Chapter 3

Erin Victory/TCI

Refuge cliffs and dunes

Affected Environment

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- Current Conditions
- The Regional Socio-Economic Setting
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Introduction

This chapter describes the physical, biological, and sociological environment of Nomans Land Island NWR. We begin with the physical landscape, the setting of the Refuge and our project area, including historical information, followed by Refuge administration and programs and then, descriptions of specific Refuge resources.

The Physical Landscape

Watershed

A watershed is a terrestrial concept that describes an area where all the water (subsurface and surface) converges in the same place. This is a hierarchical system that derives from the smallest stream outward to regional watercourses. Though a watershed map has not been derived for Nomans Land Island, the following inferences about the local hydrology can be made based on water sampling conducted by the Navy (Foster Wheeler Environmental Corporation 2001). Topology and geology are the primary factors influencing surface and subsurface water flow on the island. While many hydrological features are present, there are no apparent streams that connect them. Therefore, there may be some amount of surface water flowage from higher to lower elevations during rain events, however, water movement is primarily though groundwater flow.

This generally takes place from the south-central and north-central hills into the lower wetland areas between, and then outward where it is eventually discharged into the ocean. Around the periphery of the island, there is subsurface saltwater intrusion, and it is because of this that the groundwater on the island is isolated from that on Martha's Vineyard. Much of the ponds on the island are below the seasonal water table and are therefore groundwater fed, though Ben's and Rainbow Ponds are also fed by surface water runoff as well. These two ponds are hydraulically connected to the surrounding wetlands through groundwater flow. Some ponds have outlets that discharge directly into the ocean.

Extrapolating outward, the Refuge does not fit into the traditional watershed concept at a more regional scale because it is a maritime island and is therefore isolated and subject to oceanic processes. However, the 628-acre Nomans Land Island NWR has been included within the Martha's Vineyard Island watershed, which incorporates Martha's Vineyard, the Elizabeth Islands and Nomans Land Island. In total, it drains approximately 89 square miles and includes 13 streams, 42 lakes and 125 miles of coastline. Watershed priorities have been identified by the State of Massachusetts for the Martha's Vineyard watershed. Because Nomans Land Island is uninhabited and closed to the public, many of the priorities are not applicable to the Refuge, beyond increasing opportunities for environmental education. You may access this information through the Massachusetts Office of Energy and Environmental Affairs website, and searching for "Martha's Vineyard Watershed" (http://www.mass.gov/?pageID=eoeeaterminal&L=4&L0=Home&L1=Air%2C+Water+%26+Climate+Change&L2=Preserving+Water+Resources&L3=Massachusetts+Watersheds&sid=Eoeea&b=terminalcontent&f=eea_water_marthasvineyard&csid=Eoeea).

On a larger scale, the Cape Cod watershed encompasses both the Martha's Vineyard and Nantucket Island watersheds and other small islands south of Cape Cod. It is classified by the U.S. Geological Survey as hydrologic unit (HUC) 01090002. The watershed extends 70 miles into the Atlantic Ocean and is surrounded by the salt waters of Buzzards Bay, Cape Cod Bay, Nantucket Sound, and the Atlantic Ocean. The watershed drains approximately 440 square miles and 559 miles of coastline. The Massachusetts Executive Office of Energy and Environmental Affairs provides more information about the watershed at Massachusetts Executive Office of Energy and Environmental Affairs-Cape Cod, and you can go to http://cfpub.epa.gov/surf/huc.cfm?huc_code=01090002 for more information from the USGS.

Geographical Setting

Biophysical Ecoregion

The Nature Conservancy (TNC) has divided the continental United States into 63 ecoregions which are large geographic areas that share similar geologic, topographic, ecological, and climatic characteristics. These ecoregions are modified from the U.S. Forest Service "Bailey System" (Bailey 1995). TNC has developed Ecoregional Conservation Plans that identify conservation targets and prioritize conservation actions.

Nomans Land Island NWR is in the North Atlantic Coast (NAC) ecoregion as described by TNC (see Map 3-1). This ecoregion extends from Pemaquid Point in Maine south to Delaware Bay. Flat topography, low elevations (<600 feet), scattered moraines, large rivers draining into estuaries and bays, and a mild, humid climate characterize this region. Rocky coasts dominate the shorelands in the north, grading into salt marsh communities to the south. The once extensive forest graded from white pine-oak-hemlock forest, to dry oak-heath forests, to mesic coastal oak forests from north to south. Wetlands, beaver meadows, pine barrens, and heathlands were embedded in this forested landscape. Hundreds of years of land clearing, agriculture, and widespread development has fragmented the landscape and eliminated large areas of forest. Still, smaller ecological systems remain, including barrier beaches and dunes, salt marshes, and freshwater wetlands (TNC 2006a). Current action sites for TNC exist on Martha's Vineyard and the Cape, where land protection and management activities are already occurring. Nomans Land Island has been classified by TNC as an additional ecoregional priority.

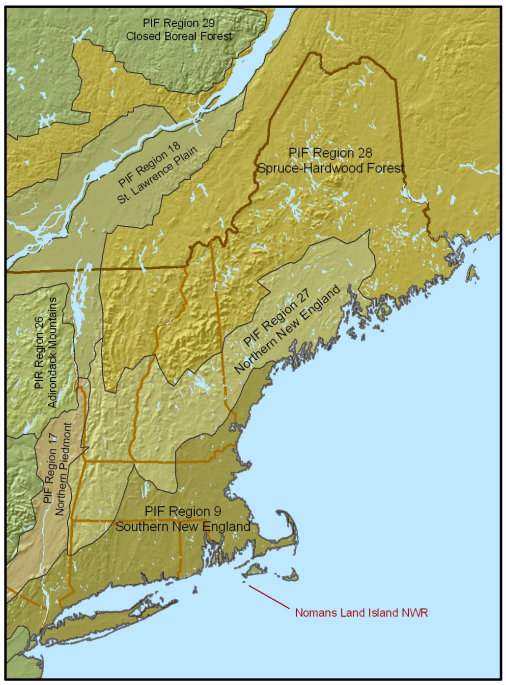
Atlantic Coast Flyway

Nomans Land Island NWR is within the Atlantic Flyway (see Map 3-1). Flyways have been used for many years in North America as the unit for managing waterfowl populations because they allow land managers to link efforts to conserve migratory bird species and their habitats on breeding, migration, and wintering grounds. The Atlantic Coast Joint Venture area includes the entire U.S. Atlantic Coast lying completely within the Atlantic Flyway. In this large area, the ACJV partners work together to assess the status, trends, and needs of bird populations and their habitats. The partners then use this information to help guide the distribution of resources to the needs and issues of highest priority.

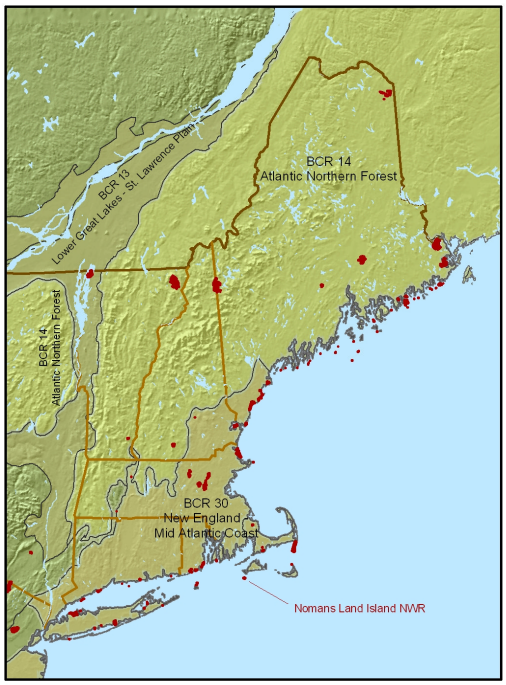
Map 3-1

Nomans Land Island National Wildlife Refuge - Comprehensive Conservation Plan

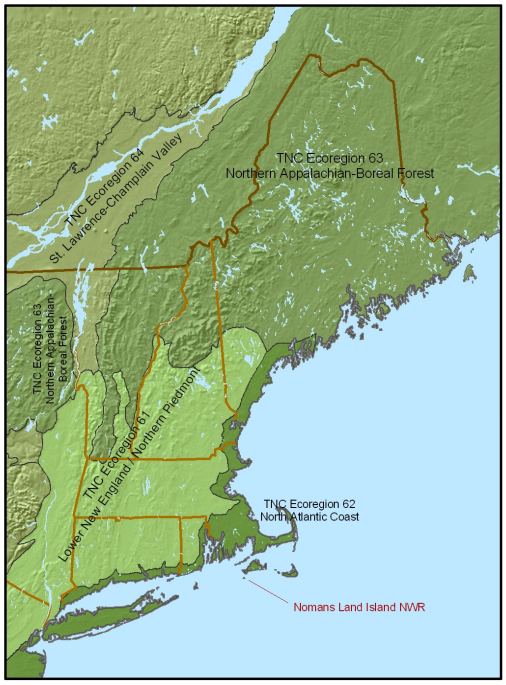
Conservation Regions



Partners in Flight Physiographic Areas



Bird Conservation Regions



The Nature Conservency Ecoregions

Atlantic Flyway

Landscape Conservation Cooperatives

In cooperation with the USGS, the Service is initiating a new approach to landscape conservation through a national geographic network that will create a spatial frame of reference to build partnerships and connect projects to larger scale biological priorities. These 21 geographic areas are aggregates of Bird Conservation Regions (see Chapter 1), and provide a basis for forming Landscape Conservation Cooperatives with other federal agencies, non-governmental organizations, states, tribes, universities and other stakeholders to accomplish conservation goals.

Nomans Land Island NWR is located in the North Atlantic LCC which combines BCRs 14 (Northern Atlantic Forest) and 30 (New England/Mid-Atlantic Coast), and contains 12 out of 13 Northeast states as well as the District of Columbia (Map 3-2). Near Nomans Land Island, there exist many conserved lands with which the Refuge can partner along Cape Cod and associated islands (Map 3-3).

Consisting of a diverse array of ecosystems, from high elevation spruce-fir forests to coastal islands, there will be many different conservation priorities to be addressed in the North Atlantic LCC. On a landscape level, these will include climate change and extirpation of wildlife populations from disease or habitat loss. Many partnerships for watershed, fish, and migratory bird conservation already exist within this geographic region and will provide a basis from which to initiate the LCC, which will also incorporate Canadian partners as well. This LCC will focus on federal-listed and candidate species such as Atlantic salmon, piping plover, red knot, Canada lynx, New England cottontail, dwarf wedgemussel and Karner blue butterfly, among others. For more information, go to, http://www.fws.gov/science/SHC/lcc.html.

Map 3-2


Nomans Land Island National Wildlife Refuge - Comprehensive Conservation Plan
USFWS Land Conservation Cooperatives
Unclassified
Quebec
Upper Midwest and Great Lakes
Ontario
North Atlantic
Maine
New Brunswick
Nova Scotia
North Atlantic
VT
NH
MA
CT
New York
Pennsylvania
Appalachian
Nomans Land Island NWR
NJ
MD
Virginia
South Atlantic
Sources:
LCC and Refuge Boundaries from USFWS.
Basemap from ESRI.
0 50 100 200 300 400 500 600 Miles
0 100 200 400 600 800 Kilometers
N
W
E
S

Map 3-3

Nomans Land Island National Wildlife Refuge - Comprehensive Conservation Plan

Conserved Lands in the Vicinity of Nomans Land Island National Wildlife Refuge

Sources:
Connecticut River watershed and Refuge Boundaries from USFWS.
Basemap USGS 1:250,000 DEM's
Bathymetry from MassGIS

0 1 2 4 6 8 10 12 14 16 18 20 22 24 26 28 30 32 Miles

0 1 2 4 6 8 10 12 14 16 18 20 22 24 26 28 30 32 34 36 38 40 42 44 46 48 50 Kilometers

N W E S

Notable Physiographic and Landform Features

Geomorphic regions or "physiographic provinces" are broad-scale subdivisions based on terrain texture, rock type, and geologic structure and history. Our project area lies in the Sea Island Section of the Atlantic Coastal Plain delineated by the U.S. Geological Survey (http://tapestry.usgs.gov/physiogr/physio.html). Many of these islands off the coast of Massachusetts mark the southern limit of the last glacial maximum (21,000 YBP), and are where terminal moraines of clay-rich, poorly sorted glacial materials were deposited between 15,000 to 20,000 years ago. This had an influence on the subsequent development of beaches, off-shore islands, and other landforms (http://tapestry.usgs.gov/features/features.html).

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Eroding cliffs reveal geology

The surface of Nomans Land Island NWR is comprised of a glacial moraine deposit of sand, gravel, cobble and large boulders. The island is four sided and there is about 4.25 miles of shoreline. The continuous wave action of the Atlantic Ocean has eroded the western and southern shores, creating shoreline with steep 50-foot bluffs that expose clay deposits. Below these bluffs around much of the island is a narrow beach of coarse gravel, cobble and boulder. The northern shore does not receive such continuous wave impact, and is characterized by a gentle sloping sand-gravel beach and prominent sand spit. Maximum relief on the island rises to 110 feet above mean sea level, with impounded freshwater ponds at the 38 to 42 foot mean sea level elevation. General slope is to the north, and there are sporadically spaced moraine hills, valleys, and perched water table bogs. The presence of peat-bog fossil material substantiates historical accounts of timber on the island (French 1973c).

Major Historical Influences Shaping Landscape Vegetation

Estimating what the historic natural vegetation types were on the Refuge, how they were distributed, and what ecological processes influenced them prior to major, human-induced disturbance, can help us evaluate future management options. However, many ecologists caution against selecting one point in time, and instead, recommend evaluating the "historical range of variation" for each habitat type.

According to noted ecologist Robert Askins of Connecticut College, "This approach recognizes that the proportions of grassland, shrub land, young forests, and old-growth forests have shifted constantly over the past few thousand years as the climate changed and people have modified the land by hunting, burning, and farming. Preserving the biological diversity of any region requires a range of habitat types, including those created by natural disturbances. If there are no natural or artificial disturbances generating grassland, shrub land, and young forest, then not only will early succession obligates be in trouble, but so will mature forest specialists that use early succession habitats at key points in their life cycles. Only large public lands like refuges, parks, preserves can sustain the full range of early succession and forest habitats, so in most regions land managers will need to cooperate to ensure that these habitats are adequately represented across the regional landscape" (Askins 2002).

A brief summary of influences on natural vegetation patterns across the landscape follows.

Glaciation

Massachusetts, like all of New England, was covered by the Laurentide ice sheet during the last glacial maximum (LGM), approximately 21,000 to 18,000 YBP). The glacier reached its southernmost extent at Martha's Vineyard, Nantucket and Nomans Land Islands, marked by the deposition of terminal moraines on these islands (http://pubs.usgs.gov/gip/capecod/glacial.html). These are formed when the glacier becomes static, having reached the southernmost point where its rate of advancement is roughly equal to that of its rate of melt, resulting in essentially zero net advancement. These terminal moraines are a build

up of the rock debris, or glacial till, that is embedded in the glacier that gets sloughed off and deposited along the leading edge of the glacier. The sedimentation on these islands is consistent with this process (Motzkin and Foster 2002).

At LGM, much of what is now the submerged continental shelf along the Massachusetts coast was exposed dry land because much of the world's water was locked up in continental ice sheets. It is estimated that worldwide sea levels were lower than today by 279 to 427 feet (Pielou 1991). By approximately 18,000 YBP, the ice sheet began to retreat in response to the warming climate and by about 14,000 to 15,000 YBP it had at least reached what is now the northern border of Massachusetts. As the ice sheets retreated, sea levels gradually rose. In addition, the earth's crust was slowly rebounding from the heavy weight of ice, but not as fast as sea levels were rising. This caused coastal flooding along the northern New England coast as far south as Boston (Jorgensen 1971). By about 12,000 YBP the coastline between the Bay of Fundy and Cape Cod was much as it is now (Pielou 1991).

The advance and subsequent retreat of the glacier, and changing climate had a profound impact on the local biota. With the advance of the glacier, many northern species were locally displaced and subsisted in southern areas of refugia. The retreating glacier marked a period of time when much of the physical environment was in a constant state of flux. Climatic factors such as temperature, precipitation, humidity, and atmospheric carbon dioxide were fluctuating. The earth's crust was rebounding at the same time that sea levels were rising, and the local hydrology was still in a dynamic state. The glacier itself was directly altering the landscape as it retreated by depositing till, boulders, isolated slabs of ice that melted to form kettle hole ponds, and by forming proglacial lakes as a result of the voluminous meltwater pouring off the retreating glacial front (Williams 2002, Jackson et al. 2000, Prentice et al. 1991). Combined, these factors made for ever-changing conditions as plant and wildlife species attempted to recolonize the area.

As the climate warmed and the ice retreated farther north, continual weathering and erosion of rock over time released nutrients and created new soils for plants to grow. Just south of the glacier, it is thought that tundra-like vegetation was dominant on the landscape, though there may have been places where the ice abutted spruce forests (Pielou 1991, Jackson et al. 2000). The tundra-like landscape was dominated by sedges and dwarf shrubs for several thousand years. As the climate warmed, these plants and associated animals followed the glacier as it receded north. The tundra continued to retreat, eventually restricted to the highest mountaintops (Davis 1983, Marchand 1987).

It has been shown that regional temperature and moisture levels working in concert may explain the variability in post-glacial phytogeography in southern New England better than climatic temperature alone. By 14,600 YBP spruce populations were prevalent in New England and they persisted until 11,600 YBP when white pine became the dominant taxa, replacing spruce during a drier, warmer climatic period. Hemlock (Tsuga canadensis), beech (Fagus grandifolia) and birch (Betula) increased by about 8,200 YBP, replacing the white pine (Pinus strobus) after a concurrent rise in moisture availability. Hemlock, a more mesic species, experienced a population crash around 5,400 YBP, which was originally thought to have been due to the first ever recorded occurrence of a pathogen. However, recent evidence indicates that its decline took place during a drier microclimate which may also have been a factor. Deciduous species such as hickory (Carya) and chestnut (Castanea dentata) were much slower to reach New England, 6,000 BP and 3,000 YBP respectively. This was likely due to regionally cooler temperatures and lower moisture levels than today (Shuman et al. 2004, Shuman et al. 2005).

For the first few thousand years after glacial retreat (about 11,500 YBP), sea level was 300 feet lower than today (Mulholland et al. 1998). Much of the area now inundated, including Vineyard Sound and the area between Martha's Vineyard and Nomans Land Island was probably occupied by Native Americans. Gradually, sea levels continued to rise, and by 10,000 YBP, sea level was 45 feet lower than today, and Martha's Vineyard and Nomans Land Island were still connected to the mainland. Three thousand YBP, water level was 16 feet lower than today, and by 2,000 YBP, sea level was 6.6 feet lower (Mulholland et al. 1998). It is thought that up until approximately 1,000 years ago, a sand spit connected Martha's Vineyard to Nomans Land Island (LaFarge 1933).

Erin Victory/TCI

View of Martha's Vineyard from the Refuge

Large mammals, including mastodons, wandered the spruce parkland and grassy savanna, but disappeared quickly at the same time as the glacier receded and humans advanced across the region. Thirty-five to 40 large mammals became extinct 9,000 to 12,000 YBP, while other mammals that were present then, such as white-tailed deer (Odocoileus virginianus), are still present today in New England (Pielou 1991, Askins 2002).

More Contemporary Influences on Vegetation Patterns

Natural disturbances vary across New England, depending on geographic location, forest type, and local conditions. Before European settlement, coastal regions experienced the highest rates of disturbance because of the prevalence of sandy pine-oak barrens, high densities of Native Americans, higher frequencies of hurricanes, and longer snow free periods. These disturbance regimes may have maintained about one to three percent of the inland northern hardwoods forests, greater than 10 percent of the coastal pine-oak barrens, and perhaps seven percent of spruce swamp and spruce flat habitats in early successional habitat (Lorimer and White 2003). However, it is likely that Nomans Land Island was mostly forested before European settlement.

Native insects and disease, ice storms, droughts, floods, landslides, and avalanches have caused minor and major disturbances. Lorimer and White (2003) depict hurricane frequencies as varying from 85 years in southeastern New England, 150 years through central Massachusetts and the southeast corner of New Hampshire, to 380 years or more in northern New England. Lorimer (1977) estimated catastrophic disturbances from fire and windthrow at intervals of 800 and 1,150 years, respectively.

After European settlement, agriculture, logging, fire, windthrow, exotic pests and diseases, fluctuations in wildlife species abundance and distribution, and development have significantly altered the New England landscape. Agriculture had the greatest effect on New England's forests, causing major changes in cover types and soils over a wide area. Intense fires fueled by logging slash did have a lasting impact on forest vegetation patterns (DeGraaf and Yamasaki 2001).

Sheep Grazing

Grazing was common throughout the New England coast during the eighteenth and nineteenth centuries. As European settlement increased, coastal islands were cleared of forests, and though fire was used to some extent, it was the chronic, intensive disturbance created by plowing, harrowing, and grazing by sheep and cattle that had a more lasting impact on modern vegetation (Motzkin and Foster 2002). As a result, the

landscape changed from a primarily forested one with small-scale disturbances that created a shifting mosaic of openings, to one in which grasslands were ubiquitous by the 1800's. On Nomans Land Island, the beech, sassafras, hickory and oak forests were cleared during the 1800's and sheep grazed year-round in the moderate coastal climate (Snow 1975). Sheep-raising was profitable for more than 150 years. Upwards of 800 sheep from Chilmark and the mainland pastured on the island (Otteson 1998); Martha's Vineyard had up to 20,000 sheep grazing pastures by the late eighteenth century (Motzkin and Foster 2002).

The impacts this had on local vegetation was rapid and long lasting. Grazing controlled the growth of woody species while increasing grass, herb, shrub and weed species. Overgrazing, on the other hand, created areas that were nutrient deficient and led to a loss of vegetation cover, wind erosion, and in some cases, dune development (Foster and Motzkin 2003). On the Refuge, trees did not reforest the island due to the effects of grazing and the pruning effects of salt spray. In addition to the vegetative changes on the island as a result of this activity, the number and variety of mammals greatly declined due to lack of habitat (Snow 1975).

The abandonment of these practices in the late 1800's resulted in the gradual reforestation of many areas, with the exception of coastal habitats which slowed the process of succession due to heavy winds, salt spray and the absence of seed sources. Modern shrub, grass and heathland communities are primarily the result of the intensive agricultural land use practices by European settlers, and likely do not represent ecological communities or species associations found prior to European settlement (Foster et al. 2002). However, these modern open land communities do support many species of conservation concern and therefore have high conservation value. They provide much needed habitat for current day indigenous species that have lost habitat throughout their ranges as a result of human development and other anthropogenic factors.

Fire

The history of fire on Nomans Land Island prior to the twentieth century is largely unknown. Archaeological evidence from Nomans Land Island indicates that Native Americans were using the island by at least 5,000 years ago (Jacobson 2000), and there is agreement in the literature that Native Americans did use fire as a tool to clear the forest understory and small openings around their seasonal camps (Motzkin and Foster 2002, DeGraaf and Yamasaki 2001). On Martha's Vineyard, paleoecological evidence shows charcoal records that indicate the occurrence of fire over time, but the origin, extent and frequency of these fires are not known (Foster et al. 2002). Given the geologic similarities and physical proximity between the two islands, and presumed similarities in Native American land use on both islands, fire has almost certainly had an impact on the island's vegetation over time.

More recently, fires, likely due to bombing, have occurred on Nomans Land Island NWR, but because of the infrequent visits to the island, our information is incomplete. There are records of fire occurring prior to 1973 (French 1973b) but the acreage and location are unknown. Frequent fires occurred in the early 1980's and greatly reduced the height and density of woody vegetation (Ladd 1982b). About one third of the island burned in April of 1980 (Atwell 1980). A "fairly large fire" occurred again in early winter of 1980-1981, followed by two small fires in the spring of 1981 (Ladd 1981). In addition, several spot burns of 1 to 10 acres occurred on the southern side of the island in the spring of 1982 (Ladd 1982a, Ladd 1982b) and small fires and spot burns occurred again in 1983 (about 25 acres; Ladd 1983a, Ladd 1983b). The southern part of the island was burned again in 1984 (Ladd 1984) and much of the island was burned in 1985 (Organ 1985). In 1986, Refuge staff noted that fires during the spring continued to reduce the thick growths of upland shrubs such as bayberry, rose, arrowood and greenbrier, thereby opening up additional areas for goose browse production and gull nesting (Atwell 1986). The eastern half of the island experienced a wildfire that burned about 200 acres in 1991. The cause of this fire is unknown, but due to the point of origin, it appears not to have been the result of any military activity (USFWS 1991).

Prescribed burns occurred on Nomans Land Island NWR in 1997, 1998 and 2008 as part of the Navy's ordnance surveys and removal. The most recent burn in 2008 had an estimated 80 percent coverage (Phillips 2008).

Occasional, dormant-season burns (winter or spring burns), as carried out by the military, appear to have increased the stem density and cover of clonal shrubs on the island, such as bayberry and arrowwood (per Vollick/Mitchell site visit, July 2001). This is consistent with fire ecology literature for these species. Increased cover of berry-producing shrubs may provide habitat for a variety of neotropical migratory songbirds in the fall.

Land Use History

Early Native American Influences

There is some indication in the archaeological record of paleo-Indian people populating New England, likely including the Cape Cod region, shortly after the post-glacial recolonization of many plant species in the region (12,000-9,000 YBP). However, given the paucity of data available from this time period, it is not possible to provide much insight into their relationship to the landscape or their subsistence strategies beyond the now disabused notion that they were specialized in hunting megafauna. It appears more likely that while seasonal big game movements and hunting was an important factor, they also incorporated a more generalist strategy that utilized all the technology and resources available to them (MHC 1986).

The Early Archaic Period (9,000-7,000 YBP) is represented from archaeological sites found on Cape Cod and Nantucket, though none have been documented on Martha's Vineyard. These indicate a regional movement pattern around a centralized area, though there were some differences in subsistence patterns noted between those sites found interior, and sites found associated with hydrological features. The Middle Archaic (7,000-5,000 YBP) period shows a marked increase in the number of sites found, and thus indicates an increase in the population or at least occupation of the Cape Cod region. Sites representing this time period are found on Cape Cod (34), Nantucket (12) and Martha's Vineyard (25). These sites were associated with headwaters of streams and other areas with access to anadromous fish runs. There is also indication from sites on Martha's Vineyard of hunting and fishing activities. By the Late Archaic Period (5,000-2,700 YBP), there were several traditions, or tool forms, in use (Laurentian, Susquehanna, Small-stemmed and Orient) that indicate an adaptability and utilization of a wide range of resources and a more fixed presence on the landscape (MHC 1986).

In the Cape Cod region, Early Woodland (2,700-2,000 YBP) sites are not well represented, in part due to overlap in traditions (Small-stemmed in particular) from the Late Archaic Period and in part due to problems with ceramic analysis and dating techniques. However, there are sites that represent the Early Woodland period in conjunction with Middle (2,000-1,200 YBP) and/or Late Woodland periods (1,200-400 YBP) as well. The Early Woodland period ushers in an era of ceramic use, as well as the use of materials from other geographic locations indicating contacts with other regions which were important, but not pervasive. It was primarily a regionally insular way of life. Quartz, quartzite and felsite were the primary materials used, and these were easily found along local beaches and river channels. The Late Woodland period is the time when the pre-historic Cape Cod regional population was at its peak, and sites indicate the use of every habitat type. The remains of sea mammals, terrestrial mammals, shellfish and great auk have been associated with these sites (MHC 1986).

Within the last 1000 years, there was a noticeable shift to a more sedentary lifestyle. While similar shifts have been associated with the onset of agrarian enterprise in the Great Lakes region, there have been no village sites in the Cape Cod region associated with fossil evidence of domesticated plants. Instead, this sedentism is evidenced in archaeological sites through an increase in the size and density of shell middens, and the shift in seasons for shellfishing; from the summer months to the winter months, presumably to take advantage of the summer growing season. This increasing emphasis on horticultural endeavors in the last 1000 years is likely due to a more favorable climate. As a result, subsistence patterns, settlement patterns, and social organization may have changed or been influenced, resulting in changes to how early Native Americans interacted with the landscape. However, exactly how these changes were incorporated and what effects they had are still largely absent from the archaeological record (MHC 1986).

Every major archaeological period is represented on Martha's Vineyard and would be expected to be found on Nomans Land Island as well. In fact, five pre-Contact sites (prior to the 1600's) have been documented to date on the island, and one confirms the presence of Native Americans at least as early as the Late Archaic-Early Woodland period (5000-2700 YBP; Jacobson 2000). The modern south shore of Nomans Land Island is close to the location of the mainland shore 10,000 years ago, and may have attracted pre-Contact settlement by paleo-Indian people (Mulholland et al. 1998). According to the Wampanoag Tribe, the island's original name was Cappoaquidnet, and it is likely that it later acquired its present name from the name of its Wampanoag sachem, Tequenoman (http://www.wampanoagtribe.net/Pages/Wampanoag_Way/chilmark). The origin of the island's present name, however, is still unconfirmed.

Oral traditions of the Wampanoag Tribe of Gay Head (Aquinnah) tell that the first Indians on Martha's Vineyard were the giant, Maushop (Proto-Algonquian for "big man" or "giant") and his wife, Squant (derived from the seventeenth-century word, Squáuanit, the woman's god) and their children. One Maushop story recurs frequently, but was first collected in 1792 and published in the Massachusetts Historical Society Collections in 1806. In this story, Maushop separates Nomans from Martha's Vineyard by making marks with his toe across the beach, isolating a section of the isthmus that separates (or joins) them. Water rushed into the cuts on each side of the isthmus and eroded the rest of the beach, separating the islands (Simmons 1986). In fact, Nomans Land Island was likely attached to Martha's Vineyard until recent geological time, within the past 1,000 years. The separation of Nomans Land Island from the Vineyard reflects rising sea level, but the event that finally removed the spit was a storm (LaFarge 1933).

Natural processes were the dominant forces acting on the pre-European landscape. Native prairies, extensive beaver meadows, periodic fires, and occasional hurricanes created a "shifting mosaic" of open land habitat within the forested landscape (Cronon 1983, DeGraaf and Yamasaki 2001). Low-intensity natural disturbances including wind, ice and insects were frequent and local, while higher-intensity large-scale disturbances including hurricanes, tornadoes, and insect epidemics were infrequent. Beavers (Castor canadensis)created extensive wet meadow habitat, although there is no evidence that large grazing animals would have maintained open areas in the uplands (Foster and Motzkin 2003).

Native Americans also contributed to this "shifting mosaic" of open land habitat in southern New England through shifting local agrarian areas for maize, bean and squash crops. They also cut trees for fuel and used fire as a tool to clear the forest understory to aid in travel and hunting game such as white-tailed deer (Marchand 1987, DeGraaf and Yamasaki 2001). Despite some disagreement in the literature regarding how extensive these open land habitats were, Foster and Motzkin (2003) suggest an emerging view that New England native populations were mobile and practiced shifting agriculture that created a mosaic of forest ages, but not extensive areas of cleared land (that would result in extensive grasslands, heathlands, or shrublands). Southern New England tribes were more sedentary than northern New England tribes, and therefore likely set repeated fires that would have had a more lasting impact on the landscape (Patterson and Sassaman 1988).

European Influences

Captain Bartholomew Gosnold, an English explorer, was one of the first white men to record the discovery of Nomans Land Island. Although Native Americans were already occupying the island, the Duke of York claimed authority over the island for New York in 1664. The island was first called Nomans Land Island in 1666 (Banks 1911), and although there are a variety of explanations, the true origin of the name remains uncertain.

The Duke of York granted the island to four men in 1666 with the stipulation that they construct a harbor within three years, develop a fishing trade and pay annually one barrel of cod fish as a quitrents (Banks 1911). However, the grant was forfeited when the men did not meet the conditions, and the island reportedly remained in the control of the Duke for the next 14 years. Although the crown claimed control over the island, records indicate that the first deed record of ownership documents aboriginal ownership at least by 1674 when Sachem Cascanabin sold the western half of the island to his brother Tackquabin in 1686

(Wood 1978). Then, "When [New York] Governer Dongan invested Matthew Mayhew in 1685 with the Lordship of Martha's Vineyard, he included Nomans Land Island by name in the patent and a few days afterwards, Mayhew sold it to Dongan, who thus came into possession of the Island by purchase. . . Dongan sold it on August 3, 1689, to William Nichols of Islip, Long Island…." Then, "John Philip, sachem, sold the island in 1692 to Matthew Mayhew as steward for £50 and Mayhew sold his rights to Nichols the next year" (Banks 1911).

By 1702, Nomans was "well watered and well wooded", and was "very fertile…it is claimed that one of the fields of grass has yielded so large a crop that it could not be cured on the surface of the field" (Sewall in Wood 1978). It was evidently being used in some form of agricultural production, but had not yet had any permanent European habitation. Its Native American inhabitants were Seventh Day Indians, or Sabbatarian Baptists (Sewall in Banks 1911). Sabbatarian Baptists observed Saturday as the Sabbath and underwent religious persecution in England. Some came to Newport, Rhode Island in 1665 (Ward undated).

William Nichols retained the island for twenty-five years, likely without having occupied it, until it was annexed to the Town of Chilmark, Massachusetts (Banks 1911, Wood 1978). In 1715, Nichols sold Nomans Land Island to Jacob Norton whose family kept it for over 50 years (Banks, 1911). Norton may have been the first Englishman to settle on the island, building the Jacob Norton House on the island between 1715 and 1722 (Henry Scott, The Story of a House, Perhaps the Island's Oldest, in Mulholland et al. 1998). The Norton family owned the entire island until 1772, when Jacob's daughter, Abigail, sold one-fourth of the island to John Banester (Wood, 1978).

With the death of the Norton descendents in the mid-1700's, the ownership of the island becomes unclear due to a variety of litigations between claimants, and remains unclear for the next century (Wood 1978). During the eighteenth and nineteenth centuries, the island was owned by several people, and had several permanent inhabitants, including Israel Luce who was buried on the island upon his death in 1787. The fishing opportunities on Nomans began attracting many people during the fishing season. Two villages arose, Gull Town (also known as Crow Town; Wood 1978) and Jimmy Town, and there were over 20 dwellings and fishing shacks that were home to about 40 families. In addition, the island housed a church, school, store, gristmill, graveyard, and a boardinghouse for sailors.

The three major occupations were fishing, raising sheep, and piloting. Men fished in the early spring; about 50 fishermen and their families moved to the island during the cod fishing season. Seasonal cod fishing was important on Nomans Land, and the last community there was focused on fishing (Mulholland et al. 1998). Because there was no safe harbor to anchor their boats, early fishermen fished mostly with hand lines in double ended boats which could easily be hauled on shore. In the late spring, men sheared sheep that inhabited the island. Later, sheep were actually transported to the island from Martha's Vineyard in the spring and summer, and then taken back in the fall (Chilmark Open Space Plan 1984). By the turn of the twentieth century, the woods were gone (Banks 1911). Several low stone walls on the northern side of the island and a wood and stone cistern near the center of the island provide evidence of the community that lived on the island.

Human Influences over the past 100 years

In the early twentieth century, fishing and raising sheep was much less profitable. In 1914, the island was purchased by Joshua Crane (Chilmark Open Space Plan 1984). The island was used as a hunting and fishing camp by the family (Crane et al. 1970), and was named The Crane Estate. Crane created "The Goose Club" with his sportsmen friends, and introduced Belgian hares for fur and meat, muskrats, and birds for trapping and shooting, and he stocked the lakes and ponds with trout for good fishing (Wood 1978). The hare population exploded and the Cranes tried to eliminate them. An admirer of Scotland, Crane also planted Scotch pine and heather along the banks of Ben's Pond (Wood 1978). Joshua Crane introduced Hampshire sheep which produced good wool sold in Boston. Later, his trustees introduced Dorset Delaine sheep shortly before the Navy took over the island. Artist Alexander Crane, Joshua Crane's son, painted

numerous watercolors of the island. A year-round caretaker, Ralph Waldo Wood, lived on the island from 1924 to 1933 (Wood 1978).

In the early 1940s, the U.S. Navy began leasing the island from Joshua Crane as a radar triangulation point for Buzzards Bay and Newport, permitting only military access. In 1943, it was also used as a gunnery range and for bombing activity. For several years immediately following WWII, a Construction Battalion unit, the Seabees, were stationed on the island. Their purpose was to improve the airstrip, erect structures including a radio tower, and to maintain the bombing range. These structures were eventually removed or demolished, and no one has lived on the island since then. However, from 1943 to 1952, Nomans Land Island was used as a military aerial bombardment and gunnery range and live munitions were employed to train military pilots. In 1952, the Navy outright purchased the island from the Crane estate through a declaration of eminent domain, and continued training exercises from 1952 until 1996, substituting dummy bombs for the live ones used during the war (Stone and Webster 1996, http://www.mass.gov/dep/cleanup/sites/nlihstry.htm).

When high explosive munitions ceased to be used in the early 1950's, a number of inert munitions were substituted. Target manuals from 1955 and 1967 list a variety of munitions used including rockets with inert heads, water or sand filled practice bombs, practice shapes, and tracer and other authorized ammunition. They were delivered by glide, dive, toss, masthead, horizontal, rocket, low level and radar bombing, as well as photo and searchlight operations. It appears likely that the majority of these practice ordnance discharged a colored smoke plume to allow pilots to assess target precision (Foster Wheeler Environmental Corporation 2001). Nomans Land Island was used by the Naval Air Stations at Quonset Point (Rhode Island, up until the early 1970s) and South Weymouth (Massachusetts); both oversaw daily operations on the island. It was also used by the Navy Seals (Tetra Tech 2004).

In 1970, the eastern third of the island, approximately 200 acres, was set aside as a migratory bird and wildlife refuge although the Navy still used it for military purposes. The eastern third of the island became a no fire zone in 1982 and the Service began managing the area. In 1995, the Naval Air Station South Weymouth, including Nomans Land Island, was listed for closure under the 1990 Base Realignment and Closure Act. In 1996 all military operations were ceased on the island, and an extensive surface ordnance sweep was commenced to ready the island for transfer to the Service under the cleanup guidelines of that Act. The island was transferred from the Department of Defense to the Department of the Interior in 1998, under the Act Authorizing the Transfer of Certain Real Property for Wildlife (16 USC 667b). A transfer agreement was established by both parties to clearly delineate the terms of the transfer and the ongoing responsibilities of both parties in the future. These terms mandate that the Service keep the island closed to the public due to safety and liability hazards, and that the Navy continue surface ordnance clearing operations to a level commensurate with only minimal access by Service staff for management needs. This will require continued periodic surveillance and surface ordnance clearing as necessary by the Navy in the future, as frost heave and erosion may continue to expose sub-surface ordnance over time.

Erin Victory/TCI

Exposed surface UXO

The Navy retains responsibility for contaminants and MEC that remain on Nomans Land Island as a result of past military operations. The Navy's current management of residual MEC is based on the Services designation of Nomans Land Island as an unstaffed wildlife refuge. Any change to this designation that would result in increased exposure to MEC would require additional cleanup at the Service's expense.

As noted elsewhere in this document, the Navy has been working with the Service and the Massachusetts Department of Environmental Protection on the cleanup of the site since the mid-1990's. Contaminant remediation has taken place and extensive clearance operations were conducted in 1998. In addition there have been two limited follow-up MEC surface clearances, in 2003 and 2008, to address MEC that was exposed by erosion.

A draft Phase III/Feasibility Study Report has been prepared for the Navy which identifies and evaluates appropriate RAAs to address the risk to safety for Nomans Land Island. Risks to the environment, human health, and public welfare have been previously addressed and closure attained. The feasibility of alternatives for remedial actions is evaluated according to criteria set forth in CERCLA and the 2004 Naval Facilities Engineering Command - Guidance for Optimizing Remedy Evaluation, Selection, and Design, and is consistent with the guidance and regulations from the Massachusetts Contingency Plan. The public will be provided an opportunity to comment on the Phase III/Feasibility Study Report in 2010. Once that report is finalized, the Navy will prepare a Proposed Plan to indicate the preferred remedy.

Refuge staff will develop habitat management and inventory and monitoring plans that comply with final Navy Operations and Maintenance plans. We do not anticipate any conflicts with our proposed management of the Refuge as a result of these final Navy plans.

Current Conditions

General Climate Description

"It is said that nowhere else at the same latitude in the northern hemisphere is it as cold as in the Northeast, except perhaps in northeastern China and Hokkaido, Japan" (Marchand 1987). The reason for the region's cold climate is partly a result of the pattern of atmospheric circulation in this hemisphere. Low-pressure systems all converge on New England regardless of their origin and pull cold Canadian air in behind as they pass over the northeast (Marchand 1987). New England weather conditions are influenced more by the North American landmass than by the Atlantic Ocean except along the coastline (Taylor et al. 1996). Forty to forty-five inches of precipitation fall about evenly throughout the year, although drought periods occur in some years (Patterson and Sassaman 1988). According to the Crane daughters, when they lived part-time on the island, "The climate is very mild, there is practically no snow, the wind blows constantly, there is plenty of water, and crops can be sown twice a year" (Crane et al. 1970). The closest weather data station is in Edgartown, Martha's Vineyard (also in Dukes County). Average daily temperatures at this station from 1971 to 2000 were 30.7 °F in January, 46.0 °F in April, 70.5 °F in July, and 53.8 °F in October. The growing season ranges from 158 to 204 days. Average annual rainfall between 1971 and 2000 was 46.06 inches (http://cdo.ncdc.noaa.gov/cgi-bin/climatenormals/climatenormals.pl). Heavy winds and highs seas often accompany storms.

Global Climate Change

Global climate change is a significant concern to the Service and to our partners in the conservation community. Scientists are predicting changes in temperature, precipitation, soil moisture and sea level, all of which could adversely affect vegetation and ecological systems. We expect that species ranges will shift northward or toward higher elevations as temperatures rise, but responses likely will be highly variable and species-specific. Under those rapidly changing conditions, migration, not evolution, will determine which species are able to survive (USFWS 2006). Species that cannot migrate will suffer the most. For example, plants, mussels, and amphibians are more vulnerable to shifts in temperature that may affect their ability to survive, grow, and reproduce.

Climate change impacts in coastal regions include a higher frequency of intense hurricanes and storms, more severe impacts of lesser intensity storms, including nor'easters, warming ocean waters, and rising sea levels (Frumhoff et al. 2007). Sea-level rise is one of the most potentially serious consequences of global climate change for coastal ecosystems like Nomans Land Island. According to the USGS, sea levels have been steadily rising 1-2 mm (0.04 to 0.08 inches) per year since the 19th century (http://geochange.er.usgs.gov/poster/sealevel.html). This is a result of a reduction of ice caps, ice fields, and mountain glaciers, in combination with the thermal expansion of ocean waters. If sea level continues to rise, this could have serious impacts on coastal islands including Nomans Land Island NWR.

The IPCC's most recent climate change report offers a range of estimates of sea level rise over the next century based on model projections under different emissions scenarios. With no likelihood attributed to any of these scenarios, the lowest estimate is 0.18 to 0.38 meters (7 to 15 inches) under the B1 scenario, and the highest estimate is 0.26 to 0.59 meters (10 to 23 inches) under the A1FI scenario (IPCC 2007). It is important to note, however, that these upper bounds do not represent the upper limit of potential sea level rise, because of limitations in knowledge for all of the drivers of sea level change.

Local impacts would be determined by whether the land is subsiding (lowering in elevation due to underground changes, e.g., ground water pumping) or uplifting, topography, and the presence of sea walls and other anthropogenic factors (Galbraith et al. 2002). In the Northeast, sea level rise is higher than the global average because of land subsidence, and parts of both Nantucket and Martha's Vineyard have been classified as areas of high vulnerability to sea level rise by the USGS. Nantucket, for example, is currently eroding at a rate of 15 feet per year (Frumhoff et al. 2007). Coastal communities in Massachusetts such as Gloucester and Marshfield are predicted to lose more than five percent of their land area due to rising ocean waters by 2100 (TNC 2006b). By the mid 1990's, Boston had already seen an increase in mean sea level since 1950 by 5 to 6 inches, and was predicted to see another increase of 22 inches by 2100 (TNC 2006b, USEPA 1997).

These losses in coastal land area include intertidal, salt marsh, and drier coastal upland habitat, resulting in a decrease in feeding, resting and breeding habitat for many coastal fish and wildlife species. These include many marine and coastal bird species, commercial fish including menhaden, alewife and herring, and lobster and clams, among other species (Frumhoff et al. 2007). On Nomans Land, rising sea levels could mean that shoreline habitat for shorebirds and seabirds would migrate inland where elevation is low on the northern side of the island. This could affect the total land area of the Refuge, reduce a portion of the available upland habitat, and may even impact the marshes and ponds on the Refuge through inundation depending on how much ocean waters rise, and considering tidal fluctuations. In addition, erosion of the cliffs will likely accelerate due to increased wave action, and this too could result in a reduction of upland habitat.

In recognition of this, Nomans Land Island NWR is one of several coastal refuges in the northeast for which a formal analysis was completed in 2009. SLAMM (Clough and Larson 2009) is designed to project potential coastal habitat changes correlated with sea level rise by 2025, 2050 and 2100. They include the IPCC A1B Mean and Maximum scenarios, as well as 1.0 and 1.5 m projections. In particular, this analysis highlights the potential impacts of sea level rise on Nomans Land Island NWR, and will enable the Refuge manager to take steps if necessary to mitigate for any of the potential outcomes.

Habitat classifications for the model consisted of dry land (71.9%), swamp (10.5%), open ocean (6.0%), inland open water (5.9%), inland fresh marsh (3.6%), rocky intertidal (1.2%), and ocean beach (1.0%). The model indicates that under all four sea level rise scenarios, there will be minimal to no impact to much of the Refuge due to its higher elevation. Habitats classified as dry land, inland open water, rocky intertidal and ocean beach represented most of the losses in all scenarios, though with varying rates of severity across habitat types and scenarios (Table 3.1). Dry land was lost at rates between three and five percent, depending on the scenario, resulting in a loss of 14 to 22 acres of this habitat type. Inland open water was lost at rates between 5 and 6 percent, or a loss of approximately two acres. Rocky intertidal was lost at rates between 38 and 100 percent, or a loss of 3.5 to all 9.6 acres, and ocean beach was lost at rates between

56 and 98 percent, or a loss of six to almost all 11 acres. As this study was for losses in land area due to sea level rise only, it does not incorporate losses due to erosion or other factors.

Table 3.1. From Application of the Sea Level Affecting Marshes Model (SLAMM 5.0) to Nomans Land Island NWR report (Clough and Larson 2009). Indicates the losses in Refuge lands characterized as Dry Land, Swamp or Ocean Beach under the four different sea level rise scenarios by 2100.

Sea level rise by 2100 (m)	0.39	0.69	1.0	1.5
Dry Land	3.0%	4.0%	4.0%	5.0%
Swamp	1.0%	1.0%	2.0%	2.0%
Ocean Beach	56.0%	62.0%	98.0%	98.0%

Erin Victory/TCI

East Bend Pond; predicted to be inundated by ocean waters by 2100

Table 3.2. Modified from Application of the Sea Level Affecting Marshes Model (SLAMM 5.0) to Nomans Land Island NWR report (Clough and Larson 2009). Indicates initial acreage of Refuge lands by habitat classification, and the projected change in acreage in each category by 2100 according to the four sea level rise scenarios.

	Initial acreage	Sea level rise projections by 2100 (m)			
		0.39	0.69	1.0	1.5
Open Ocean	1106.9	1128.7	1134.8	1143.1	1148.4
Dry Land	449.0	435.6	432.4	430.3	426.8
Swamp	64.9	64.3	64.0	63.8	63.7
Inland Open Water	36.5	34.5	34.5	34.2	34.2
Inland Fresh Marsh	22.0	22.0	22.0	22.0	22.0
Ocean Beach	11.1	4.9	4.3	0.2	0.0
Rocky Intertidal	9.6	5.9	3.7	1.5	0.2
Estuarine Open Water	0.0	3.1	3.0	3.3	3.2
Tidal Flat	0.0	0.0	0.3	1.1	0.9
Estuarine Beach	0.0	1.0	1.1	0.4	0.5
Total (incl. water)	1700.0	1700.0	1700.0	1700.0	1700.0

In all scenarios, the cobble spit on the north end of the island is lost or much reduced by 2100, as are much of the lands classified as ocean beach around the northern and northwestern portions of the island. These areas are the lowest in elevation and are therefore most vulnerable to increases in sea level. The inland open water most affected is East Bend Pond at the northern tip, which is already influenced by storm tides, and is likely to be inundated with rising ocean waters and particularly by tidal fluctuations without the buffer of the cobble spit and ocean beaches present today. The only habitat type predicted to remain unchanged is inland fresh marsh under all scenarios (Table 3.2). On the other hand, additional habitat types are predicted to emerge, though on a small scale. Though there are currently no habitats classified as estuarine open water, tidal flat or estuarine beach, these three habitat types are predicted to occur as a result of the rising ocean water and losses of the present shoreline buffer, though to varying extents depending upon the scenario.

When using models, there can always be uncertainties in the results due to limitations in input data and knowledge of all of the components of an ecosystem. However, this does not mean that the use of models is uninformative, nor does it undercut their importance as tools to help with management decisions. It simply

highlights the need to place the results in the appropriate context for decision making. In setting up the model for Nomans Land Island NWR, there was a slight mismatch between the National Wetlands Inventory map and the digital elevation map used to create input data for the model, and this was most evident at a small portion of the southern end of the island. In addition, there was some known uncertainty because of poor resolution from a lack of accurate elevation data. Since no LiDAR elevation data was available for the Refuge, National Elevation Data (NED) was used instead which was based on a survey conducted in 1942. Therefore elevational data for the island were extremely out of date and were of poor resolution. The uncertainty within NED means that the predictions in the losses of dry land and ocean beaches could be refined with more accurate elevational input data, though this is more relevant along the shoreline. The interior portion of the island is at a high enough elevation that the model predictions that it will remain largely unchanged by sea level rise are thought to be sound. See Appendix I for the report.

This analysis provides us with some picture of what to expect in the next century, and provides an opportunity to begin incorporating climate change monitoring and to consider our options for management and mitigation of these potential outcomes. The ocean beach and rocky intertidal habitats are particularly vulnerable to sea level rise on Nomans Land Island. These results indicate that in the absence of any mitigation, there will be some losses to overall Refuge acreage, which will result in losses to valuable wildlife habitat for beachnesting birds of conservation concern. As climate change becomes better understood, our ability to model climate change impacts increases; therefore the Refuge will continue to look for opportunities to take advantage of latest scientific advancements to aid in Refuge management.

Air Quality

The Massachusetts Department of Environmental Protection (MA DEP) monitors levels of ozone and particle pollution from several stations in Massachusetts for attainment or exceedance of the National Ambient Air Quality Standards (NAAQS) set by the USEPA. These standards are reviewed every five years by the USEPA and may be changed due to new scientific information. It is incumbent upon each state to ensure these standards are met and maintained. In the case of an exceedance of these standards, pollution control strategies are implemented, and once the standards are attained, a plan is developed to maintain that standard in such a way that incorporates future economic and emissions growth.

In 2008, Massachusetts was in attainment of the air quality standards for all pollutants except ozone. Ozone at ground level is a respiratory irritant that can reduce the overall function of the lungs, cause asthma attacks, and aggravate chronic lung diseases. It also inhibits vegetation growth, and is often found in higher concentrations far downwind from the origination of the precursors that react to form it, which is why it is applicable for Nomans Land Island despite the islands' uninhabited status (MA DEP 2009). Over the last decade, the State of Massachusetts has made progress in reducing the number and severity of ozone exceedances, and in January 2008 submitted a State Implementation Plan to the USEPA that describes strategies to attain the 8-hour ozone standard by 2010 (MA DEP 2008a).

There are a total of 14 air quality monitoring stations across Massachusetts. Based on information collected from these sites, there were a total of 49 exceedances of NAAQS for ozone over 15 days in 2008. The closest two monitoring stations to the Refuge are included in those that registered exceedances: Fairhaven, MA (4 days) and Truro, MA (3 days). Exceedances at a station averaged over three years can lead to a violation of NAAQS. Based on data from 2006 to 2008, both of these stations were in violation of the 8-hour ozone standard (MA DEP 2009).

Water Quality

Summary of the General Condition of Nomans Land Island

Nomans Land Island is surrounded by the Atlantic Ocean. Average tidal rise and fall is 8.5 feet, with extremes from 8.0 to 14.0 feet in storm or hurricane induced tides. Tides generally do not reach inland, except occasionally on the north shore (French 1973c). Wetland types range from persistent emergent

wetlands to permanently flooded-open water. All inland wetlands are classified as palustrine (Wray and Ladd 1985). These wetlands supply water to the ponds, as water flow is generally from emergent wetlands to open wetlands to the larger ponds. The ponds exist in low-lying portions of the island and are primarily spring-fed, and water levels of some fluctuate according to seasonal changes in groundwater elevation. Perched conditions exist where clay deposits act as barriers to vertical groundwater flow, and because of multiple clay layers, it is possible for several discrete aquifers to exist on the island. This may explain the presence of wetlands at higher elevations on the island, as these perched aquifers impede the movement of groundwater (Foster Wheeler Environmental Corporation 2001). The freshwater ponds are shallow and are succeeding rapidly toward a marshy condition with emergent vegetation beginning to dominate. The water is tannic and has low dissolved oxygen content (G. Ben David, personal communication).

Two large ponds are present on the island. Ben's Pond lies just west of the center of the island and is 1,000 feet by 500 feet. Rainbow Pond lies on the east end of the island. It is about 625 feet long and has two arms extending from it (Stone and Webster 1996). Adjacent to Rainbow Pond is a small pond with a vitreous clay pipe outlet, which failed in 1998 during a heavy rainstorm. The resultant water flow was causing severe erosion on the cliff side of the island and a new water control structure consisting of a corrugated metal pipe was installed that same year (Prior 1998). Water levels have been maintained at the same elevation as they were prior to the clay pipe outlet failure. In addition, there is one natural pond at the north end, which is subjected to salt-intrusion during storm tides (French 1973c).

Early settlers created artificial ponds on the island, largely on the western portion, by diking the outflow of bogs or digging below the water table and mounding the excavated dirt in a horseshoe shape to retain the water. In total, there are approximately 40 surface acres of spring-fed and runoff-fed waterbodies. In addition, sphagnum-cranberry-type bogs meander over about 200 acres of the island (French 1973c).

Erin Victory/TCI

One of the Refuge's ponds

Long-Term Trends and Status of Water Quality

State-reported Impaired Waters

In 2008, the DEP released the 305(b)/303(d) Integrated List of Waters (report; MA DEP 2008b). It combines both the 305(b) Water Quality Assessment and the 303(d) Report on Impaired Waters for each river basin. The DEP compiled those reports and submitted them to the USEPA and Congress, to satisfy the federal reporting requirements under section 305(b) of the Clean Water Act.

Much of the data in this report comes from a number of different third party sources including federal, state, and non-governmental agencies, as well as projects with state, local or federal funding that submit individual watershed reports. Though the sources of data are varied, they must all have a Quality

Assurance Project Plan, use of a state certified lab, QA/QC for data management, and documentation in a citable report. This ensures they are all subject to the same documentation and validation procedures.

The report on impaired waters in the state describes segments of streams, lakes, and estuaries that exhibit violations of water quality standards, details the pollutant responsible for the violation(s) and the cause and source of the pollutant, if known. In the Islands Watershed (Martha's Vineyard, The Elizabeth Islands and Nantucket), there were 18 waterbodies listed as impaired. Pathogens were the primary cause for impairment, but other impairments included nutrients, organic enrichment/low dissolved oxygen, other habitat alterations, turbidity, and noxious aquatic plants. Waterbodies on Nomans Land Island are not monitored, and therefore the island is not included in this report.

For more specific water quality information pertaining to Nomans Land Island, see the Influences on Water Quality, and Comprehensive Site Assessment sections below.

Submerged Aquatic Vegetation (SAV) as an indicator of water quality

SAV is a critically important component of the aquatic environment in shallow coastal ecosystems, and its presence and robustness are indicators of good water quality. SAV can only thrive in shallow depths where light reaches the benthic zone. The rooted aquatic beds provide shelter and food for numerous aquatic invertebrates. SAV also recycles nutrients, helps to stabilize sediment, and oxygenates the water (http://www.mass.gov/dep/water/resources/maps/eelgrass/eelgrass.htm).

SAV composition varies with salinity. In Massachusetts, the most common species is eelgrass (Zostera marina) along the coastline. The MA DEP began a program in 1995 to track and monitor changes in existing eelgrass beds to provide an indicator of water quality. Eelgrass is an ideal species because it is sensitive to nitrogen loading and to physical disturbance, and can be documented using aerial photos.

The state has no SAV monitoring site immediately adjacent to Nomans Land Island. Two sites exist on the westernmost part of Martha's Vineyard, however, and these both indicate a reduction in eelgrass area in acres. Menemsha Pond showed a decrease of 73.9 acres, or 17.3% between 1995 and 2001, and Lobsterville showed a decrease in 2.0 acres, or 2.1% over the same time period (http://www.mass.gov/dep/water/resources/maps/eelgrass/eelgrass.htm).

Influences on Water Quality

Beginning in 1943, the U.S. Navy leased Nomans Land Island as a target range to train military pilots. Its use for over 50 years resulted in varying degrees of impact to water quality, soils, vegetation, and wildlife. As a result of their use, the U.S. Navy has subsequently conducted extensive environmental monitoring on Nomans Land Island. A Supplemental Environmental Baseline Survey (SEBS) Completion Report written by TetraTech FW in 2004 provides information about surface and groundwater quality in Ben's Pond, Rainbow Pond, and other areas of potential concern. Surface water samples were collected for chemical analysis (explosives, metals and perchlorate) in conformance with state and federal guidelines. Even though some benchmarks were exceeded, quantitative risk assessment conducted in conformance with MA DEP and CERCLA guidelines demonstrated no unacceptable ecological or human health risks. See Appendix H for more detailed information.

Contaminants and Unexploded Ordnance

At the conclusion of World War II, the island contained large numbers of unexploded bombs and craters. The Navy continued training exercises substituting inert dummy bombs for the live bombs used during the war and continued to use the island for aerial gunnery and bombardment until 1996. In a Notice of Responsibility letter to the Navy dated September 26, 1997, Nomans Land Island was listed as a disposal site by the MA DEP for the reported release of hazardous materials due to the historical use of the island. Reports supporting this action include: the Base Re-Alignment and Closure Cleanup Plan (September 13, 1996), the Environmental Baseline Survey - Phase I Report (November 18, 1996), and the Prescribed Burn Prescription (January 7, 1997). Under the Defense Base Closure and Realignment Act of 1990, the island

was transferred from the Department of Defense to the Department of the Interior's Fish and Wildlife Service on June 26, 1998. There were three contaminant issues involved in the transfer of the island to the Service: (1) unexploded ordnance removal, (2) underground storage tank removal, and (3) comprehensive site assessment.

Ordnance Debris Removal

Ordnance debris removal is one of the largest tasks involved in the transfer agreement between U.S. Navy and the Service. In 1997 and 1998, to prepare the island for transfer under the conditions stipulated in the Base Realignment and Closure Act of 1990 and the transfer agreement, UXO clearance operations were initiated. They included site preparation (including a controlled burn to reduce the vegetation cover), surface clearance of ordnance debris and residual target materials, neutralizing suspected explosive ordnance, consolidation of ordnance related material, marking of inert ordnance, screening for potential depleted uranium, data compilation and reporting, and off-site transport and recycling of ordnance related materials (Foster Wheeler Environmental Corporation 1998a). Since 1998, the Navy has continued surface MEC surveillance operations every five years, returning in both 2003 and 2008 to locate and remove exposed surface ordnance, and they will continue to do so. See Appendix H for more detail of all Navy UXO clearance operations.

Closure of Underground Storage Tanks

In the removal of one underground storage tank (UST) and associated pipelines as part of the preparation for the transfer, additional underground storage tanks were identified, along with petroleum-contaminated soil. This resulted in the removal and off-site transport and disposal of petroleum product from two tanks, removal of the USTs and associated piping, cleaning tanks, removal of approximately one half cubic yard and 25 cubic yards of petroleum-impacted soil from two tank excavations, post-excavation soil sampling and screening, re-grading and site restoration, off-site transport and disposal of USTs and piping to an approved tank yard, and off-site transport and recycling of petroleum-impacted soil (Foster Wheeler Environmental Corporation 1998b). For more detailed information see Appendix H.

Comprehensive Site Assessment

The Comprehensive Site Assessment of the island consisted of several phases. Phase I was completed to document site conditions and to assess potential site contamination, and Phase II was completed to evaluate the levels of risk associated with the contaminants detected during Phase I. Phase II addressed the contaminated media (soil, sediment, groundwater and surface water on the island), and assessed the risks to human health, environment, public welfare, and public safety (Foster Wheeler Environmental Corporation 2001). These risk characterizations were cumulative assessments of the identified hazards, dose-response assessments, and exposure assessments for USFWS workers, authorized visitors, and adult and child trespassers. They were based on estimates of future use of the island including type and extent of activities in a given habitat, duration of visits, seasonality of visits, and total annual number of visits. Estimates of age, weight and amount of exposed skin (i.e., short sleeves vs. long sleeves) were also taken into account.

The findings related to human health and public welfare were established as "No Significant Risk" and "No Significant Finding," respectively. This is because the risks to human health, including USFWS staff, other authorized visitors and trespassers were assessed based on current and future use of the island as an unmanned national wildlife refuge. The evaluation for public welfare was based on the contaminant levels and the associated nuisance conditions and community effects, and no significant risk was identified. Risks to public safety, on the other hand, were evaluated based on the presence of UXO. Despite the fact that the Navy will continue their efforts to remove ordnance that may be exposed or observed over time, the island will always pose a potential risk. In addition, despite the joint efforts of the Navy, Coast Guard and Service to deter public trespass through warning signs and monitoring patrols, there is no guarantee that trespass will be prevented. Therefore, a finding of "No Significant Risk" was not established for public safety. See Appendix H for more information.

The Regional Socio-Economic Setting

Socio-economic Factors: Regional Economic Setting

Nomans Land Island is part of the Town of Chilmark. Chilmark is a rural community located toward the western end of Martha's Vineyard. It is bordered by the Atlantic Ocean on the north, northeast, and south; West Tisbury on the west; and Aquinnah to the southwest. In 2007, the population was 963 people, compared to 650 in 1990 and 843 in 2000 (U.S. Census Bureau, http://www.census.gov/popest/archives/). The total area of Chilmark is 34.70 square miles of which 19.14 square miles is land area (http://www.state.ma.us/dhcd/iprofile/062.htm#NARRATIVE). Per capita income in 1999 was $30,029 (Department of Revenue 2000).

Most of Chilmark's acres are residential or agricultural. The center of town contains an elementary school (one room school built circa 1850), a public library (built in 1790), a town hall (built circa 1897), and a church (built in 1843). Chilmark also contains a small fishing village, Menemsha, which includes a U.S. Coast Guard Station, commercial pier and small marina (http://www.state.ma.us/dhcd/iprofile/062.htm#NARRATIVE). Ferry service is the vital link to and from Martha's Vineyard. The Wood's Hole, Martha's Vineyard and Nantucket Steamship Authority provide year-round ferry service.

Refuge Revenue Sharing Payments

The Refuge Revenue Sharing Act of 1935 (16 USC 715s), as amended, provides annual payments to taxing authorities, based on acreage and value of refuge lands. We have contributed refuge revenue sharing payments to the Town of Chilmark for Nomans Land Island since the Refuge was established in 1998 (see Table 3.3). Money for these payments comes from the sale of oil and gas leases, timber sales, grazing fees, the sale of other Refuge System resources and from Congressional appropriations. The actual Refuge Revenue Sharing Payment does vary from year to year because Congress may or may not appropriate sufficient funds to make full payment. Payments are based on one of several different formulas, whichever results in the highest payment to the local taxing authority. In Massachusetts, the payments are based on three-quarters of one percent of the appraised market value. The purchase price of a property is considered its market value until the property is reappraised. The Service reappraises their properties every five years.

Table 3.3. Annual Refuge Revenue Payments for Nomans Land Island NWR.

Year	Refuge Revenue Sharing Payment for Nomans Land Island NWR
1999	$41,276
2000	$38,631
2001	$33,711
2002	$37,756
2003	$35,271
2004	$33,900
2005	$29,984
2006	$33,863
2007	$31,341
2008	$30,306
Total	$346,039

Refuge Administration

Refuge Establishment and Land Acquisition

Nomans Land Island was used for aerial gunnery and bombardment by the U.S. Navy from 1942 to 1996. In 1970, we began managing an "overlay" Refuge on the eastern third of the island under a Joint Management Agreement between the Department of the Interior and Department of Defense. Following an extensive surface clearance of ordnance in 1997 and 1998, the island was transferred to the USFWS to become Nomans Land Island National Wildlife Refuge. It was established " ...for use as an inviolate sanctuary, or for any other management purpose, for migratory birds" [16 USC § 715d (Migratory Bird Conservation Act)].

The Federal-to-Federal Real Property Transfer Agreement (Appendix G) with the Navy is subject to certain conditions, covenants, and reservations including (1) the Navy's reservation of right to access the property for the purpose of conducting ongoing investigations, studies, and required remedial action related to environmental clean-up and (2) the Navy's responsibility of liability as long as the Service administratively closes the island to all public access and maintains appropriate and adequate warning devices. In addition, waters surrounding Nomans Land Island are restricted to all unauthorized vessels (see the Law Enforcement section below).

The Eastern Massachusetts NWR Complex and Staffing

Since the Refuge was established, it has been administered as a satellite of the Eastern Massachusetts NWR Complex located in Sudbury, MA. We use the term "refuge complex" to describe two or more individual refuges, typically in the same region of a state or adjoining states, administratively combined under a single refuge manager's responsibility. Present staffing for the complex include sixteen permanent positions, thirteen located at the complex headquarters in Sudbury and three located on Monomoy NWR, three yearly term biologists, and several seasonal interns and volunteers. There is no staff stationed on Nomans Land Island NWR, however, complex biologists conduct site visits several times a year. The Refuge Manager is responsible for determining how to distribute staff time to accomplish priority work.

Funding

The funding for Nomans Land Island NWR is embedded in the budget for the entire refuge complex. Operational funding includes salaries, supplies, travel, and all other operational activities (wildlife and habitat surveys and management) that are not funded by special projects. Our annual funding fluctuates according to the number and size of the projects funded each year (e.g., vehicle or equipment replacement, visitor service enhancements, and facility improvements). Table 3.4 below summarizes the levels of funding for the entire Eastern Massachusetts NWR Complex, including Nomans Land Island, in fiscal year 2007, 2008 and 2009.

Table 3.4. Fiscal year funding for the Eastern Massachusetts NWR Complex for 2007 to 2010 by type.

	2007	2008	2009	2010
Operations	$2,070,809	$2,181,898	$1.919,275	$2,124,247
Supplemental			$327,500	$330,975
Construction	$2,898,619	$497,465	$4,560,000	$2,030,071
Total Fiscal Year Budget	$4,969,428	$2,679,363	$6,806,775	$4,485,293

Refuge Facilities and Maintenance

Currently, there are no existing intact structures on Nomans Land Island that would serve as a Refuge facility. The last inhabitation of the island was by Navy personnel in the 1950's, and public access is restricted due to the presence of unexploded ordnance. All of the buildings associated with the use of the island before the Navy acquired the island, and all the buildings associated with the Navy's use of the island, have been demolished or lost due to time and weather. There are a total of 4.6 miles of old farm and military roads on the island that are maintained by Refuge staff for access to the island. In addition, there are eight large warning signs erected around the edge of the island which must be maintained by Refuge staff as well as two brown USFWS signs. Three steel Conex storage structures hold equipment needed by staff to conduct Refuge operations. In 2008, two moorings were installed by the Navy offshore the island. These are now property of the Service. Depending on the alternative chosen, the water control structure for the wetland near Rainbow Pond may require periodic maintenance. Also, additional clearing of old roads may be necessary, depending on the alternative chosen.

Refuge Step-down Plans

The following step-down plans have been completed, and apply to all eight refuges in the Eastern Massachusetts NWR Complex:

- Fire Management Plan—completed in 2003
- Avian Influenza Surveillance and Contingency Plan—completed in 2007; updated annually
- Hurricane Action Plan—completed in 2009; updated annually

Additionally, each year an annual work plan, known as the Refuge Annual Performance Plan, is prepared for the Refuge. While this is not considered a step-down plan, it is a plan that is developed annually and guides the work completed by staff each year on the Refuge.

We plan to complete the following step-down plans after completion of the CCP (see Chapter 2). Additional plans may be required depending on the alternative selected for the final CCP. An updated Fire Management Plan is scheduled to be completed in 2010. Please see Appendix F for general fire program direction.

- Annual Habitat Work Plan
- Safety Management Plan, which includes UXO Inspection Logs
- Habitat Management Plan
- Inventory and Monitoring Plan
- Law Enforcement Management Plan
- Cultural Resources Management Plan

The Navy is completing an UXO Safety Operations and Maintenance Plan for the island. That plan contains a field observation log for recording the presence of MEC which has been exposed due to erosion or the freeze-thaw cycle. The requirements of this plan will be incorporated into the Refuge Safety Plan.

Findings of Appropriateness and Compatibility Determinations

Chapter 1 describes these two decision processes in detail. To date, no compatibility determinations or appropriateness evaluations have been completed for Nomans Land Island NWR because of its closure to the public. See also the discussion below for Special Use permits.

Government-to-Government Relationship with Wampanoag Tribe of Gay Head (Aquinnah)

In 1987, the Wampanoag Tribe of Gay Head (Aquinnah) received federal recognition through a Congressional act (Wampanoag Tribe of Gay Head, Inc. Indian Claims Settlement Act - PL 100-95, August 18, 1987). In 1999, the Tribe received Tribal Historic Preservation authority by the National Park Service which oversees the National Historic Preservation Act. Under this action, an ancestral territory map was created, which includes Nomans Land Island, for purposes of consultation with issues related to Section 106 of the National Historic Preservation Act (http://www.wampanoagtribe.net).

Because the Wampanoag Tribe of Gay Head (Aquinnah) is federally recognized, a government-to-government relationship exists with the Service. The Service consults with the Wampanoag Tribe regarding compliance with Native American Policy. This policy commits the Service to involving the Wampanoag Tribe in all Service actions that may affect its cultural and religious interests, cooperating with the Tribe in the administration of fish and wildlife conservation, and the identification of funding sources for fish and wildlife resource management. The Tribe is a member of the core planning team for the development of this CCP. We have a good working relationship with the Tribe on fish and wildlife funding projects. A partnership agreement is underway to further define our working relationship as it relates to biological and cultural issues on Nomans Land Island. This agreement will address issues such as providing access to the Wampanoag Tribe for occasional ceremonial purposes, the collection of vegetation in certain areas for ceremonial purposes, the potential repatriation of Wampanoag remains in a designated area on the Refuge, cooperative outreach efforts to inform the public about the value of Nomans Land Island to the Tribe, and potential for collaboration on biological and law enforcement activities.

Nomans Land Island is very important to the Wampanoag Tribe, many of whom reside within sight of the island in Aquinnah on Martha's Vineyard. The Tribe occupied the area before European settlement, and according to their history, the island was used by the Tribe for millennia. The island is an important component of their oral traditions (http://www.wampanoagtribe.net).

Partnerships

Though the Refuge is administratively closed to the public, we have relied on partnerships to assist Refuge staff in documenting and monitoring species on the island. Some partners have joined us to complete a single project or provided funding, technical support, and on-the ground help. Our most enduring partnerships involve several regional, state, and national organizations who have contributed additional information about the habitat and species on the Refuge through independent surveys of their own in conjunction with Refuge endeavors. These include the Massachusetts Audubon Society, Edey Foundation, Polly Hill Arboretum, and New England Wildflower Society. In addition, we have strong ties to state agencies and universities in achieving mutual conservation objectives. Much of what we know about the floristic species on the Refuge, as well as help with avian monitoring and management, is through the work done by these partners. These include the Massachusetts Natural Heritage and Endangered Species Program, University of Massachusetts Dartmouth, New York State Museum, and Harvard University Herbaria.

Community Outreach

Maintaining effective relationships and outreach with the residents and officials from Chilmark and Aquinnah is important and needs to be improved, particularly since public access is not allowed on the Refuge. The Service has compensated for this through the development of a virtual tour which is available on the Refuge web site (http://www.fws.gov/northeast/nomanslandisland). The virtual tour has narrated videos which provide an overview of the Refuge, island features, and descriptions of wildlife and habitats.

In the future, as described in Alternatives B and C, public outreach efforts would be expanded to include kiosks, displays, and brochures available on Martha's Vineyard and at the refuge complex headquarters and visitor center. School programs could potentially be developed around the importance of island ecosystems. Refuge staff would make an effort to occasionally participate in special events on Martha's Vineyard.

Volunteer Program

The refuge complex has an active volunteer program with 10,468 hours contributed by volunteers in Fiscal Year 2009. Most volunteer work is conducted at four of the eight refuges in the refuge complex. Volunteer contributions at Nomans Land Island NWR are limited due to the restricted access on the Refuge and the limited number of visits conducted by staff annually. All volunteers are accompanied by staff, and undergo safety training. They assist in biological and maintenance activities, such as conducting biological surveys, wildlife inventories, invasive species control, trail clearing and sign maintenance. The number of volunteer hours donated each year varies from zero to 350, but generally averages about 100 hours per year. Most volunteers are biological interns working at the complex headquarters in Sudbury or former Service employees who continue to provide volunteer service to the refuge complex.

Special Use Permits, including Research

Special use permits are issued to individuals, organizations, and agencies that request the use of Refuge facilities or resources beyond what is available to the public. In order to ensure that wildlife disturbance is minimized, special conditions and restrictions are identified for each request.

We support research activities on the Refuge, when they are compatible with the Refuge purposes, and help us gain knowledge and understanding to benefit our management goals and objectives. Because of the unusual circumstances for this Refuge regarding access and the presence of UXO, opportunities for research typical on other refuges may be more limited on Nomans Land Island. However, we evaluate each request individually. Refuge staff, university researchers, conservation organizations, and others have conducted research projects and surveys on the Refuge. Table 3.5 identifies some of the permits we have issued for research in the last few years. You may obtain additional information on these studies from the refuge complex headquarters.

Table 3.5. Sample of special use permits for Nomans Island NWR since 2004.

Year Issued	Organization/ Permittee	Purpose
2004	Harvard University Herbaria	Lichen surveys
2004	University of Massachusetts, Dartmouth	Marine algae (seaweed) surveys
2005	New England Wildflower Society	Plant surveys
2005-2007	Gordon Waring	Aerial surveys-pupping areas for gray seals
2007	New York State University	Moss and liverwort surveys
2008	U.S. Navy	Ordnance clearing

Refuge Natural Resources

Soils—General Description

The classification of Nomans Land Island NWR as a U.S. Navy Restricted Area has prevented the surveying of its soils. However, the generalized geologic map of Dukes County identifies the island as Squibnocket Moraine and Beach Deposits. Squibnocket Point of south Aquinnah, Martha's Vineyard, is also identified as Squibnocket Moraine. The soils of Aquinnah have been surveyed, and it is assumed that the soils of Nomans Land Island NWR would be similar because of its similar geological origin. The geological deposits that make up Dukes County consist of recent beach and marsh sediments, glacial deposits, interglacial deposits, and glacially deformed ancient coastal plain sediments. The Squibnocket Moraine is made up of the oldest deposit, a compact, pink and purple-gray till. This moraine is covered by a Wisconsin-age veneer consisting of stony till and outwash that also covers the Gay Head moraine and which forms a ridge and valley topography extending from Aquinnah to Chilmark and West Tisbury, Martha's Vineyard (Fletcher and Roffinoli 1982).

The Gay Head Moraine consists of folded and faulted older Pleistocene deposits, coastal plain sand silt, and clay of Cretaceous and Tertiary Age. The common soils in this moraine are the Eastchop, Chilmark, and Nantucket soils. The Eastchop-Chilmark-Nantucket soil type is nearly level to steep, very deep excessively drained and well drained, sandy and loamy soils formed in reworked glacial outwash, ice-thrusted coastal plain sediments, or glacial till on moraines. The poorer drained soils of Aquinnah are the Ridgebury Variant and Whitman Variant soils, and it is assumed that these would be the soil types of Nomans Land Island NWR's wetland areas. Whitman soils are associated with cranberry bogs on Martha's Vineyard and Nomans Land Island (Fletcher and Roffinoli 1982).

During the Navy's cleanup operations, soil cores were taken. These indicated a well developed soil profile over coarse to fine sands with interspersed with cobbles and boulders. Five soil horizons (Oe, A, E, B, C) were present, indicating successive stages of breakdown from a rich organic layer at the surface down to weathered "parent material", which in this case is glacial till. Some glacial erratics exist around the island, but no bedrock outcrops were located (Foster Wheeler Environmental Corporation 2001).

Refuge Habitat Type and Vegetation

In 1985, a survey of vegetation types was conducted on Nomans Land Island NWR by the Service. In 2000, a vegetation cover type map was created by the Service based on aerial photography dated September 20, 1984, and ground-truthed (checked on the ground) in 1985. In 2010, we will be making efforts to delineate wetland vegetation and will endeavor to produce a cover type map that will more accurately reflect Refuge habitats, and provide better resolution than previous maps.

Nomans Land Island NWR was well forested in the 17th century, but was cleared almost completely during the 1800's for farming and sheep-raising. Current vegetation is indicative of a previously forested area. Greenbrier (Smilax rotundifolia), a major component of pine-oak-maple woods and shrub thickets elsewhere in southeastern Massachusetts, is abundant on the eastern half of the island. Plants typically found in the shaded woodland such as Indian cucumber root (Medeola virginiana), Canada mayflower (Maianthemum canadense), grove sandwort (Moehringia lateriflora), swamp prickly sedge (Carex seorsa) and skunk cabbage (Symplocarpus foetidus) are all fully exposed to the sun on Nomans Land Island NWR. It is likely that these species first established on the island in shaded, forest habitat (Sorrie et al. 1988).

Map 3-4

Nomans Land Island National Wildlife Refuge - Comprehensive Conservation Plan

Nomans Land Island National Wildlife Refuge

Habitat Classes

Habitat Type

Maritime Shrub Habitat

Harsh oceanic winds, salt spray, and lack of shelter have since created a brush, forb, grass, and sedge vegetative complex across 400 acres of the island. Although a few dwarf willows (Salix spp.), pitch pine (Pinus rigida), and eastern red cedar (Juniperus virginiana) are present, natural reseeding is inhibited by the absence of seed trees. Dominant upland vegetation includes rose (Rosa species), poison ivy, (Rhus radicans), bayberry (Myrica pensylvanica), and arrowwood (Viburnum dentatum). Openings created by recent past fires support grasses and forbs including poverty grass (Danthonia spicata), timothy grass (Phleum pretense), blue joint grass (Calamagrostis canadensis), little bluestem (Schizachyrium scoparium) and yellow thistle (Cirsium horridulum).

Dune Habitat

It is estimated that there is approximately 15 acres of vegetated dune habitat on the island. Sand dune-beach plant communities along the northern shore are comprised of beach grass (Ammophila breviligulata), switchgrass (Panicum virgatum), beardgrass (Andropogon species), seaside goldenrod (Solidago sempervirens) and beach pea (Lathyrus maritimus) (Wray and Ladd 1985). This habitat grades into a gravel-sand beach that, together with the vegetated dune, provides habitat for beachnesting species including terns and American oystercatchers.

Emergent Marsh Wetlands, Bogs, and Open Water

Wetland types range from persistent emergent wetlands to permanently flooded-open water. All inland wetlands occupy a total of 100 to 150 acres of the island, and are classified as palustrine (Wray and Ladd 1985). A diversity of wetland types support varied plant communities. Virginia chain fern (Woodwardia virginica), cranberry (Vaccinium macrocarpon), and sphagnum mosses (Sphagnum species) represent a common wetland plant community. Other associated wetland plant species include broad-leaved cattail (Typha latifolia), sweetflag (Acorus calamus), blueberry (V. Corymbosurn), sheep laurel (Kalmia augustifolia), common reed (Phragmites australis), soft rush (Juncus effusus), and marsh fern (Thelypteris dryopteris) (Organ 1985, Wray and Ladd 1985).

Early settlers created four artificial ponds by installing dikes at the outflow of bogs. Other man-made ponds were created by digging below the water table and depositing the excavated soil in a horseshoe shape around the site to retain the water. In addition, two large freshwater ponds and a number of smaller ponds dot the island. The smaller ponds are spring-fed and runoff-fed that total 40 acres, and are a result of kettle holes. These are areas where blocks of glacial ice were deposited and left to melt. Of the two larger ponds, Ben's Pond lies just west of the center of the island and is 1,000 feet by 500 feet. The 625 foot long Rainbow Pond lies on the east end of the island. A wetland associated with this pond historically had a vitreous clay pipe outlet that failed in 1998 during a heavy rainstorm. The resultant water flow was causing severe erosion on the cliff side of the island and a new water control structure consisting of a corrugated metal pipe was installed that same year (Prior 1998). Water levels are maintained at the same elevation as they were prior to the clay pipe outlet failure. The freshwater ponds are shallow and are succeeding rapidly toward a marshy condition with emergent vegetation beginning to dominate. The water is tannic and has a low dissolved oxygen content (G. Ben David, personal communication). Sphagnum-cranberry bogs occur on over 200 acres of the island. In addition, there is one natural pond at the north end that is subjected to salt-intrusion during storm tides (French 1973c).

Marine Intertidal Beach and Rocky Shore

A majority of the perimeter of the island is characterized by 50-foot bluffs, and a narrow band of coarse gravel, cobble and boulders. The exception to this on the north-side of the island, which is more characteristic of a sand-gravel beach (see Dune Habitat above). There is approximately 100 acres of marine intertidal beach and rocky shore on the island, including a cobble spit. This habitat provides the interface between land and ocean. Intertidal habitat consists of a rich invertebrate community that is constantly

replenished by the ocean. These are important areas for foraging shorebird species. The shoreline provides important nesting habitat for bird species, including the double-crested cormorant and American oystercatchers. Harbor and gray seals also use the island's beaches as a haul-out site throughout the summer months as well (See Refuge Biological Resources below).

Comprehensive Floristic Surveys

Vascular plants

In 1988, a comprehensive floristic survey was conducted on Nomans Land Island NWR by Massachusetts Natural Heritage and Endangered Species Program and the Service (Sorrie et al. 1988). A complete list of plant species found during this survey is in Appendix B. During the inventory, three state-listed plant species were found: dragon's mouth (Arethusa bulbosa, state threatened), shore pygmy weed (Crassula aquatica, state threatened), and sandplain blue-eyed grass (Sisyrinchium arenicola, state species of special concern). Dragon's mouth (Arethusa) was first seen on the island in 1985 (Andrews 1985) and was last seen in 1998 (Oliveira 1998b). Sandplain blue-eyed grass and shore pygmy weed have not been seen on the island since, but sandplain blue-eyed grass has been seen in Dukes County as recently as 1998 and may still be occurring on the island.

Erin Victory/TCI

Yellow thistle

In 2005, another floristic survey was conducted by the New England Wildflower Society (Haines 2005) in conjunction with the Edey Foundation and the Polly Hill Arboretum. A complete list of plant species found during this survey is in Appendix B. During the inventory, Dr. Arthur Haines was primarily looking for rare species, but he also attempted to verify many species from the survey conducted in 1988. About 50 additional plant species not documented in 1988 were documented in 2005. Five rare plants were also documented: saltmarsh toad rush (Juncus ambiguus Guss.), whorled marsh-pennywort (Hydrocotyle verticillata Thunb.), yellow thistle (Cirsium horridulum Michx. var. horridulum), sickle-leaved golden-aster (Pityopsis falcata (Pursh) Nutt.), and seaside knotweed (Polygonum glaucum Nutt.).

Lichens

In June 2004, a survey of lichens was conducted by the Harvard University Herbaria and the New England Botanical Club with support from the Edey Foundation and the Polly Hill Arboretum (Kneiper 2004). Sixty-eight species of lichens were documented and listed in Appendix B.

Mosses and Liverworts

In August 2007, a survey of bryophytes conducted by the New York State Museum (Miller 2008) resulted in 36 species of moss and six species of liverworts (Appendix B) including five mosses and two liverworts which are not currently known from Martha's Vineyard (though they may occur there). Additionally, Isopterygium tenerum (also found on Martha's Vineyard), is at its northern range limit, and is not otherwise reported for Massachusetts. There were four species identified that are not often encountered: Plagiothecium latibricola, Sphagnum henryense, Calypogeia sullivantii, and Nardia insecta. Otherwise, all other species encountered were common. Though much of the island was difficult to traverse given the dense shrubs, there were several pockets of bryophytes identified throughout the accessible portions of the island. Those portions of the wetland areas that were accessible contained a number of peat moss species, and the willow thickets were another bryophyte-rich area due to their proximity to intermittent streams. The short visit timeframe, lack of extensive trails, and thick shrubby vegetation prevented more of the island being searched and there are likely additional species that were undetected due to these reasons.

Algae

In July 2004 a survey of nearshore macroalgae (seaweed) was conducted by the University of Massachusetts Dartmouth with support from the Edey Foundation and the Polly Hill Arboretum (Sears 2005). Sixty-eight species of lichens were documented and listed in Appendix B. Fifty-seven species of macroalgae were documented along the shoreline.

Federal- and State-Listed Plants

There are no known federal-listed plants on the Refuge. State-listed plants that have been found to date on the Refuge are listed below (Table 3.6). According to the Massachusetts Natural Heritage BioMap Core Habitats Program, one of the state's best populations of the purple needlegrass (Aristida purpurascens, state threatened) is also found on the island.

Table 3.6. State-Listed Plants on Nomans Land Island.

Common Name	Scientific Name	Status
Saltmarsh toad rush	Juncus ambiguus	Rediscovered in New England on Nomans in 2005 , but currently without formal status
Sandplain blue-eyed-grass	Sisyrinchium arenicola	State Special Concern
Dragon's mouth	Arethusa bulbosa	State Threatened
Seaside knotweed	Polygonum glaucum	State Watch List
Shore pygmy-weed	Tillaea (Crassula) aquatica	State Threatened
Whorled marsh-pennywort	Hydrocotyle verticillata	State Special Concern
Yellow thistle	Cirsium horridulum	State Watch List
Sickle-leaved golden-aster	Pityopsis falcate	New England Division 1 species

Unique and Significant Natural Plant Community Types

Much of the habitat on the Refuge is Maritime Shrubland, which is ranked S3 for rare species in the state of Massachusetts. These are found in coastal areas characterized by patches of dense shrubs with scattered more open areas of low growth or bare ground. State rankings range from S1 to S3 (most rare to least rare) and indicate the rarity of a species based on the number of occurrences or remaining individuals or unit area. For this habitat type on the Refuge, the S3 rank indicates that there are either 21 to 100 occurrences or limited acreage in the state.

Also on the Refuge is a small amount of Maritime Beach Strand Community (S3) and a small amount of Maritime Dune Community (S2).

Invasive Plants

The presence of invasive plants can have a major adverse impact on the biological integrity, diversity and environmental health of refuges and other natural areas. Currently, at least 14 invasive plant species occur on Nomans Land Island. They are:

Table 3.7. Invasive species documented on Nomans Land Island NWR.

Common Name	Scientific Name
European privet	Ligustrum vulgare
Black swallow-wort	Cynanchum louiseae
Silver poplar	Populus alba
Purple loosestrife	Lythrum salicaria
Glossy buckthorn	Rhamnus frangula
Gray willow	Salix cinerea
Common reed	Phragmites australis
Autumn olive	Elaeagnus umbellata
Asiatic bittersweet	Celastrus orbiculatus
Yellow iris	Iris pseudacorus
Japanese honeysuckle	Lonicera japonica
Spotted knapweed	Centaurea biebersteinii
Japanese rose	Rosa rugosa
Cypress spurge	Euphorbia cyparissias

Locations of these non-native species have been documented and mapped since 2002. Other potential invasive plants include: drooping brome-grass (Bromus tectorum), and sheep sorrel (Rumex acetosella) (Sorrie and Somers 1999).

Efforts to control these species began in 2004. Methods of control include hand pulling and herbicide application. In 2004 and 2005 Phragmites was aerially treated with glyphosate. Backpack sprayers with either glyphosate or triclopyr have been used to treat Japanese honeysuckle, Asiatic bittersweet, black swallow-wort, Phragmites, autumn olive and silver poplar. Poplar and autumn olive are also cut and the stumps treated with glyphosate. Purple loosestrife and spotted knapweed have been pulled by hand. Treatment has varied each year based on the timing of trips to the island, weather and staffing.

Refuge Biological Resources

Federal-listed endangered or threatened species

Although Nomans Land Island currently does not host any resident or nesting federal-listed species, it is one of the most important migratory stop over sites for peregrine falcons (T. French, personal communication), a state-listed endangered species. In addition, one pair of piping plovers (federal threatened) nested on the island in 1980 (Andrews 1980) and roseate terns (federal endangered) nested most years from 1970 to 1985, with a high of 400 nesting pairs in 1972 (Blodget undated, Nisbet 1976, Erwin and Korschgen 1979, Andrews 1980, Ladd 1982b, Ladd 1983c, Andrews 1985, USFWS 1985, Andrews 1990, USFWS 1998). Because comprehensive formal surveys have not been conducted for many taxa, it is possible that other endangered or threatened species use Nomans Land Island NWR for nesting, resting, and feeding. No critical habitat for any federal-listed species occurs within the Refuge.

Birds

Comprehensive surveys of breeding birds have been consistently conducted (in most years) on Nomans Land Island NWR since 2001. Specifically, we have conducted secretive breeding marshbird surveys, BBSs, and inventories of nesting common terns, double crested cormorants and American oystercatchers. Survey points have been limited, however, due to access restrictions on the island because of remaining UXO. In addition to these formal surveys, there is some historical census information and many casual observations by Refuge staff and partners of species that nest, rest, and feed on the island. Please see Appendix A for a list of Refuge bird species of concern, and their respective national, regional, federal and state conservation status. A complete list of avian species observed on and around Nomans Land Island NWR is in Appendix B.

Songbirds

Refuge staff conducted annual breeding bird surveys using region-wide survey methods from 2001 to 2007. Over 25 species of landbirds have been documented during these surveys. The most common songbirds recorded are song sparrow, common yellowthroat, eastern towhee, red-winged blackbird and gray catbird. Grassland species including savannah sparrow nest on the island and have been recorded during breeding bird surveys since 2001.

Raptors

Nomans Land Island NWR is the most important peregrine falcon (state endangered) stopover site in Massachusetts during the fall migration (T. French personal communication). Northern harriers (state threatened) are seen frequently on the island, and are suspected to be nesting on the Refuge, though no nest has been found (Ladd 1982c, Smith 1998). In addition, bald eagles (federal threatened), Cooper's hawks (state species of special concern), kestrel, and merlin have occasionally been seen on the island (Ladd 1982c, Smith 1998).

In October 2003 and 2004, we partnered with the Massachusetts Audubon Society to band migrating raptors. As a result, two Cooper's hawks, one northern harrier, and five peregrine falcons were banded in total. These efforts have resulted in counts of migrating raptors of over fifty peregrine falcons in a given year, as well as observations of red-tailed hawks, sharp-shinned hawks, osprey (Pandion haliaetus), and short-eared owls (Asio flammeus) in addition to those mentioned above.

Waterfowl

Nomans Land Island hosts a variety of nesting and resting waterfowl including: Canada goose, American black ducks, mallards, and green-winged teal (Atwell 1986, Atwell 1987a, Ladd 1983a, Oliveira 1998b, Prior 2000a, Prior 2000b). It is likely that other species such as blue-winged teal, northern shovelers and northern pintails also occur and may nest on the island, but no formal waterfowl brood surveys have been conducted.

Sea ducks may also rest along the Refuge shore, and use nearshore waters to feed during migration and winter months. These waterfowl will aggregate in large numbers in the waters off of Massachusetts throughout winter. Mid-winter waterfowl surveys are conducted by state wildlife agencies, and are a nationwide effort to estimate population trends for these species that are not counted in other avian surveys because of their life history characteristics. In Massachusetts, these surveys are carried out by the MA DFG along the coast and islands. Seaducks found in waters off of Martha's Vineyard include mallard, American black duck, scaup species, common goldeneye, bufflehead, long-tailed duck, scoter species, common eider, merganser species, Canada geese, Atlantic brant, and swan species.

Occasionally, seaduck carcasses will wash up onshore of the Refuge, sometimes in large numbers. When possible, staff biologists record these mortality events when they are observed during site visits and report them to SEANET. This is a collaborative program reliant upon volunteers that endeavors to track

mortality events in seaducks and other coastal and marine birds to investigate causes of mortality and threats to these species.

Shorebirds

Few shorebird species nest on Nomans Land Island. One pair of nesting piping plovers was recorded in 1980 (Andrews 1980), but none have been reported nesting since then. American oystercatchers have been nesting on the island since at least 2001 with one to four pairs generally confirmed nesting each year along the shoreline perimeter. In 2009, there were three nesting pairs (S. Koch, personal communication). Spotted sandpipers were recorded nesting in 1976 (Nisbet 1976) and may have nested in 1980 (Andrews 1980) and 1985 (Organ 1985). They were also likely nesting in 2008 and may have nested undetected previously in recent years. Killdeer have also been suspected nesting in some years. Although numbers are generally low, a variety of shorebird species also use the perimeter of the island (especially the wrack habitat) and some of the inland shallow wetlands during migration. Historically, upland sandpipers (Bartramia longicauda, state endangered) were seen on the island in the early 1900's (MA NHESP 1998).

Waterbirds and Marshbirds

A small rookery containing nesting black-crowned night-herons has been present on the island at least since the early 1980's (Atwell 1980, Ladd 1981, Ladd 1982b, Ladd 1983a), and at one time included snowy egrets. During surveys of coastal waterbird nesting colonies in 1984 (Andrews 1990) 60 pairs of black-crowned night-herons and 13 pairs of snowy egrets were counted. Comprehensive surveys of nesting pairs have not been conducted recently, due to difficulty and safety issues with accessing likely rookery areas. Since 2001, consistent staff visits to the island during the nesting season resulted in very few observations of these species, though a few black-crowned night-herons were frequently seen traveling north towards Martha's Vineyard from Nomans Land Island at dusk, presumably to feed. Nesting black-crowned night-herons were confirmed for the first time in recent years in 2008 when three nests with eggs were found in early May. A visit later in May confirmed successful hatching; one nest had three chicks. In addition, glossy ibis and green-backed heron (Butorides striatus) have been seen occasionally on the island (Ladd 1981, Ladd 1983a).

From 2003 to 2007, we annually conducted secretive marshbird callback surveys of the island's wetlands using a nationwide protocol (found at http://ag.arizona.edu/research/azfwru/NationalMarshBird/). Species included in this national protocol that are found in this area are American bittern (Botaurus lentiginosis), clapper rail (Rallus longirostris), least bittern, pied-billed grebe (Podilymbus podiceps), sora (Porzana carolina), and Virginia rail. With the exception of one least bittern recorded in 2007, only Virginia rails have responded to the call back tapes during the surveys. Because of access restrictions in these areas on the island, we are only able to sample a small area of the total available habitat, and therefore do not have an estimate of the Virginia rail population on the Refuge. In the absence of mammalian predators, they are suspected to be using upland habitats as well, which is unusual for this species. Based on the relative number of responses of birds during the surveys, it is likely a robust population.

Seabirds

Nomans Land Island was historically an important nesting site for common terns (state species of special concern), arctic terns (state species of special concern) and roseate terns (federal endangered). This was the southernmost colony of arctic terns worldwide, and the largest breeding colony throughout Massachusetts (Nisbett 1976). Numbers of nesting common terns peaked in 1970 at 1200 pairs. Nesting roseate terns peaked at 400 pairs in 1972 and numbers of nesting arctic terns remained relatively stable at 20 to 35 pairs most years during the early 1970's. In 1976, an estimated 20 to 25 pairs of arctic terns nested, which was the largest colony in Massachusetts and the southernmost colony in the world (Nisbet 1976). However, during the second part of the 1970's, numbers of nesting common and roseate terns declined dramatically (Erwin 1979). Common terns declined to just a few hundred pairs in 1975 and 1976 and roseate terns declined to just three pairs in 1976 (Blodget, undated notes). During surveys of coastal waterbird nesting colonies from Maine to Virginia in 1977, only 40 pairs of common terns and five pairs of roseate terns were counted (Erwin

and Korschgen 1979). During surveys of these same areas in 1984 (Andrews 1990), although 150 pairs of common terns nested, no nesting arctic terns, and only three pairs of roseate terns were counted. Least terns (Sterna antillarum, state species of special concern) began nesting on the island in 1978 (Blodget undated, Ladd 1982c), but only one pair was observed in 1984 (Andrews 1990), and this was the last year least terns were observed nesting on the island. Numbers of nesting common, roseate, and arctic terns never recovered from the high counts of the early 1970's, and arctic terns probably have not nested on the island since 1987 (Blodget undated, Atwell 1986, MA NHESP 1998). Roseate terns were last observed nesting on the island in 1985.

In recent years, common terns have returned to the Refuge to nest. Since 2001 when consistent site visits to the Refuge were undertaken, 2005 was the first year they were documented nesting again, with two nests and at least three chicks observed. They have nested each year since then with counts of four nesting pairs and the presence of older chicks observed in 2006, 20 nests observed in 2007, nine nests but no productivity in 2008, and one nest recorded in 2009.

Gulls have nested on the island for the last several decades. Their presence was coincident with the initial declines in tern numbers on the Refuge. The first records of nesting great black-backed (Larus marinus; one pair) and herring gulls (Larus argentatus; 30 to 40 pairs) were in 1976 (Nisbet 1976). During surveys of coastal waterbird colonies in 1977 (Erwin and Korschgen 1979), 10 pairs of great black-backed gulls and 60 pairs of herring gulls were noted nesting on Nomans Land Island NWR. During surveys of these same areas in 1984 (Andrews 1990), 200 pairs of great black-backed gulls and 1200 pairs of herring gulls were counted. Both species are still nesting on the island, and although a formal census has not been conducted recently, it is likely that nesting numbers are much lower than the high counts of the mid 1980's.

In 1989, the first evidence of breeding double-crested cormorants in recent history was recorded when three nests were discovered (French 1989). Between that time and 2001, no formal counts of nesting pairs were conducted, but over 350 pairs were counted in 1998 (Oliveira 1998b) and 2000 (USFWS 2000a). When regular site visits to the Refuge began again in 2001, counts of nesting double crested cormorants took place each year, with the exception of 2007 and 2008 when Navy restrictions precluded it. From 2001 to 2006, there were 510, 550 to 595, 569, 631, 489, and 630 nests in each respective year. In 2009, there were 544 nesting pairs (S. Koch, personal communication).

It was suspected for some time that Leach's storm-petrels (state endangered) historically nested on Nomans Land Island NWR. This was due to the presence of "mystery" burrows (potential nesting burrows) and an emaciated carcass of a Leach's storm-petrel found near the shore in June 1980 (Andrews 1980). In 2002, however, nesting was confirmed when 10 birds were heard calling from burrows, and one burrow was dug up carefully to confirm the presence of eggs. The actual number of nesting birds is not known, as a comprehensive survey was not undertaken.

Fish and other Aquatic Species

Aquatic resources of Nomans Land Island NWR include several freshwater ponds, one brackish pond located on the east side of the island, and the surrounding Atlantic Ocean. The freshwater ponds are shallow and succeeding rapidly toward a marshy condition with emergent vegetation beginning to dominate. The water is tannic and has low dissolved oxygen content (G. Ben David, personal communication). There is very little information available for the fisheries in the ponds on the island. No formal comprehensive surveys of fish on the island have been conducted. Gill netting and angling in 1974 turned up only one ninespine stickleback (Pungitius pungitius, Knight 1974) and in 2001, 11 American eels were found dead in a dried up wetland on the Refuge.

Marine species found in the surrounding waters of the Atlantic Ocean include many of the same species as found off Nantucket and Monomoy National Wildlife Refuges, and are included in Appendix B. Offers from MA DFG to conduct fisheries surveys in the Refuge's ponds have been declined by the Service due to the presence of UXO in the ponds. The safety of the Refuge staff and other researchers cannot be guaranteed,

so no access into the ponds is allowed. Please see Appendix A for a list of Refuge aquatic species of concern, and their respective national, regional, federal and state conservation status. A complete list of fish and other aquatic species observed on and around Nomans Land Island NWR is in Appendix B.

Mammals

Marine Mammals

Nomans Land Island beaches are frequently used by harbor seals and gray seals (state species of special concern) in the fall and winter (USFWS 1992). In recent years, the National Marine Fisheries Service seal monitoring surveys have documented the occasional presence of a female gray seal and pup on the island (Waring et al. 2009). In 1989, a dolphin (Delphinidae spp.) vertebra was found on the northeast gravel spit (French 1989), and one dead dolphin (Delphinidae spp.) was found on the shore in 1998 (Oliveira 1998a).

Erin Victory/TCI

Harbor seal entangled with netting on the Refuge

Terrestrial Mammals

As previously mentioned, Joshua Crane imported several mammal species to the island for profitable enterprises. Among these were Belgian hare and muskrat for hunting and trapping. A small mammal survey conducted in 1974 revealed evidence only of muskrats (USFWS 1974). No comprehensive formal surveys of mammals have been conducted since then and there is little evidence of any other mammals inhabiting the island. Evidence of small rodents (Microtus species) was also reported in 1987 during a site visit to the island (Atwell 1987b). However, attempts to trap small mammals in recent years have resulted in no evidence of small rodent presence. Finally, sheep historically occupied the island, and Crane's trustees introduced a new variety of sheep to the island just prior to Navy management. In June 1998 two sheep were seen (Oliveira 1998b), however, the sheep were not seen on subsequent visits and their fate is unknown. Please see Appendix A for a list of Refuge mammal species of concern, and their respective national, regional, federal and state conservation status. A complete list of mammal species observed on and around Nomans Land Island NWR is in Appendix B.

Reptiles and Amphibians

No formal comprehensive surveys of reptiles or amphibians have been conducted on Nomans Land Island NWR. There are records and sightings of reptiles, but not amphibians. Snapping turtles (Chelydra serpentina) and eastern painted turtles (Chrysemys picta picta) have been seen periodically on Nomans Land Island since the 1970's and 1980's, respectively, and up to and including present time (French 1973a, Oliveira 1998b, Andrews 1980). In addition, spotted turtles were seen on the island in 1981, 1985, 1989, and 1998 (Organ 1985, Wray and Ladd 1985, French 1989, Oliveira 1998b). Eastern garter snakes (Thamnophis sirtalis sirtalis) have been seen on the island regularly since the early 1970's (French 1973a) and as recent as in 2008 (S. Koch, personal communication). A leatherback turtle scapula was found on the northeast

gravel spit (French 1989). Please see Appendix A for a list of Refuge reptile and amphibian species of concern, and their respective national, regional, federal and state conservation status. A complete list of reptile and amphibian species observed on and around Nomans Land Island NWR is in Appendix B.

Invertebrates

A wide variety and number of invertebrates (both terrestrial and aquatic) are of biological importance. Unfortunately, no comprehensive formal invertebrate surveys have been conducted on Nomans Land Island. Marine invertebrates found in the surrounding waters are listed in Appendix B. Chain dot geometer (Cingilia catenaria, state species of special concern), was sighted in 1992 and Regal fritillary (Speyeria idalia, state endangered) was sighted in 1986 (MA NHESP 1998). Vast migrations of monarch butterflies headed for Mexico have been seen on the island. In October, monarchs forage and roost at night on the island. In addition, eight species of butterflies were seen on the island in 1989 (G. Ben David, personal communication). In total, 21 species of butterflies, seven species of moths, 20 species of dragon and damselflies, and five species of beetles have been documented on the Refuge.

Twenty-six species of invertebrates that are currently state listed have been identified in Dukes County and it is possible that some of these species occur on the island (http://www.state.ma.us/dfwele/dfw/nhesp/duke.htm). According to the Massachusetts BioMap Core Habitats, it is likely that the rare dune noctuid moth, drunk apamea moth and the spartina borer moth could be found on Nomans Land Island. Please see Appendix A for a list of Refuge invertebrate species of concern, and their respective national, regional, federal and state conservation status. A complete list of invertebrate species observed on and around Nomans Land Island NWR is in Appendix B.

Refuge Visitor Services Program

Nomans Land Island NWR is not open to the public because hazards associated with the unexploded ordnance still remain. The Refuge website contains interpretive information about the island and provides slideshows so that, despite its closure to the public, people can still experience the island's natural resources. Under Alternatives B and C, we will be proposing increased visitor services programs with additional staff that would include off-site interpretive programs and outreach activities on Martha's Vineyard.

Law Enforcement Concerns

The transfer document from the Navy commits the Service to enforcing the ban on public access to Nomans Land Island NWR. This is because unexploded ordnance is ubiquitous throughout the island and can pose a significant safety hazard that may include serious bodily injury or death. The waters surrounding the island are designated as a Restricted Waterway, and this is enforced by the U.S. Coast Guard. It is very important for the public to understand and obey this closure policy of the Refuge and surrounding waters, as this constitutes a major public safety concern. In addition, the airspace over the island is restricted to military use only, and is managed by the 104th Fighter Wing.

Trespassing by anglers does occur. The exact frequency of this type of trespass is unknown; however, evidence of angling and other types of shoreline trespass has been documented on the island. Other types of beach activity may include sun bathing, beach combing, swimming, and boat mooring. The potential for

injury on the island is very high due primarily to the presence of remaining UXO throughout the island, but also the presence of slippery rocks along the remaining shoreline, and the dense vegetation, uneven terrain and poison ivy in the interior of the island. There is no immediate medical response to Nomans Land Island, therefore medical responses may take up to, or over, one hour.

In addition to safety hazards associated with trespassing, the activities mentioned above also have a negative impact on the cultural, natural and biological resources of the Refuge. Migratory birds that use the sandy beach and intertidal zone for nesting, staging, and feeding are disrupted from their normal behavior by the presence of trespassers, and this may have deleterious impacts including nest abandonment. During migration, birds are particularly susceptible to stress factors as they are using the island to rest and feed for short periods before continuing on their long journeys south to their wintering grounds. Seals also use this type of habitat for haul out sites and can be easily disturbed, and if approached, can become aggressive and cause injury.

The rich cultural history of the Refuge includes Native American and early Anglo settlers, and in more modern times, the U.S. Military. There is increased focus on the preservation of the cultural history of the island. The presence of these sites may induce curious or interested parties to search for items of antiquity, artifacts, and other items of cultural significance. Our concern for public safety is concomitant with our responsibility to protect these resources.

As the agency responsible for the administration and management of this Refuge, we are responsible for protecting the island's rich cultural history and uninhibited biological function. We will continue to enforce the federal acts that pertain to Nomans Land Island NWR, including The National Wildlife System Administration Act (16 USC 668dd), Native American Graves Protection and Repatriation Act (25 USC 3001), Archaeological Resources Protection Act (16 USC 470aa-mm), Migratory Bird protection Act (16 USC 703-712), Marine Mammal Protection Act (16 USC 1361-1407), and the Endangered Species Act (16 USC 1531-1544), as well as doing what is necessary to prevent unauthorized use of Nomans Land Island NWR.

Incident reporting and effective communication is another key issue for law enforcement. To further help achieve law enforcement goals we must strengthen communication and information sharing with other law enforcement agencies, local government agencies, and other interested parties. The reporting of incidents including boating accidents and mechanical failures that cause boats to be on the island, oil spills and other chemical spills, washed up debris of significance, and other incidents, is essential to achieving public safety and law enforcement goals.

Refuge Archaeological and Cultural Resources

There has been no professional cultural resource survey of Nomans Land Island. The possibility that there might be unexploded ordnance on Nomans Land Island means archaeology would need to be preceded by ordnance clearing. The Service would not conduct archaeology in the absence of some ground-disturbing proposal. Because the island is closed to the public, and no facility development or ground disturbing habitat management is anticipated, it is unlikely that there will be future investigation of sites at Nomans Land Island.

Five pre-Contact sites have been located from surface artifacts and reported to the Massachusetts Historical Commission. There is at least one historic ruin, also reported to the Commission, and plainly visible. In addition, the Service has inferred the locations of "Gulltown" (also referred to as Crow Town, a fishing village), the Jacob Norton house, and Joshua Crane's Lodge from historical accounts by Annie M. Woods and Pricilla C. Crane. The island also contains the Luce Cemetery, a small family burial ground. The locations of the cemetery and Gulltown have been confirmed in the field. None of these sites have undergone archaeological investigation. Several are likely to have been disturbed by the island's use as a

target range. One large site with both pre-Contact and Historic Period deposits is exposed to erosion, as is the Luce Cemetery.

In 1926, the island's owner, Joshua Crane, claimed to have discovered a stone with runic characters carved on it. Edward Gray, then British Consul in Boston and "an authority on Icelandic legends" visited Nomans Land Island in 1927 and subsequently published references to the rock in his book, "Leif Eriksson, Discoverer of America" (Wood 1978). Gray correctly understood that Eriksson had spent two years on the North American coast. He believed it was possible that Nomans was the place, and identified "a low rock enclosure, just above the … rock" as a potential ruin from the time of Eriksson's visit. However, he was not certain that the stone was evidence that Nomans was the site of Eriksson's visit. Excavations at the "Viking Castle" (on the island) by the Peabody Museum at Andover in 1939 yielded "many Indian relics and arrowheads" (Crane et al. 1970) rather than the Viking artifacts the expedition sought. Eventually, Crane disclosed that he himself had cut the runic stone (Crane et al. 1970). All the same, some people still believe the stone is evidence of Viking occupation, and both the Service and State of Massachusetts, which has jurisdiction over sites in the water, receive occasional requests to remove it. Today, the Peabody Museum at Andover houses the "Indian relics and arrowhead" artifacts from Nomans Land Island. It is unclear, however, if these artifacts, dated to the Late Archaic/Early Woodland Periods, have been on display.

Refuge Wilderness Resources

Section 2(c) of the Wilderness Act defines wilderness as an area which:

- Has at least five thousand acres of land or is of sufficient size as to make practicable its preservation and use in an unimpaired condition, or be capable of restoration to wilderness character through appropriate management at the time of review, or be a roadless island;
- Generally appears to have been affected primarily by the forces of nature, with the imprint of man's work substantially unnoticeable;
- Has outstanding opportunities for solitude or a primitive and unconfined type of recreation; and,
- May also contain ecological, geological, or other features of scientific, educational, scenic, or historical value. These features and values, though desirable, are not necessary for an area to qualify as a wilderness.

Nomans Land Island NWR is a roadless island. The effects of time, weather, erosion, and vegetative growth have rendered the evidence of past human habitation and use by the Navy substantially unnoticeable. The island provides outstanding opportunities for solitude and has ecological, scientific, historical, and cultural supplemental values. The wilderness resources and wilderness review are addressed in detail in Appendix C.