelium scoparium*	S1	E
Creeping Spikerush	*Eleocharis fallax*	S1	E
Large Fruited Fireweed	*Erechtites hieraciifolius* var. *megalocarpus*	S1	E
Oakes' Evening Primrose	*Oenothera oakesiana*	S2	T
Crossleaf Milkwort	*Polygala cruciata* var. *aquilonia*	S3?	R
Seabeach Knotweed	*Polygonum glaucum*	S3	R
Wild Pink	*Silene caroliniana* ssp. *pensylvanica*	S2	T
Spring Ladies-tresses	*Spiranthes vernalis*	S1	E

Table 13. Historical rare plants recorded from Plum Island, New York.

Common name	Scientific name	S-rank	State listing
Atlantic White Cedar	*Chamaecyparis thyoides*	S2	T
Bushy Rockrose	*Crocanthemum dumosum*	S1	E
Salt-marsh Spikerush	*Eleocharis uniglumis* var. *halophila*	S2	T
Northern Blazing-star	*Liatris scariosa* var. *novae-angliae*	S2	T
Scotch Lovage	*Ligusticum scothicum* ssp. *scothicum*	S1	E
Mock Bishop-weed	*Ptilimnium capillaceum*	S3	R

Table 14. Protected Exploitably Vulnerable plants recorded from Plum Island, New York.

Common name	Scientific name	S-rank	State listing
Cutleaf Grape-fern	*Botrychium dissectum*	S5	V
Spotted Wintergreen	*Chimaphila maculata*	S4	V
Fan Club-moss	*Diphasiastrum digitatum*	S5	V
Spoon-leaved Sundew	*Drosera intermedia*	S4	V
Evergreen Woodfern	*Dryopteris intermedia*	S5	V
Common Winterberry	*Ilex verticillatus*	S5	V
Turk's-cap Lily	*Lilium superbum*	S4	V
Northern Bayberry	*Morella caroliniensis*	S4	V
Cinnamon Fern	*Osmunda cinnamomea*	S5	V
Royal Fern	*Osmunda regalis*	S5	V
Green-fringed Orchis	*Platanthera lacera*	S4	V
Swamp Azalea	*Rhododendron viscosum*	S5	V
Nodding Ladies-tresses	*Spiranthes cernua*	S4	V
New York Fern	*Thelypteris noveborascensis*	S5	V
Marsh Fern	*Thelypteris palustris*	S5	V

Invasive plants

Invasive exotic plants were not recorded on the island until 1989 when Zika and Jenkins recorded European common reed (*Phragmites australis*), black locust (*Robinia pseudo-acacia*), and multiflora rose (*Rosa multiflora*). Since little vegetation work had been done in the decades preceding their visit it isn't known when or how these invasives were introduced. The flora work of Lamont and Stalter found Asian bittersweet (*Celastrus orbiculatus*), Japanese honeysuckle (*Lonicera japonica*), bush honeysuckle (*Lonicera morrowii*), purple loosestrife (*Lythrum salicaria*), cottonwood (*Populus deltoides*), privet (*Ligustrum vulgare*), and autumn olive (*Eleagnus umbellatus*). The Asian bittersweet and Japanese honeysuckle are smothering large areas of native vegetation. The purple loosestrife was introduced during the construction of the sewage treatment ponds and is invading adjacent natural wetlands. The cottonwood and European common reed are becoming common also. The remaining species are infrequent so they could be eliminated while they are at low levels. But, compared to the plants that were available to succeed human and natural disturbance in the 1800s and early 1900s, many more exotic invasive species are now growing in New England and Long Island that have an opportunity to colonize these disturbances on the island. Most of the invasive plants have probably been on the island for some time since they have become well established and will take much effort to remove. Many of the human activities such as road and trail building, military and laboratory installations and the constant traffic of humans to and from Long Island provide adequate pathways and vectors for invasive species to become and remain established.

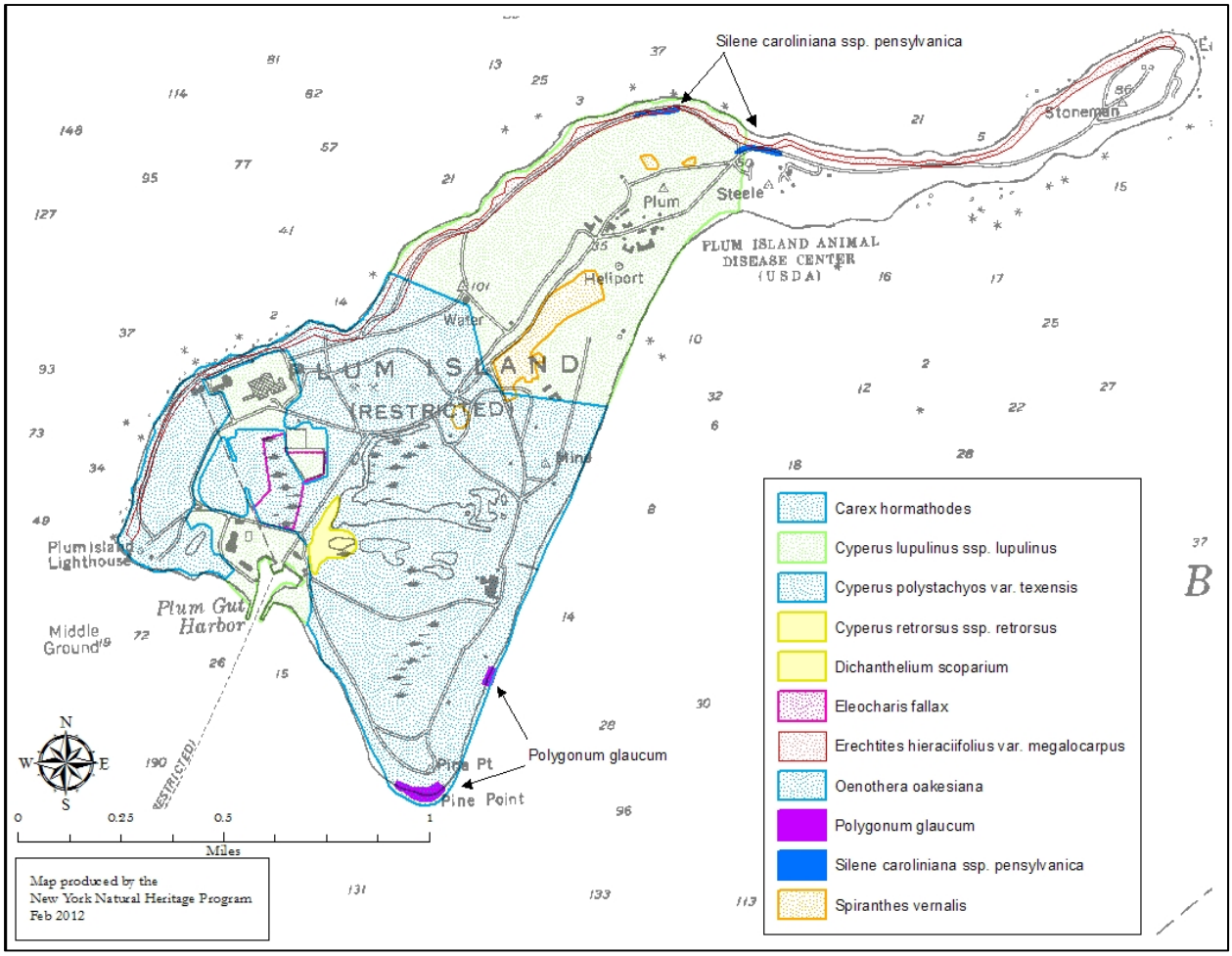

Figure 17. Extant rare plant occurrences on Plum Island, New York. The exact location of *Carex merritt-fernaldii* is uncertain; thus, it is mapped to the whole island and not depicted here. *Cyperus erythrorhizos* and *Polygala cruciata* var. *aquilonia* are not mapped, as their conservation status does not merit full tracking by NY Natural Heritage.

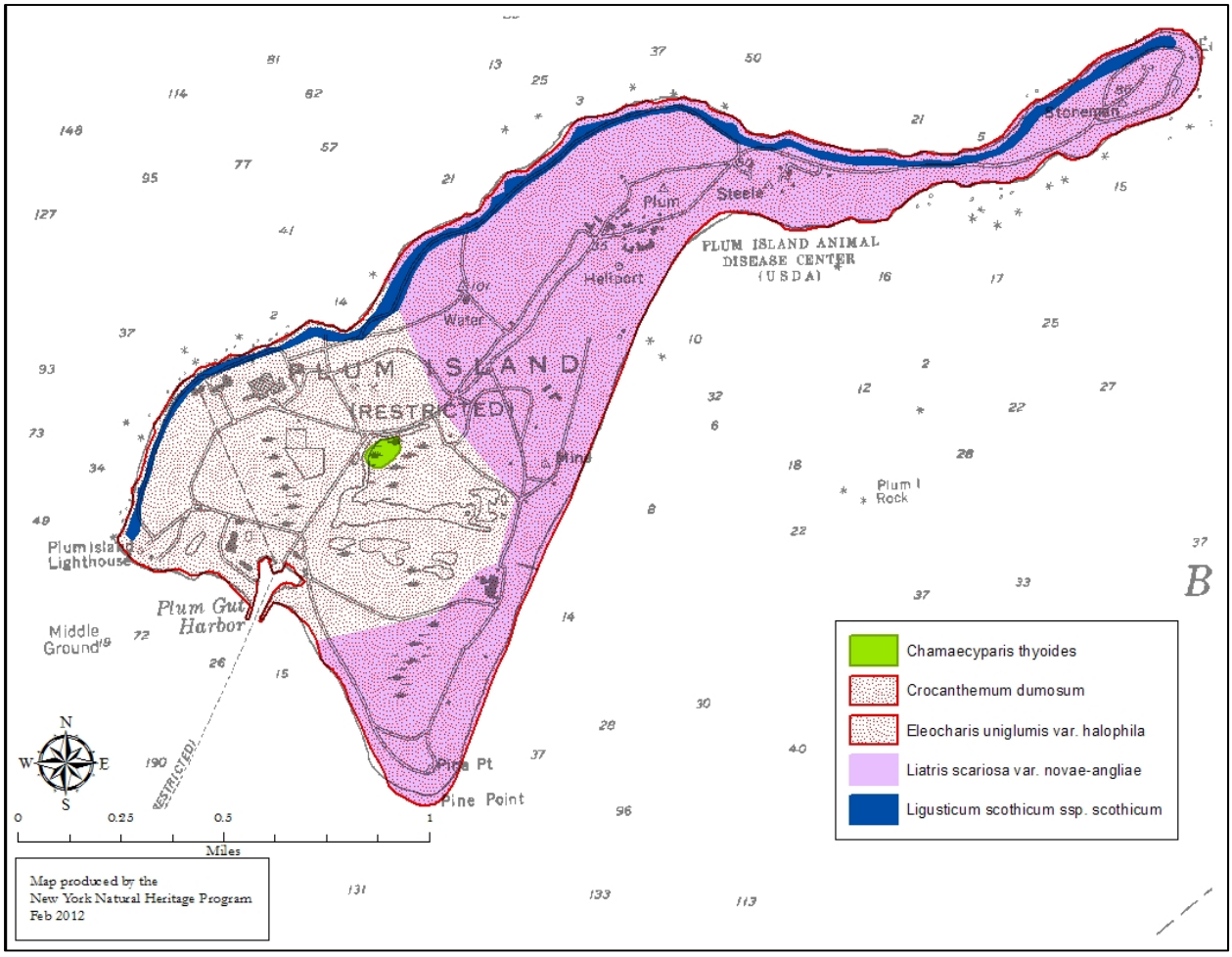

Figure 18. Historical rare plant occurrences on Plum Island, New York.

Management and restoration

Threats to Plum Island's native biodiversity include invasive species, the potential for residential development, climate change, and on- and offshore energy development such as wind and underwater turbines. A full treatment of threats to the island's biodiversity is beyond the scope of this report. However, should the opportunity become available for ecological management and/or restoration, a consortium of stakeholders could contribute to a vision of a desired future condition for the island, which will direct appropriate action. Here we briefly outline some possibilities to enhance the biodiversity value of the island. Additional and complementary actions, mostly related to birds, and for a larger area, are spelled out in "Conservation Strategies for the Orient Point to Plum Island Important Bird Area" (The Orient Point to Plum Island Conservation Committee 2009).

- **Restoration of marsh hydrology.** A drying trend in the wetland complex north of Pine Point is evidenced by the spread of woody vegetation into former stands of cattail and open water since the 1970s (P. Spitzer, personal communication), presumably resulting in the presence or expansion of the highbush blueberry bog thicket. Determining the precise degree to which the wetland's hydrology is altered and allowing the natural regime to recover could be critical for

restoring the biodiversity expected in this diverse wetland complex on the Coastal Plain. An investigation into the effects of the sea gate and dredged channel mentioned by Crandell (1962) is warranted. In addition, as the natural hydrologic regime recovers, it may be worth exploring the possibility of restoring the former Coastal Plain Atlantic white cedar swamp in the northwest corner of the marsh.

- **Eradication of raccoons.** The accidental introduction of raccoons in the mid-1990s is the near-certain culprit for the decline and eventual disappearance of the multispecies heronry in the wetland and gull nesting colony in the sandy dune grass meadow to the southwest, plus alteration of osprey nest-site selection. Raccoons are also notorious predators of other species known or expected from Plum Island, as well as those that may occur there in the future, such as Piping Plover (Doherty and Heath 2011), American Oystercatcher (Sabine et al. 2006) , diamondback terrapin (Feinberg and Burke 2003), and sea turtles (Barton and Roth 2007). Although the USDA continues to trap and remove problem raccoons, eradication has not been a stated goal. Elimination of raccoons would probably restore the ground-nesting gulls, so island personnel would have to consider gulls' role as accidental disease vectors, although this was not discussed as a problem during the times of breeding gull abundance in the 1970s (P. Spitzer, personal communication). The incredible restoration success of Great Gull Island in re-establishing huge breeding colonies of seabirds (Hays 2007) could provide a model for what might be worth attempting on Plum Island, given its history of seabird use, albeit at a smaller scale. Restoration of gulls might, in turn, alter the vegetation of the southern tip of the island through the intense seasonal deposition of gull guano that formerly prevented encroachment of woody plants, as appears to be the case on nearby Gardiners Island (P. Spitzer, personal communication). Raccoon extermination might not entirely restore the heronry if food sources on the island have been reduced too much by the drying trend of the marsh.
- **Targeted removal of invasives.** Should removal of invasive species be desirable, a seven-step protocol is recommended (adapted from O'Brien et al. 2010): 1) Write an Invasive Species Management Plan (e.g., O'Brien et al. 2010). 2) Inventory the species. A complete inventory of the location of all the invasives should be done. Survey, observation, and management data can be entered into the iMap Invasives database: http://imapinvasives.org/nyimi/home/. 3) Run the species through The Nature Conservancy's Decision Analysis Tool (http://conserveonline.org/library/an-invasive-plant-management-decision-analysis/view.html), which helps prioritize which species to control and assess costs and benefits of various actions. Funding should be secured for at least 2 years with the likelihood of long-term funding, especially for common invasives. 4) Control the high-priority species. Select control methods and develop removal plans. 5) Perform restoration if necessary. Restore treatment sites to the preferred ecological state following the removal of invasive species. 6) Monitor and maintain native ecological systems. Monitor sites to prevent re-invasion and to identify and maintain areas free of invasive species. 7) Promote stewardship. Train, educate, and provide outreach to staff and the public in order to provide support for successful invasive species control efforts.
- **Restoration (or establishment) of maritime grassland throughout the panhandle.** The 13 acres of successional old field and potential maritime grassland on the island's panhandle, and the 93 acres of mowed lawn could provide suitable habitat for area-sensitive grassland birds (Ribic et al. 2009) as well as rare moths and rare plants. Historical imagery and documentation could be consulted to determine the former extent, if any, of maritime grassland on the island, or a decision could be made to attempt to convert these sites into that community type by planting and encouraging a suite of native plant species. Any attempt at grassland restoration would require regular maintenance, possibly using prescribed fire, to prevent shrub encroachment;

regular monitoring would be advisable. It may also be possible to manage the existing old fields in such a way as to provide surrogate "grassland" habitat for species that depend upon it.

- **Continued minimal impacts to maritime and coastal communities.** The intactness of Plum Island's beach and its relative lack of human disturbance are reflected in the presence of three rare species: seabeach knotweed, Piping Plover, and hairy-necked tiger beetle. The continued presence of these species relies on an intact beach and dune ecosystem and minimal vehicular and other human traffic. Sea level rise and increasingly dramatic coastal storms (IPCC 2012) are likely to increase erosion of the maritime beach and the extensive, intact maritime bluffs and dunes that ring the island. The surrounding rocky intertidal system, dependent upon alternating periods of tidal flooding and exposure, is also likely to be especially vulnerable to rising seas. Monitoring the distribution of species in the intertidal, maritime, and coastal zones will provide valuable baseline data for protection efforts.
- **Dark skies compliance.** Given the effects of light pollution on many kinds of animals (Smith 2008), and the current and potentially growing importance of Plum Island and its surrounding waters for sea turtles, the island could pursue "dark skies" compliance to ensure its value to sensitive wildlife.

Key inventory needs

Based on our research we outline here some key inventory needs for Plum Island (Table 15), so that management decisions may be made with the most complete information possible.

Table 15. Key inventory needs for Plum Island.

Inventory need	Specific targets and notes
Natural communities	
Full natural community map	Ground-truth preliminary map; gather detailed plot-level information for all community types, including underwater surveys for eelgrass and rocky intertidal communities. Ideally, survey work would include at least two sets of visits, spring and mid-late summer, to capture the full range of species throughout the growing season
Significant natural communities	Update with current plot-level information and condition assessment
Animals	
Small mammals	Full faunal survey
Bats	Use of bunkers as roosts, use of airspace for migration
Marine mammals	Continued counts of hauled-out seals in all seasons; use of nearby waters by migrating and foraging cetaceans
Breeding birds	Continuing surveys by Audubon NY; addition of nocturnal surveys for owls would be beneficial
Wintering birds	Continuing Christmas Bird Counts and surveys by Audubon NY
Migrating birds	Analysis of available radar data; additional radar data collection and acoustical surveys to

Inventory need	Specific targets and notes
	determine use of the island as a flyway
Sea turtles	Use of seagrass beds
Freshwater turtles	Eastern mud turtles
Terrestrial snakes	Eastern hognose snake
Freshwater amphibians	Full faunal survey; northern cricket frogs, leopard frogs, spadefoot toads
Freshwater fish	Full faunal survey
Insects	Complete faunal surveys for dragonflies and damselflies, moths, butterflies, American burying beetle
Marine invertebrates	Horsehoe crab spawning, full faunal survey of rocky intertidal
Plants	
Rare plants	All rare plant occurrences should be resurveyed using New York Natural Heritage Program procedures to obtain information on quantity and quality
Invasive plants	Surveys should be done according to the guidelines outlined above
Other taxa	Baseline surveys for bryophytes, algae, and fungi

Conclusion

The future ownership and management of Plum Island is uncertain, and thus the fate of its remarkable biodiversity is uncertain as well. Particular futures are compatible with biodiversity conservation, while others are less compatible. Our report, building on historical accounts and the work of many recent scientists and naturalists, is still an early step in a full documentation of the island's ecology, and constitutes only some of the information needed if the island is planned for residential development or if further ecological management and restoration are undertaken. We hope that in documenting what is known about Plum Island's biodiversity and highlighting gaps in our information, we have whetted appetites for further inventory and heightened appreciation of this unique place.

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Appendix A: Natural Heritage Subnational (S) Conservation Status Ranks

Adapted from http://www.natureserve.org/explorer/ranking.htm

Subnational (S) Conservation Status Ranks

Status	Definition
SX	**Presumed Extirpated**—Species or ecosystem is believed to be extirpated from the jurisdiction (i.e., nation or state/province). Not located despite intensive searches of historical sites and other appropriate habitat, and virtually no likelihood that it will be rediscovered.
SH	**Possibly Extirpated**— Known from only historical records but still some hope of rediscovery. There is evidence that the species or ecosystem may no longer be present in the jurisdiction, but not enough to state this with certainty. Examples of such evidence include (1) that a species has not been documented in approximately 20-40 years despite some searching or some evidence of significant habitat loss or degradation; (2) that a species or ecosystem has been searched for unsuccessfully, but not thoroughly enough to presume that it is no longer present in the jurisdiction.
S1	**Critically Imperiled**—Critically imperiled in the jurisdiction because of extreme rarity or because of some factor(s) such as very steep declines making it especially vulnerable to extirpation from the jurisdiction.
S2	**Imperiled**—Imperiled in the jurisdiction because of rarity due to very restricted range, very few populations, steep declines, or other factors making it very vulnerable to extirpation from jurisdiction.
S3	**Vulnerable**—Vulnerable in the jurisdiction due to a restricted range, relatively few populations, recent and widespread declines, or other factors making it vulnerable to extirpation.
S4	**Apparently Secure**—Uncommon but not rare; some cause for long-term concern due to declines or other factors.
S5	**Secure**—Common, widespread, and abundant in the jurisdiction.

Variant Subnational Conservation Status Ranks

Rank	Definition
S#S#	**Range Rank** — A numeric range rank (e.g., S2S3 or S1S3) is used to indicate any range of uncertainty about the status of the species or ecosystem. Ranges cannot skip more than two ranks (e.g., SU is used rather than S1S4).
SU	**Unrankable**—Currently unrankable due to lack of information or due to substantially conflicting information about status or trends.
SNR	**Unranked**—National or subnational conservation status not yet assessed.
SNA	Not Applicable —A conservation status rank is not applicable because the species or ecosystem is not a suitable target for conservation activities.[3]
Not Provided	Species or ecosystem is known to occur in this nation or state/province. Contact the relevant NatureServe network program for assignment of conservation status.

[3] A conservation status rank may be not applicable for some species, including long distance aerial and aquatic migrants, hybrids without conservation value, and non-native species or ecosystems, for several reasons, described below.

Long distance migrants: Assigning conservation status to long distance aerial or aquatic migrant animals (e.g., species like migrant birds, bats, butterflies, sea turtles, and cetaceans) during their migrations is typically neither practical nor helpful to their conservation. During their migrations, most long distance migrants occur in an irregular, transitory, and dispersed manner. Some long distance migrants occur regularly, while others occur only as accidental or casual visitors to a subnation or nation. Some long distance migrants may regularly occur as rare breeding or nonbreeding seasonal (e.g., winter) species, but in an inconsistent, spatially irregular fashion, or as breeders that die out apparently with no return migration and no overwintering (e.g., some Lepidoptera). In all these circumstances, it is not possible to identify discrete areas for individual species that can be managed so as to significantly affect their conservation in a nation or subnation. The risk of extinction for these species is largely dependent on effective conservation of their primary breeding and nonbreeding grounds, notwithstanding actions that may benefit species collectively such as protecting migratory "hotspots," curbing pollution, minimizing deaths from towers and other obstructions, etc.

Hybrids without conservation value and non-natives: It is not appropriate to assign a conservation status to hybrids without conservation value, or to non-native species or ecosystems. However, in the rare case where a species is presumed or possibly extinct in the wild (GXC/GHC) but is extant as a naturalized population outside of its native range, the naturalized population should be treated as a benign introduction, and should be assessed and assigned a numeric national and/or subnational conservation status rank. The rationale for this exception for naturalized populations is that when a species is extinct over its entire natural range, the presence of that species within an area must be considered important to highlight and preserve, even if the area is not part of the species' natural range.

Rank Qualifier

Rank	Definition
S#?	**Inexact Numeric Rank**—Denotes inexact numeric rank. This designation should not be used with any of the variant national or subnational conservation status ranks or NX, SX, NH, or SH.

Breeding Status Qualifiers[4]

Qualifier	Definition
B	**Breeding**—Conservation status refers to the breeding population of the species in the nation or state/province.
N	**Nonbreeding**—Conservation status refers to the non-breeding population of the species in the nation or state/province.
M	**Migrant**—Migrant species occurring regularly on migration at particular staging areas or concentration spots where the species might warrant conservation attention. Conservation status refers to the aggregating transient population of the species in the nation or state/province.

[4] 4A breeding status is only used for species that have distinct breeding and/or non-breeding populations in the nation or state/province. A breeding-status S-rank can be coupled with its complementary non-breeding-status S-rank if the species also winters in the nation or state/province. In addition, a breeding-status S-rank can also be coupled with a migrant-status S-rank if, on migration, the species occurs regularly at particular staging areas or concentration spots where it might warrant conservation attention. Multiple conservation status ranks (typically two, or rarely three) are separated by commas (e.g., S2B,S3N or SHN,S4B,S1M).

Appendix B: Birds of Plum Island

Bird species observed on Plum Island, New York, or in nearby waters, and seasons with confirmed presence. Compiled primarily from Audubon New York (unpublished) and ML. Lamont (unpublished). Additional species from Buckley and Buckley (1980); P. Spitzer (unpublished); USDA (unpublished).

Common name	Scientific name	S-rank	Sp	Su	Fa	Wi
Red-throated Loon	*Gavia stellata*	SNRN‡	X		X	X
Common Loon	*Gavia immer*	S4‡	X		X	X
Horned Grebe	*Podiceps auritus*	SNRN‡	X		X	X
Red-necked Grebe	*Podiceps grisegena*	SNRN			X	X
Northern Gannet	*Morus bassanus*	SNRN	X		X	X
Brown Pelican	*Pelecanus occidentalis*	SNA		X		
Great Cormorant	*Phalacrocorax carbo*	SNRN	X	X	X	X
Double-crested Cormorant*	*Phalacrocorax auritus*	S3	X	X	X	
Least Bittern†	*Ixobrychus exilis*	S3B,S1N‡				
Great Blue Heron	*Ardea herodias*	S5	X	X	X	X
Great Egret†	*Ardea alba*	S4‡	X	X		
Snowy Egret†	*Egretta thula*	S2S3‡	X	X		
Little Blue Heron†	*Egretta caerulea*	S2‡				
Tricolored Heron†	*Egretta tricolor*	S2‡	X	X		
Black-crowned Night-Heron†	*Nycticorax nycticorax*	S3‡		X		
Glossy Ibis*	*Plegadis falcinellus*	S2‡		X		
Mute Swan	*Cygnus olor*	SNA	X		X	X
Snow Goose	*Chen caerulescens*	SNRN			X	X
Brant	*Branta bernicla*	SNRN‡			X	
Canada Goose*	*Branta canadensis*	S5	X	X	X	X
Wood Duck	*Aix sponsa*	S5		X		
Green-winged Teal	*Anas crecca*	S3		X	X	X
American Black Duck*	*Anas rubripes*	S3B, SNRN‡	X	X	X	X
Mallard*	*Anas platyrhynchos*	S5	X	X	X	X
Northern Pintail	*Anas acuta*	S1B, S3N‡	X			X
Gadwall	*Anas strepera*	S3	X		X	X
Eurasian Wigeon	*Anas penelope*	SNRN				X
American Wigeon	*Anas americana*	S3	X		X	X
Greater Scaup	*Aythya marila*	SNRN‡			X	X
Common Eider*	*Somateria mollissima*	S1B, S3?N‡	X	X	X	X
King Eider	*Somateria spectabilis*	SNRN	X			
Harlequin Duck	*Histrionicus histrionicus*	S1N‡				X
Long-tailed Duck	*Clangula hyemalis*	SNRN‡	X		X	X
Black Scoter	*Melanitta nigra*	SNRN‡	X	X	X	X
Surf Scoter	*Melanitta perspicillata*	SNRN‡	X	X	X	X
White-winged Scoter	*Melanitta fusca*	SNRN‡	X		X	X
Common Goldeneye	*Bucephala clangula*	S3B, SNRN‡	X		X	X
Bufflehead	*Bucephala albeola*	SNRN	X			
Hooded Merganser	*Lophodytes cucullatus*	S4				X
Red-breasted Merganser	*Mergus serrator*	S3	X	X	X	X
Turkey Vulture*	*Cathartes aura*	S4	X	X	X	X
Osprey*	*Pandion haliaetus*	S4B‡	X	X	X	
Bald Eagle	*Haliaeetus leucocephalus*	S2S3B,S2N‡	X	X		X

Common name	Scientific name	S-rank	Sp	Su	Fa	Wi
Northern Harrier*	*Circus cyaneus*	S3B,S3N‡	X	X	X	X
Sharp-shinned Hawk	*Accipiter striatus*	S4‡	X	X	X	X
Cooper's Hawk	*Accipiter cooperii*	S4‡	X	X	X	X
Northern Goshawk	*Accipiter gentilis*	S3S4B‡				X
Red-shouldered Hawk	*Buteo lineatus*	S4B‡	X	X		X
Broad-winged Hawk	*Buteo platypterus*	S5	X	X		
Red-tailed Hawk*	*Buteo jamaicensis*	S5	X	X	X	X
Rough-legged Hawk	*Buteo lagopus*	SNRN				X
American Kestrel*	*Falco sparverius*	S5	X	X	X	X
Merlin	*Falco columbarius*	S3?	X	X	X	X
Peregrine Falcon	*Falco peregrinus*	S3B‡	X		X	X
Virginia Rail	*Rallus limicola*	S5	X	X		X
Black-bellied Plover	*Pluvialis squatarola*	SNRN‡		X	X	
Semipalmated Plover	*Charadrius semipalmatus*	SNRN		X		
Piping Plover*	*Charadrius melodus*	S3B‡	X	X		
Killdeer*	*Charadrius vociferus*	S5	X	X	X	X
American Oystercatcher*	*Haematopus palliatus*	S3‡	X	X		
Greater Yellowlegs	*Tringa melanoleuca*	SNRN‡		X	X	
Lesser Yellowlegs	*Tringa flavipes*	SNRN		X		
Solitary Sandpiper	*Tringa solitaria*	SNRN	X	X		
Willet	*Tringa semipalmata*	S3‡		X		
Spotted Sandpiper*	*Actitis macularia*	S5		X	X	
Sanderling	*Calidris alba*	SNRN‡		X	X	X
Western Sandpiper	*Calidris mauri*	SNRN		X		
Least Sandpiper	*Calidris minutilla*	SNRN	X	X		
Pectoral Sandpiper	*Calidris melanotos*	SNRN		X		
Purple Sandpiper	*Calidris maritima*	SNRN‡			X	X
American Woodcock	*Scolopax minor*	S5‡			X	X
Laughing Gull**	*Larus atricilla*	S1‡		X	X	
Bonaparte's Gull	*Larus philadelphia*	SNRN‡			X	
Ring-billed Gull	*Larus delawarensis*	S4	X	X	X	X
Herring Gull**	*Larus argentatus*	S5	X	X	X	X
Great Black-backed Gull*	*Larus marinus*	S4	X	X	X	X
Roseate Tern**	*Sterna dougallii dougallii*	S1B‡	X	X		
Common Tern**	*Sterna hirundo*	S3B‡	X	X		
Forster's Tern	*Sterna forsteri*	S1‡		X	X	
Razorbill	*Alca torda*	SNRN‡			X	X
Rock Pigeon	*Columba livia*	SNA		X	X	
Mourning Dove*	*Zenaida macroura*	S5	X	X	X	X
Black-billed Cuckoo	*Coccyzus erythropthalmus*	S5‡		X		
Yellow-billed Cuckoo	*Coccyzus americanus*	S5	X	X	X	
Barn Owl	*Tyto alba*	S1S2‡				
Northern Saw-whet Owl	*Aegolius acadicus*	S3				
Chimney Swift*	*Chaetura pelagica*	S5	X	X		
Ruby-throated Hummingbird	*Archilochus colubris*	S5	X	X		
Belted Kingfisher*	*Ceryle alcyon*	S5	X	X	X	
Red-bellied Woodpecker*	*Melanerpes carolinus*	S5	X	X	X	X
Yellow-bellied Sapsucker	*Sphyrapicus varius*	S5			X	

Common name	Scientific name	S-rank	Sp	Su	Fa	Wi
Downy Woodpecker*	*Picoides pubescens*	S5	X	X	X	X
Hairy Woodpecker	*Picoides villosus*	S5			X	
Northern Flicker*	*Colaptes auratus*	S5	X	X	X	X
Eastern Wood-Pewee	*Contopus virens*	S5	X	X		
Yellow-bellied Flycatcher	*Empidonax flaviventris*	S3		X		
Alder Flycatcher	*Empidonax alnorum*	S5	X			
Willow Flycatcher*	*Empidonax traillii*	S5‡	X	X		
Least Flycatcher	*Empidonax minimus*	S5		X		
Eastern Phoebe*	*Sayornis phoebe*	S5	X	X	X	
Ash-throated Flycatcher	*Myiarchus cinerascens*	SNA			X	
Great Crested Flycatcher	*Myiarchus crinitus*	S5	X	X		
Eastern Kingbird*	*Tyrannus tyrannus*	S5	X	X		
Purple Martin	*Progne subis*	S4	X	X		
Tree Swallow*	*Tachycineta bicolor*	S5	X	X	X	X
Northern Rough-winged Swallow*	*Stelgidopteryx serripennis*	S5	X	X		
Bank Swallow*	*Riparia riparia*	S5	X	X		
Cliff Swallow	*Petrochelidon pyrrhonota*	S5				
Barn Swallow*	*Hirundo rustica*	S5	X	X		
Blue Jay	*Cyanocitta cristata*	S5	X	X	X	X
American Crow*	*Corvus brachyrhynchos*	S5	X	X	X	X
Black-capped Chickadee*	*Poecile atricapilla*	S5	X	X	X	X
Tufted Titmouse*	*Baeolophus bicolor*	S5	X	X	X	X
Red-breasted Nuthatch	*Sitta canadensis*	S5		X	X	
White-breasted Nuthatch*	*Sitta carolinensis*	S5	X	X	X	X
Brown Creeper	*Certhia americana*	S5			X	X
Carolina Wren*	*Thryothorus ludovicianus*	S5	X	X	X	X
House Wren*	*Troglodytes aedon*	S5	X	X	X	X
Winter Wren	*Troglodytes troglodytes*	S5			X	X
Marsh Wren	*Cistothorus palustris*	S5			X	X
Golden-crowned Kinglet	*Regulus satrapa*	S5			X	X
Ruby-crowned Kinglet	*Regulus calendula*	S3			X	
Blue-gray Gnatcatcher	*Polioptila caerulea*	S5	X			
Eastern Bluebird*	*Sialia sialis*	S5	X		X	
Veery	*Catharus fuscescens*	S5		X	X	
Hermit Thrush	*Catharus guttatus*	S5			X	X
Wood Thrush	*Hylocichla mustelina*	S5‡	X	X		
American Robin*	*Turdus migratorius*	S5	X	X	X	X
Gray Catbird*	*Dumetella carolinensis*	S5	X	X	X	X
Northern Mockingbird*	*Mimus polyglottos*	S5	X	X	X	X
Brown Thrasher*	*Toxostoma rufum*	S3S4‡	X	X	X	X
Cedar Waxwing*	*Bombycilla cedrorum*	S5	X	X	X	
European Starling*	*Sturnus vulgaris*	SNA	X	X	X	X
White-eyed Vireo*	*Vireo griseus*	S4	X	X		
Blue-headed Vireo	*Vireo solitarius*	S5	X			
Red-eyed Vireo*	*Vireo olivaceus*	S5	X	X		
Blue-winged Warbler*	*Vermivora pinus*	S5‡	X			
Tennessee Warbler	*Vermivora peregrina*	S2‡		X		
Nashville Warbler	*Vermivora ruficapilla*	S5	X	X	X	

Common name	Scientific name	S-rank	Sp	Su	Fa	Wi
Northern Parula	*Parula americana*	S3S4	X	X		
Yellow Warbler*	*Dendroica petechia*	S5	X	X		
Chestnut-sided Warbler	*Dendroica pensylvanica*	S5		X	X	
Magnolia Warbler	*Dendroica magnolia*	S5	X			
Cape May Warbler	*Dendroica tigrina*	S2‡		X		
Black-throated Blue Warbler	*Dendroica caerulescens*	S5‡	X	X		
Yellow-rumped Warbler	*Dendroica coronata*	S5	X	X	X	X
Black-throated Green Warbler	*Dendroica virens*	S5		X		
Blackburnian Warbler	*Dendroica fusca*	S5	X			
Pine Warbler	*Dendroica pinus*	S5	X	X		
Prairie Warbler	*Dendroica discolor*	S5‡	X	X		
Palm Warbler	*Dendroica palmarum*	S2S3		X	X	
Blackpoll Warbler	*Dendroica striata*	S3	X	X	X	
Black-and-white Warbler	*Mniotilta varia*	S5		X		
American Redstart*	*Setophaga ruticilla*	S5	X	X		
Common Yellowthroat*	*Geothlypis trichas*	S5	X	X	X	
Wilson's Warbler	*Wilsonia pusilla*	SNA	X	X		
Scarlet Tanager	*Piranga olivacea*	S5‡		X		
Northern Cardinal*	*Cardinalis cardinalis*	S5	X	X	X	X
Rose-breasted Grosbeak	*Pheucticus ludovicianus*	S5	X			
Indigo Bunting*	*Passerina cyanea*	S5		X		
Eastern Towhee*	*Pipilo erythrophthalmus*	S5	X	X	X	X
American Tree Sparrow	*Spizella arborea*	S4			X	X
Chipping Sparrow*	*Spizella passerina*	S5	X	X	X	
Field Sparrow	*Spizella pusilla*	S5	X		X	X
Vesper Sparrow	*Pooecetes gramineus*	S3‡			X	X
Savannah Sparrow	*Passerculus sandwichensis*	S5	X		X	X
Fox Sparrow	*Passerella iliaca*	SNRN				X
Song Sparrow*	*Melospiza melodia*	S5	X	X	X	X
Lincoln's Sparrow	*Melospiza lincolnii*	S4		X	X	
Swamp Sparrow	*Melospiza georgiana*	S5	X		X	X
White-throated Sparrow	*Zonotrichia albicollis*	S5	X		X	X
White-crowned Sparrow	*Zonotrichia leucophrys*	SNRN			X	
Dark-eyed Junco	*Junco hyemalis*	S5	X		X	X
Snow Bunting	*Plectrophenax nivalis*	S5N			X	X
Bobolink	*Dolichonyx oryzivorus*	S5‡	X	X		
Red-winged Blackbird*	*Agelaius phoeniceus*	S5	X	X	X	X
Eastern Meadowlark	*Sturnella magna*	S5‡			X	X
Common Grackle*	*Quiscalus quiscula*	S5	X	X	X	X
Brown-headed Cowbird*	*Molothrus ater*	S5	X	X	X	X
Orchard Oriole*	*Icterus spurius*	S4	X	X		
Baltimore Oriole*	*Icterus galbula*	S5	X	X	X	
Purple Finch	*Carpodacus purpureus*	S5			X	X
House Finch*	*Carpodacus mexicanus*	SNA	X	X	X	X
Common Redpoll	*Carduelis flammea*	SNRN			X	
Pine Siskin	*Carduelis pinus*	S5			X	
American Goldfinch*	*Carduelis tristis*	S5	X	X	X	X

Common name	Scientific name	S-rank	Sp	Su	Fa	Wi
House Sparrow*	*Passer domesticus*	SNA	X	X		

* Current-day breeder
** Met the criteria for confirmed or probable breeding in recent surveys but most likely nesting off the island
† Historical breeder
‡ Species of Greatest Conservation Need

Appendix C: Conservation guides

NY Natural Heritage conservation guides are available online at http://guides.nynhp.org/. A compendium of guides for all natural communities and all Heritage-tracked species documented on Plum Island is available upon request.