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Chapter 3: Affected Environment

3.1 Introduction

This chapter describes the physical, biological, and socioeconomic environment of the refuge. The physical environment section includes the refuge's geographic setting, its hydrogeomorphic features, soil information, and air and water quality. Biological resources are covered in sections on vegetation and wildlife that discuss how those resources have been influenced by human activity and management. For the refuge's current sociological environment, we explain refuge socioeconomics, land use and transportation, and visitor services. Finally, at the end of the chapter we explain the cultural and historic resources on the refuge, as well as important aspects of refuge administration. The information in this chapter acts as a reference for chapter 4, which documents the Environmental Consequences of each alternative on these resources.

3.2 Physical Environment

3.2.1 Geology

Geology

Regionally, the Delmarva Peninsula lies in the Atlantic Coastal Plain physiographic province, a seaward sloping province bounded on the west by a fall line and the Chesapeake Bay, and on the east by the Atlantic Ocean. The peninsula extends about 200 miles in a north-south direction and includes the State of Delaware and the eastern shores of Maryland and Virginia. The surficial sediments of Assateague Island are discontinuous Holocene Series deposits (tidal marsh and barrier sands). The subsurface sediments of the Delmarva Peninsula form a wedge of unconsolidated sands, silts, and clays that is over 7,000 feet thick and ranges in age from Cretaceous to Tertiary. The subsurface sediments rest on a seaward sloping basement of Paleozoic crystalline rocks. The basement is folded and faulted into a series of northwest-southeast trending ridges and depressions.

The Delmarva Peninsula was formed about 14,000 to 18,000 years ago during the last glacial retreat, when rising sea levels filled the large valley of the lower Susquehanna River, which became the Chesapeake Bay, thus isolating the area from the mainland. Consequently, the Delmarva Peninsula coastline with its barrier islands has changed dramatically since the retreat of the last glacial ice sheets and the melting of the polar ice caps. Sea level has risen more than 300 feet and the shoreline has shifted approximately 50 miles to the west. In general, the continued sea level rise will result in the submerging of the continental shelf and shifting barrier islands landward and upward.

However, the processes of barrier island and marsh-lagoonal system formation, and the migration of barrier islands along the eastern side of the Delmarva Peninsula (formed over several thousand years by broad sea level fluctuations) are not completely understood. One hypothesis is that as the sea level rose along the coastline, beaches retreated. Ridges of beach dunes originally formed by wind-blown sands were breached by storm waves from the rising water. The lowlands between the ridges and the coast were flooded and the ridges became barrier islands.

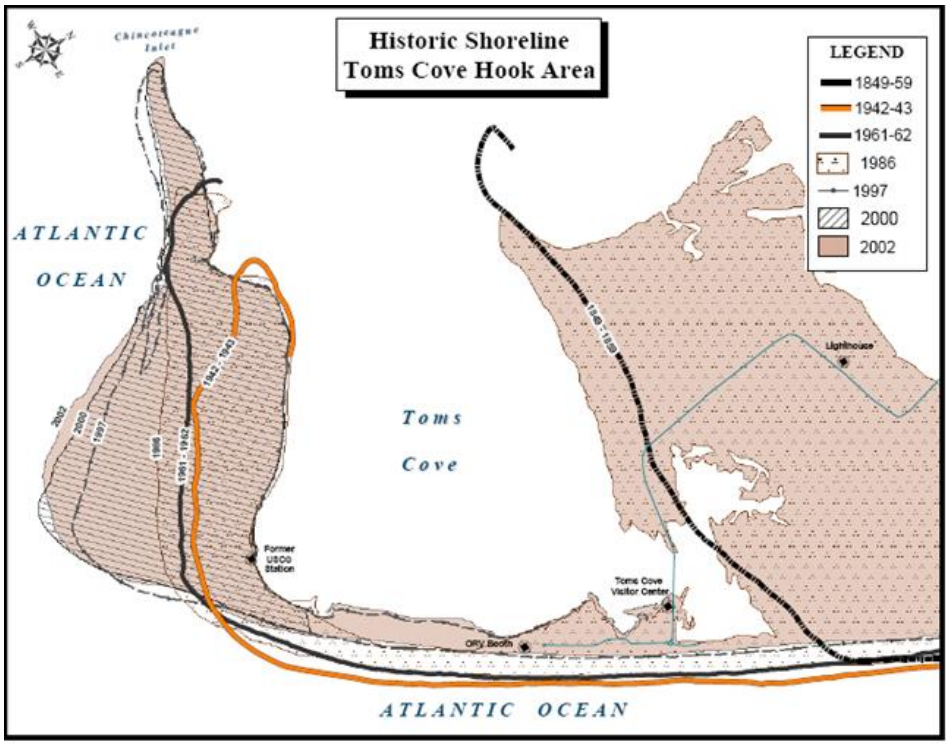
Assateague Island is a sand barrier resting on soft lagoonal mud that contains oyster, clam, and snail shells. The lagoonal mud overlies organic coastal salt marsh mud, and peat, which, in turn, overlies organic debris-rich sandy mud (USACE 1994). The sand and mud surface of Assateague

Island is underlain by 4,500 to 7,500 feet of discontinuous layers of sand, gravel, and clay that have accumulated during 135 million years of continental erosion and coastal action. Cretaceous Cenozoic and Mesozoic sands, silts, and clays account for more than half of the thickness of subsurface sediments (USDA 1994).

Today, Assateague Island (the longest barrier island on the Delmarva coast) is more than 37 miles long, but it is changing daily. Sea level rise, ocean currents, hurricanes and storms, and the very nature of barrier islands have created inlets and divided the island several times over the past few centuries. Geological research suggests that the southern portion of Assateague Island has developed as a series of recurved spits deposited by currents that erode the sands from northern beaches. Historical maps of the island indicate Toms Cove Hook is a sand spit that accreted since the 1850s (Figure 3-1).

Assawoman Island is approximately 2.5 miles long and, in recent years, joined to Wallops Island when Assawoman Inlet closed. Metompkin Island is 6.6 miles long and is also cut by an inlet. Cedar Island is 6.5 miles in length. Since Cedar Island does not have a large offshore sand supply similar to the other islands, it is moving westward at a greater rate than the other islands in the refuge (USFWS 1993a).

Figure 3-1. Changing Shoreline of Southern Assateague Island (USFWS 2004c)



Topography

Topographically, the Delmarva Peninsula region is nearly flat, indicating the past influence of the ocean and the more recent leveling effects of winds. The topography of Assateague Island, like other mid-Atlantic barrier islands, rises from the sea to merge into flat and gently rolling sand dunes. These dunes may exhibit a transition from beachgrass to myrtle brush to loblolly pine on higher ground, or fall gently into low-lying potholes and salt meadows in the interior of the island.

Island elevations range from sea level to approximately 14 meters mean sea level (MSL) (about 46 feet) with the bay side of the island mostly timbered with pines and bordered by salt marsh and salt meadows.

Accretion and Erosion—Wind and Wave Effects on Barrier Islands

Due to the natural phenomenon of barrier island systems, Assateague Island is changing. The Maryland Geological Survey estimates that the eastern shore of Assateague Island is eroding at a rate of about 1.5 feet each year. Barrier islands are coastal features composed of sand and other loose sediments transported by waves, currents, storm surges, and winds. They are formed by sediments eroded from glacial deposits, or from ocean bottom sediments and/or coastal plain materials. For every 1-foot rise in sea level, it has been estimated that coastal barrier islands move 100 to 1,000 feet inland. When more sand is deposited than removed, the beach is said to be accreting. When long shore transport results in a net loss of sand, it is eroding. Erosion and accretion rates differ from island to island, as a result of differing sand supplies, prevailing winds, and wave energies; this, coupled with sea level rise, leads to an ever-changing landscape throughout the Virginia Barrier Islands (USFWS 1988).

The near shore zone is an area of wave turbulence and littoral drift where constant ocean currents and wave action create sand bars and shallow troughs that are exposed at low tide. Long shore currents move from north to south, transporting sands to Toms Cove Hook, where they accrete on bars and flats. Accreting spits, like Toms Cove Hook, are often sites for beach ridge development. Long shore currents and waves build new platforms of sand (i.e., beach), and organic debris accumulates on the beach crests. As sands continue to build, plants grow from buried drift lines, accumulating more sand in curved ridges corresponding to the original drift line position. Continued shoreline accretion builds more curvilinear ridges. The resulting spit displays a system of ridges with upland vegetation; between them, low interdunal areas support wetland species.

The beach is the transition area between marine and upland environments. By definition, barrier islands protect other features, such as lagoons and salt marshes, from direct ocean wave attack. Assateague Island protects Chincoteague Bay from the forces of the open sea, providing quiet waters where sands and silts settle out and accumulate. Inlet currents and wave action along the shore push these sediments into calmer areas where they eventually build up into the intertidal zone as sand and mudflats. The intertidal foreshore is flooded and exposed by daily tides; the backshore, separated from the foreshore by a berm, or terrace, is subject to storm waves. Broken rhizomes and beach plant seeds, along with other organic debris, accumulate in drift lines along the backshore. Windblown sands are caught in this debris and build up around sprouting plants. Capable of surviving sand burial, beach grasses grow with the accumulating sand, providing a relatively stable substrate and facilitating dune development. Erosion by storm action or other interference often precludes this process.

3.2.2 Soils

Soils directly influence habitat by shaping the kind and amount of vegetation and the amount of water available. In this way, they indirectly influence the kind of wildlife that can live in an area. Soils are organized into a taxonomic classification system by the USDA, Natural Resources Conservation Service, in which each soil is categorized by order, suborder, great group, subgroup, family, and soil series. Nationwide, there are 12 soil orders. Entisols are the dominant soil order on the refuge. Entisols are soils defined by the absence or near absence of horizons (layers) that clearly reflect soil-forming processes. The soils of the refuge consist of sand, silty loams, and shell

fragments, with sands found primarily on upland areas and silty loams found on tidal marshes and other wetlands. The soils of the refuge are a mixture of several Entisol soil series, all of which have a thermic soil temperature regime and mixed mineralogy as shown in Table 3-1, Figure 3-2, Figure 3-3, Figure 3-4, and Figure 3-5. Chincoteague NWR Soil Cover Map – Cedar Island (USFWS refuge staff). Chincoteague silt loam (0 to 1 percent slope), Assateague fine sand (2 to 35 percent slope), Camocca fine sand (0 to 2 percent slope), Fisherman fine sand (0 to 6 percent slope), Beach sand (1 to 5 percent slope), and other Entisol soils that occur within Udorthents and Udipsamments great group soils (see below) are the dominant soils found on the refuge. All of these soils are mixed and intermingled in many locations on the islands. Other associated soil complexes recognized by the soil scientists include Fisherman-Camocca (0 to 6 percent slope) and Fisherman-Assateague (0 to 35 percent slope) (USFWS 1992a).

Details for the dominant soil series are:

- Soils of the Chincoteague silt loam series are nonacid Typic Sulfaquents (great group) that are very deep and very poorly drained. They are formed in loamy sediments and are found throughout the refuge impoundments and in salt marshes primarily between the barrier islands and the seaside mainland as well as some barrier tidal flats. Soil permeability is moderately slow and they are very poorly drained with slow runoff, and saturated with salt water. These soils provide habitat for wetland wildlife and spawning grounds for shellfish and fin-fish species. Common plant life consists of cordgrasses, glasswort, and saltgrass. Cultivated crops, nursery stock, pasture grasses and legumes, and loblolly pines are all unsuitable on this soil because of flooding by salt water, wetness, excess salt, and ponding. Construction is similarly unsuitable with additional limitations of low strength and potential groundwater pollution.

- Soils of the Assateague fine sand series are primarily quartz (and other heavy minerals) within Typic Udipsammments (great group). They are very deep and excessively drained with very rapid permeability and are formed in sandy sediments. Assateague soils are found on undulating to steep sand dunes associated with beaches and salt marshes throughout Assateague Island. Assateague fine sand areas are rarely flooded. These soils provide habitat for wildlife and recreation. Common plant life consists of wax myrtle, bayberry, loblolly pine, and beach grasses. Potential for loblolly pine productivity on this soil is moderately high, although some areas support only salt-tolerant shrubs because of salt spray. Seedling survival is limited by moisture stress (very low water storage capacity). Cultivated crops, pasture grasses, and legumes are all unsuited to this soil. Flooding by salt water, low availability of fresh water, and erosion by water (slight) and wind (severe) are limitations.

- Soils of the Camocca fine sand series are Typic Psammaquents (great group) with a mixed mineralogy. Camocca soils are very deep, poorly drained and rapidly permeable. They are formed in sandy sediments and are found in shallow depressions (concave surface) between coastal dunes and on nearly level flats between dunes and marshes. Salt water flooding is common and the soil is periodically inundated by storm tides. The soil provides habitat for wildlife and a foundation for recreation. Common plant life consists of waxmyrtle, cordgrass, and greenbrier shrub community. Some areas support sparse stands of native pines and hardwoods where salt water flooding is less frequent.

- Soils of the Fisherman fine sand series are Aquic Udipsamments with a mixed mineralogy. Fisherman soils are very deep, moderately well drained, have very rapid permeability, and are formed in sandy sediments. They are found on nearly level and gently sloping areas and in depressions of undulating areas (back dunes) associated with dunes and salt marshes on Assateague and Chincoteague Islands. Depth to the water table is usually only 18 to 36 inches. The soil provides habitat for wildlife and a foundation for recreation. The natural plants are commonly cordgrasses, saltgrasses, and wax myrtle.

- Beach soils are found along a thin strip on the seaward side of the island. These are regularly flooded and generally characterized by poor drainage and are subject to wave, wind, and tidal action. This nearly level to moderately sloping soil unit consists of sandy sediments deposited by wave action. It is used primarily for recreation and for wildlife habitat. Most other uses are limited by flooding with salt water, severe erosion, and accretion of sediments.

Other sulfaquent soils are found in association with tidal marshes located behind the beaches on all three southern islands (Cedar, Metompkin and Assawoman). They have high sulfur content, drain poorly, and subject to tidal flooding, excessive settlement, and salinity (USFWS 1988).

Table 3-1: Soil Map Legend

Soil Abbreviation	Soil Taxonomic Name
As	Askecksy loamy sand
AtD	Assateague fine sand, 2 to 35 percent slopes, rarely flooded
Be	Beaches
BeB	Beaches, 1 to 5 percent slopes
BoA	Bojac fine sandy loam, 0 to 2 percent slopes
BX	Boxiron and Broadkill Soils
CaA	Camocca fine sand, 0 to 2 percent slopes, frequently flooded
ChA	Chincoteague silt loam, 0 to 1 percent slopes, frequently flooded
FhB	Fisherman fine sand, 0 to 6 percent slopes, occasionally flooded
FmD	Fisherman-Assateague complex, 0 to 35 percent slopes, rarely flooded
FrB	Fisherman-Camocca complex, 0 to 6 percent slopes, frequently flooded
MaA	Magotha fine sandy loam, 0 to 2 percent slopes, frequently flooded
MoB	Molena loamy sand, 0 to 6 percent slopes
MoD	Molena loamy sand, 6 to 35 percent slopes
MuA	Munden sandy loam, 0 to 2 percent slopes
PoA	Polawana mucky sandy loam, 0 to 2 percent slopes, frequently flooded
Pu	Purnell Peat
TP	Transquaking and Mispillion Soils
UnK	Unknown
UpD	Udorthent and Udipsamment soils, 0 to 30 percent slopes
W	Water

Figure 3-2. Chincoteague NWR Soil Cover Map – Northern Assateague Island (USFWS refuge staff)

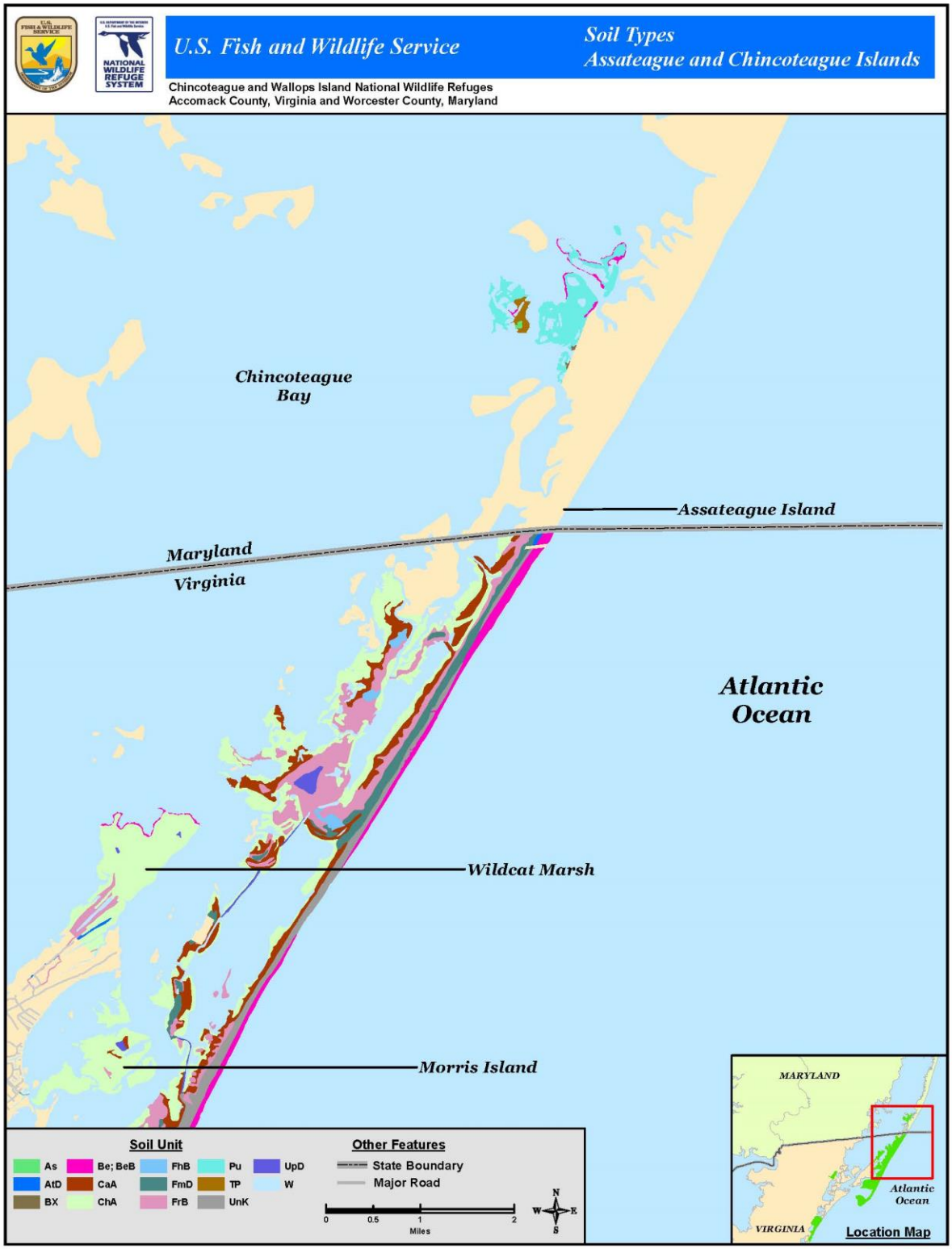


Figure 3-3. Chincoteague NWR Soil Cover Map – Southern Assateague Island (USFWS refuge staff)

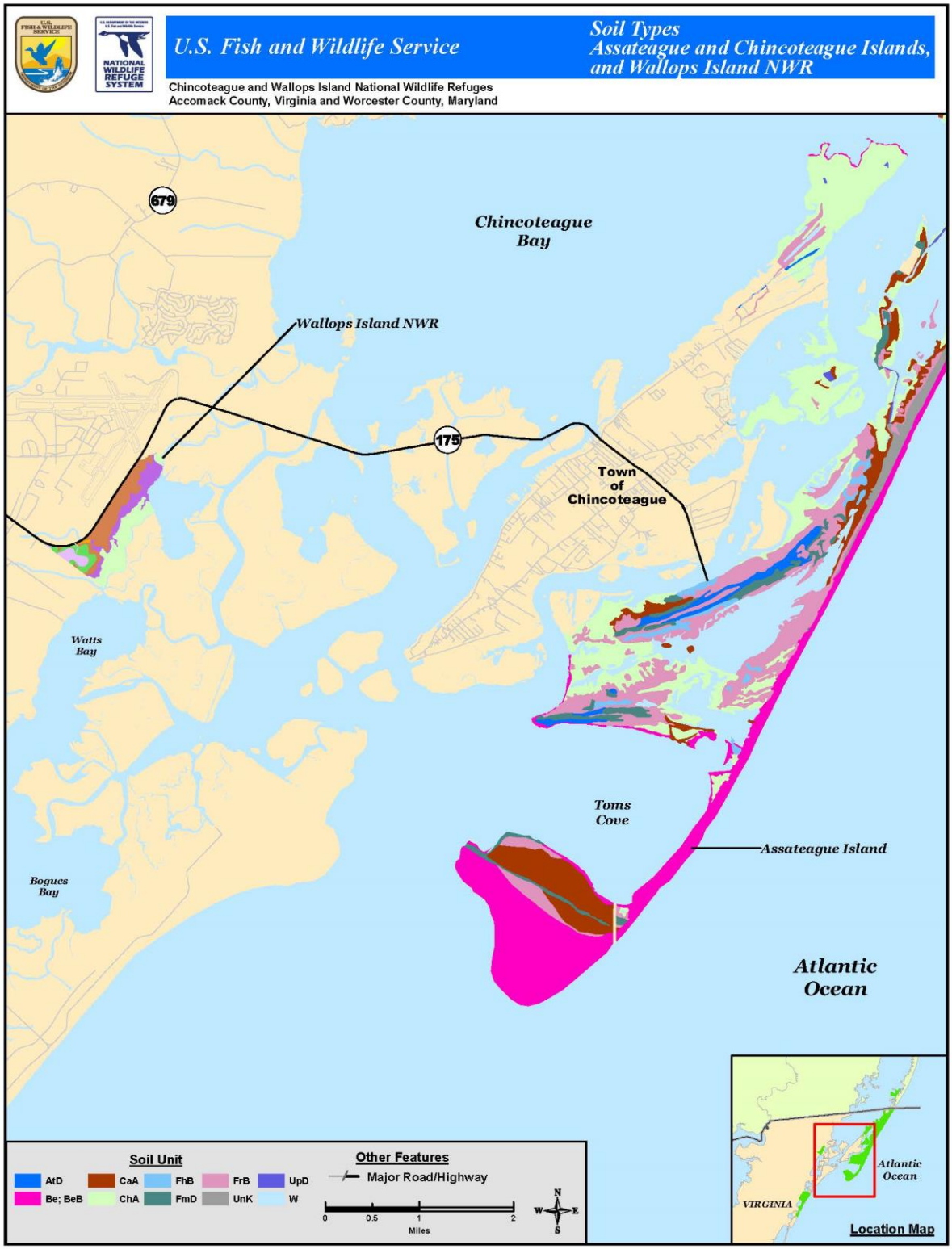


Figure 3-4. Chincoteague NWR Soil Cover Map – Assawoman and Metompkin Island Islands (USFWS refuge staff)

Figure 3-5. Chincoteague NWR Soil Cover Map – Cedar Island (USFWS refuge staff)

3.2.3 Air Quality

Air quality in the area of the refuge is influenced both by local sources of pollutants, such as ammonia from agricultural operations, and by industrial and automobile emissions occurring hundreds of miles away.

Since 2000, a National Atmospheric Deposition Program monitoring station (NADP-MD18) that is located on Assateague Island, adjacent to Assateague State Park in Worchester County, Maryland, has been monitoring atmospheric (wet) deposition of nitrogen, a major source of the nutrient load affecting the coastal bays adjacent to Assateague Island. The NADP station collects rainwater samples weekly and measures them for nitrogen compounds. Atmospheric deposition makes up more than 30 percent of the overall nitrogen load to the bays. Other air pollutants such as mercury seem to be less problematic as recurring surveys of aquatic sediments have failed to detect heavy metals at levels of concern. Recent ozone monitoring data from 2004 to present indicate that the area does experience periodic high levels during the summer months, but that local meteorological conditions serve to moderate the potential threat (National Parks Conservation Association 2007).

The Clean Air Act (CAA) of 1970 (as amended in 1990 and 1997) requires the U.S. Environmental Protection Agency (EPA) to implement air quality standards to protect the nation's health and welfare. National Ambient Air Quality Standards (NAAQS) were set for six pollutants commonly found throughout the United States: lead, ozone, nitrogen oxides (NO_x), carbon monoxide (CO), sulfur dioxide (SO_2), and particulate matter less than 1.0 and 2.5 microns in diameter (PM_{10} and $PM_{2.5}$).

Regionally, the states of Virginia, Maryland, and Delaware all maintain and operate air quality programs that satisfy the CAA monitoring requirements to assess compliance with the NAAQS. The Office of Air Quality Monitoring in Virginia's Department of Environmental Quality measures ambient air quality at approximately 45 locations throughout the Commonwealth (Virginia Department of Environmental Quality 2007). Maryland's Air Quality Monitoring Program in the Air and Radiation Management Administration, Department of the Environment, conducts ambient air monitoring at 26 sites (Maryland Department of the Environment 2006). The Air Quality Management Section of Delaware's Division of Air and Waste Management, Department of Natural Resources and Environmental Control, maintains an ambient air monitoring network consisting of 11 sites (Delaware Department of Natural Resources 2006 and 2008). Although these monitoring sites are located throughout the region, most of the sites are concentrated in the urban/industrial areas, which have the highest population and largest number of pollutant sources. Areas that meet the NAAQS are designated “attainment areas,” while areas not meeting the standards are termed “non-attainment” areas.

On a regional basis (including the refuge), NAAQS for ambient concentrations of lead, carbon monoxide, nitrogen dioxide, and sulfur dioxide are in attainment; and long-term trends indicate that concentrations of the criteria pollutants have either been level or declining.

EPA's Air Quality Index (AQI) is a summary index for reporting daily air quality. It tells how clean or polluted the air is, and what associated health effects might be of concern. The AQI focuses on health effects that humans may have experienced within a few hours or days after breathing polluted air. EPA calculates the AQI for five major air pollutants regulated by the CAA: ground-level ozone, particle pollution (also known as particulate matter), carbon monoxide, sulfur dioxide, and nitrogen dioxide. Because all areas of the United States are currently attaining the

NAAQS for lead, the AQI does not specifically address lead. For each of these pollutants, EPA has established national air quality standards to protect public health. The higher the AQI value is, the greater the level of air pollution, and the greater the health concern. For example, an AQI value of 50 represents good air quality with little potential to affect public health, while an AQI value over 300 represents hazardous air quality. An AQI value of 100 generally corresponds to the national air quality standard for the pollutant, which is the level EPA has set to protect public health. AQI values below 100 are generally thought of as satisfactory. When AQI values are above 100, air quality is considered to be unhealthy at first for certain sensitive groups of people, then for everyone as AQI values get higher (EPA 2011).

More than 80 air quality monitoring sites are located within 100 miles of the refuge. However, the two closest sites, and thereby those two sites assumed to be most representative of the air quality of Assateague Island, are located in Sussex County on the Delaware Eastern Shore, about 70 air miles north of the refuges. They are Lewes (site # 10-005-1003), a coastal site, and Seaford (site #10-005-1002), a suburban site. Calculated AQI values, based on data collected in 2006 and 2007 at these two sites, showed that the air quality in Sussex County (representative of the air quality on the refuge) had good air quality 67 to 70 percent of the time; moderate air quality 26 to 27 percent of the time, and unhealthy/sensitive air quality 4 to 6 percent of the time. The single pollutant responsible for the highest index value is referred to as the "Main Pollutant." The Main Pollutant was ozone (74 to 75 percent of the time) and particulate matter less than 2.5 microns (25 to 26 percent of the time). High AQI values due to ozone and small particulate matter are often associated with bright summer days and periods of hot, stagnant, summertime air, favoring the formation of ozone and condensation nuclei (EPA 2009).

3.2.4 Hydrology and Water Quality

Hydrology

No natural freshwater streams or lakes exist on the refuge. Rainfall and tidal overwash are the only sources of surface water on Assateague Island. Overwash is the process that causes the transportation and deposition of water and sediment over the beach crest. The man-made moist-soil units (impoundments) are slightly brackish to highly saline because of tidal overwash, salt spray, and the accumulation of salt residue as water evaporates. These same environmental factors also render the shallow groundwater beneath the islands brackish. Evaporation and transpiration account for major surface water depletion during the summer months. The drinking water supply for Chincoteague Island and the refuge comes via pipeline from three deep wells and a shallow well field near the NASA base on the mainland. On Cedar Island, there are approximately a dozen wells, and none currently exist on either Metompkin or Assawoman Islands (USFWS 1988). Large bodies of water bordering the island are the Atlantic Ocean (to the east) and Chincoteague Bay and Assateague Channel (to the west) (USFWS 2007b).

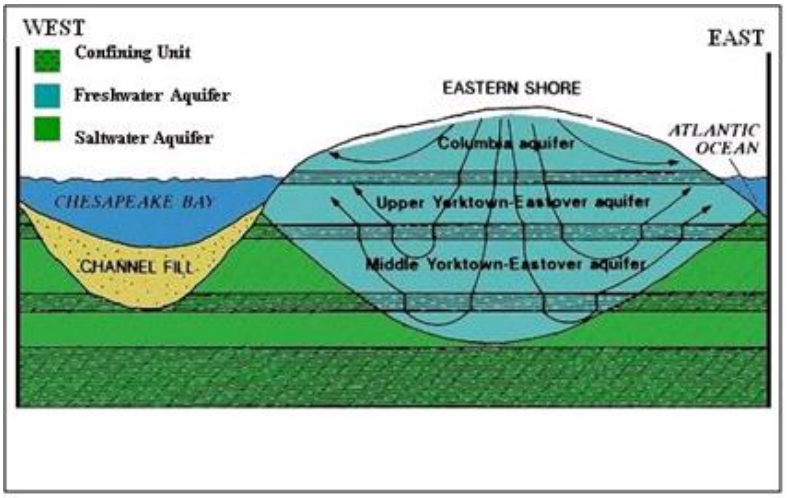
Assateague Island protects Chincoteague Bay from the strong wave activity of the open ocean, which allows for the accumulation of sands and silts that can eventually build up into mud flats. Algal mats, salt marsh cord grass, and mollusk colonies help stabilize the flats. This low salt marsh zone is flooded by tides twice daily. Tides and tidal currents in the inshore waters of Chincoteague Bay are controlled by the inlets at either end of Assateague Island. Ocean City inlet to the north and Chincoteague inlet to the south have mean tidal ranges of 3.4 to 3.8 feet, but near the midpoint between the two inlets in Chincoteague Bay, the tidal range is only about 0.4 feet. Through the

tides, approximately 7 percent of the water in the bays is renewed each day (USACE 1994, USFWS 1992a).

Groundwater

On the Eastern Shore, there are four major aquifers that make up the near surface system (see Figure 3-6). The system is comprised of the near-surface, unconfined Columbia (or Quaternary) aquifer (commonly referred to as the water table aquifer) and a series of deeper, confined aquifers and intervening semi-confining units. The Columbia aquifer is composed of sediments that are primarily sands with inter-fingering clay and silt beds. It ranges from near surface to a depth of about 100 feet, resulting in more susceptibility to surface sources of contamination. Consequently, the Columbia aquifer is not used as a major source of drinking water. The three deeper, confined aquifers deposited during the Miocene era (with depths up to 800 feet) consist of coarse shelly sands and are found in three layers separated by clay confining units. They are known as the Upper Yorktown-Eastover (or Pocomoke) aquifer; the Middle Yorktown-Eastover aquifer, and the Lower Yorktown-Eastover aquifer. The clay confining units help to protect the Yorktown-Eastover aquifer from surface water contamination, and generally the deeper aquifers have better water quality. The clay confining units separating the aquifers are somewhat porous and allow some groundwater exchange between the two deeper Yorktown-Eastover aquifers. Recharge of the aquifers comes from surface water—rain, snow, and leakage from ponds. The total available ground water supply is limited to the amount of fresh water recharging the aquifers from precipitation directly falling on the land surface. The salt water that completely surrounds Assateague Island (Atlantic Ocean and Chincoteague Bay) causes the groundwater to become brackish at relatively shallow depths (Horsley Witten Hegemann, Inc. 1992).

Figure 3-6. Schematic of Ground Water Aquifers—East-West Cross Section of the Eastern Shore of Virginia (Horsley Witten Hegemann, Inc. 1992)



Surface Water

Because there are no perennial freshwater streams on Assateague Island, surface water systems are vitally important for fish and other wildlife on the island and are managed accordingly. Many of the freshwater ponds are surface expressions of shallow groundwater, often ephemeral,

forming during the wet winter months and drying during the summer. Surface waters consist of bays, lagoons, and ponds. The numerous bays and inlets formed by the barrier island serve as a mixing zone for sea water that flows from the east and for the less saline waters from mainland creeks and streams. Due to the lack of a significant freshwater inflow, these back bays are not considered to be estuaries in the classical sense. Nonetheless, they are extremely important as finfish and shellfish areas, providing important nursery habitat for a rich variety of fish (USFWS 1988).

Freshwater wetlands on Chincoteague NWR occur at natural low points in the dunes or flats, or, impounded areas. On Toms Cove Hook, low areas between the beach ridges and dunes collect rainwater and support wetland vegetation. A few other small natural freshwater marshes occur behind the dunes of the northern beach. The refuge's impoundments are located between mean high and spring high tide and abut upland areas as well as fresh or brackish marshes not affected by tides (USFWS 1992a).

Thirteen impoundments covering over 2,650 acres were constructed on Chincoteague NWR to provide submergent and emergent wetland vegetation as forage for waterfowl and habitat for a variety of waterbirds (see Figure 3-7). Management of these impoundments is directed at providing fall and winter habitat for waterfowl and spring/fall stopover habitat for migrating shorebirds. A system of dikes confines these wetlands. Most dikes are also maintained as roads for public and/or staff access. Beach Road from the bend beyond the refuge headquarters to the rotary at the beach is a dike separating Black Duck Pool (A Pool) from the Black Duck Marsh and Swan Cove Pool (F Pool) from Little Toms Cove. Approximately half of the Wildlife Loop is a dike surrounding Snow Goose (B-South Pool), separating it from Black Duck Pool (A Pool), Swan Cove Pool (F Pool), and Shoveler Pool (B-North Pool). The dike between Black Duck and Swan Cove Pool (A and F Pools) is a bike trail. The Swan Cove bike trail, with access to the recreational beach, is built on a dike separating Swan Cove Pool (F Pool) from natural wetlands to the east.

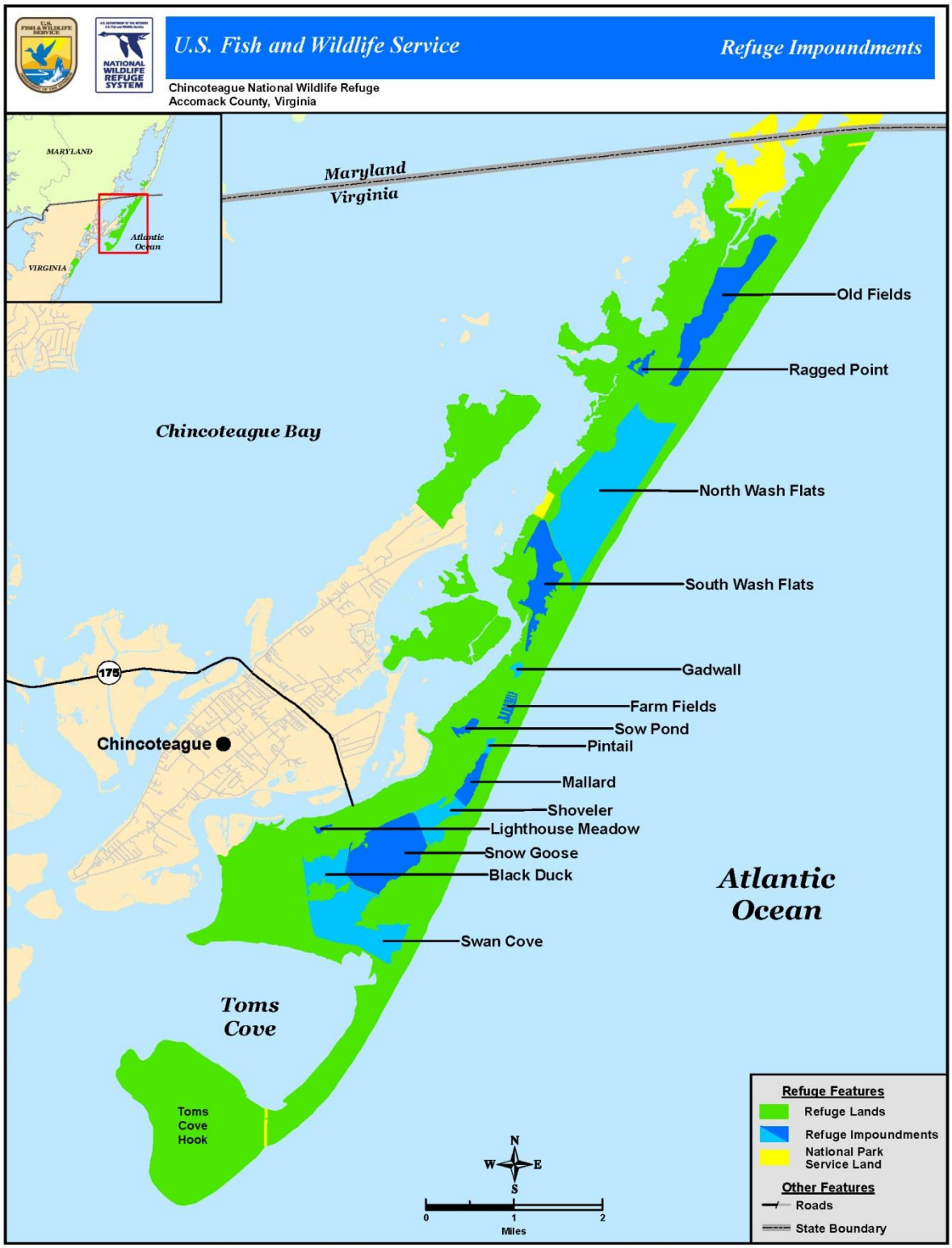
Most dikes have adjacent borrow ditches along their pool side. These ditches serve to:

- provide wading bird resting and feeding habitat;
- provide wading bird and waterfowl brood rearing habitat, an especially important function when drought or impoundment drawdown removes open water from other pool areas;
- facilitate drainage as flow channels to water control structures; and
- restrict visitors to use of dikes only, minimizing intrusion into protected wetland habitats.

Water control structures are used to manipulate impoundment water levels according to which species of plant or animal is being managed. These structures release water either into adjacent pools or through bayside channels into the tidal marshes. Impoundment water level control enables production of good quality wildlife food and assures a variety of wetland habitats for diverse species of wildlife.

In general, impoundments are located above high tide level so estuarine water cannot enter them; however, tidal influx can occur through the Virginia Creek water control structure (WCS) into Old Fields Impoundment. During severe weather and extreme high tides, overwash reaches impoundments from the sea and bay side; Black Duck (A) Pool, Snow Goose (B-South) Pool, Shoveler (B-North) Pool, Mallard (C) Pool, Pintail (D) Pool, Swan Cove (F) Pool, Wash Flats, and Old Fields impoundments are most susceptible. Other than these cases, impoundment water supply comes from direct precipitation. Impoundments receive very little surface run-off because surrounding soils are highly permeable (USFWS 1992a).

Figure 3-7. Refuge Impoundments – Chincoteague NWR (USFWS refuge staff)



Water Quality Concerns

Dissolved ammonia and nitrates are the dominant nutrients in ground water in the area. Submarine discharges from the shallow groundwater aquifer into the estuarine system have been found to carry nutrient and contaminant loads. Chincoteague Bay (and Sinepuxent Bay) suffers from an influx of excess nutrients, primarily nitrogen and phosphorus. As much as one-half of the excess nutrients are believed to come from agricultural sources such as chemical fertilizers and manure generated by intensive chicken production facilities on the mainland. Atmospheric nitrogen, primarily from coal-fired power plants and motor vehicles, is also a significant source (approximately 30 percent) of nutrient deposition into Chincoteague Bay surface waters. These nutrients promote the growth of algae blooms that deplete dissolved oxygen levels in the water when the algae die and decompose, resulting in fish die-offs. Since 1972, the Maryland DNR has documented a decrease in the abundance of forage species such as bay anchovy, menhaden, spot, and Atlantic silverside in Assateague Island's bayside waters. Small forage fish are most susceptible to fish kills when summer algal blooms create anaerobic conditions in shallow bays and canals. Brown tide, a harmful alga that can kill sedentary species such as shellfish, has been documented every year since 1999 in Assateague's bayside waters. Sea grasses have been increasingly stressed by deteriorating water quality and the associated proliferation of algae, which reduce light availability. Bays such as Chincoteague are particularly prone to algal blooms because their waters are exchanged with open ocean waters relatively slowly. At Chincoteague, flushing may take as long as 63 days (National Parks Conservation Association 2007 and Dillow 2002).

Floodplains

The majority of the Chincoteague NWR landmass falls within the 1-percent flood zone, commonly called the 100-year flood line. The only portions of the island not in the 100 year flood zone are the White Hills, located north of the Wildlife Loop. These hills, with the highest elevation of the refuge, are located within the 0.2 percent or 500-year flood zone (FEMA 2009). The average base flood elevation for the flood zones on the island are approximately 8 to 9 feet, meaning that this elevation, relative to the mean sea level, has a one percent chance or greater of flooding in a given year as determined by FEMA.

3.2.5 Climate Change and Sea Level Rise

Current Climate and Overwash Conditions

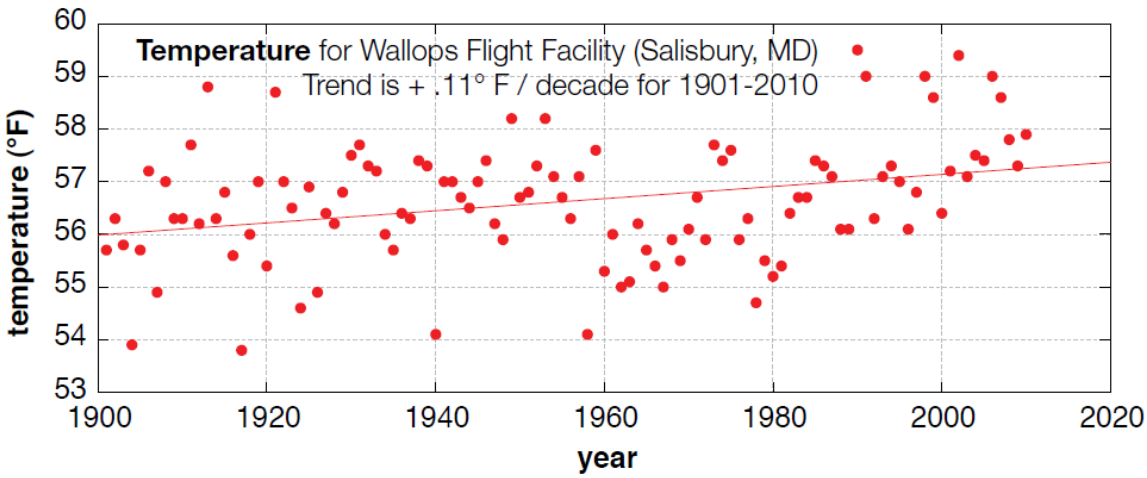
The climate of the refuge is generally temperate and humid. Seasonal temperature ranges are influenced by the moderating effects of the Delmarva Peninsula's proximity to Chesapeake Bay and the Atlantic Ocean. The area lies in the zone of prevailing westerlies, where most weather systems track west to east. The low relief and Atlantic exposure of the refuge make it extremely vulnerable to storms.

The climatic conditions of the refuge are moderated by the Atlantic Ocean. Summer days are typically hot and humid, with prevailing winds from the northeast and southeast. Occasional thunderstorms hit with little notice, presenting danger of lightning strikes and exposure to beach goers and other visitors. Although autumn days are typically cool and clear, the season also marks the onset of nor'easters. These low pressure systems move up the coast, generating storms caused by counterclockwise cycling of moist air. Nor'easters are characterized by heavy rain, strong northeast winds, high tides, and rough seas. Conditions may last for 2 to 5 days. Winter temperatures tend to be mild, though nor'easters are usually more intense, and carry the greatest

potential for overwash of the primary dunes along the ocean side of Assateague Island (USFWS 1992a).

Figure 3-8 and Table 3-2 present historic temperature and precipitation data for Assateague Island. The lowest mean monthly temperature is about 36°Fahrenheit , in January; and, the highest monthly mean temperature is about 76°F, in August. Rainfall is rather uniformly distributed throughout the year averaging about 3.5 inches a month and totaling about 43 inches a year. Annual precipitation totals have ranged from between 30 to 60 inches. Snowfall is light, with February historically having accumulations of about 2 inches. Total annual snowfall is only about 5 inches (Southeast Regional Climate Center 2007 and USFWS 2007d).

Figure 3-8. Daily Average Temperature for Assateague Island National Seashore area, and Predicated Future Climate Change (NASA 2012)



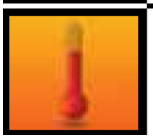
		2020's	2050's	2080's
	Average Annual Precipitation	0 to +10%	0 to +10%	0 to +15%
	Sea Level (inches)	+2 to +5	+7 to +11	+12 to +21
	Sea Level–Rapid Ice Melt Scenario (inches)	+5 to +9	+19 to +28	+42 to +56
	Average Annual Temperature (F°)	+1.5° to +2.5°	+2.5° to +4.5°	+3.5° to +6.5°

Table 3-2. Temperature and Precipitation Data Assateague Island Area (December 1, 1955 to April 29, 2012) (Southeast Regional Climate Center 2012. http://www.sercc.com/)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Average Maximum Temperature (F)	46.7	49.1	56.8	66.8	75.1	82.8	86.7	85.3	79.7	69.7	60.4	50.7	67.5
Average Minimum Temperature (F)	29.5	30.8	37.4	45.9	55.0	64.0	68.8	67.4	61.3	50.4	41.8	33.3	48.8
Average Total Precipitation (in.)	3.48	3.22	4.16	3.12	3.38	3.82	4.61	4.17	3.60	3.66	2.99	3.62	43.82
Average Total SnowFall (in.)	3.9	2.7	1.2	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.6	9.4

The tropical storm and hurricane season runs from June through November. Summer season hurricanes, occurring June through August, originate over the Atlantic in the vicinity of the Bahamas, Leeward, or Windward Islands. Storm centers usually remain offshore, bringing heavy rains, high winds, high tides, and rough seas. Hurricanes and storms occurring later in the season, September through late October, tend to originate in the Caribbean. Though hurricane storms lose much of their force as they travel across the southeastern states, they still carry a potential for devastating effects when they reach the Delmarva Peninsula.

Past documentation and observations show that normal daily tide cycles and coastal storm processes actively change the configuration of the coastline. Normal low-energy processes move small volumes of sand and are both erosional and depositional in nature. High-energy coastal storm processes involve large volumes of sediment movement (Kraft and John 1976).

One of these high-energy storms, nor'easter Ida, struck Chincoteague NWR and Assateague Island National Seashore in November 2009. This storm damaged public beach parking lots, which were washed away or buried under 3 feet of sand; brought about a tidal overwash of part of Assateague Island such that Toms Cove Hook was not accessible during high tide; and resulted in the flooding of Swan Cove Pool (F Pool), which put significant hydraulic pressure on Beach Road and undermined the road's structural stability. This storm also closed the refuge and seashore for several days and limited access for some time thereafter (Volpe National Transportation Systems Center 2009). Though storms of this magnitude have historically been sporadic, the refuge has been experiencing more frequent nor'easter activity with multiple big coastal storms making landfall during a single season, creating more rapid landscape and coastal changes. Table 3-3, below, is taken from the Chincoteague NWR: Recreational Beach Structural Decision Making Study (2011) and lists all the notable storm events since the 1800s. There have been a number of significant storms recorded over the last 200 years, some which have caused great damage to the refuge, such as the March 1962 nor'easter that destroyed most of Assateague Island's natural

foredune, and the storm in January 1992, which destroyed much of the dune line on the lower portion of the island and greatly reduced the primary dune line to the north.

More recently, in October 2012, the refuge was significantly impacted by damaging winds and water as a result of Hurricane Sandy. Trees knocked down by strong winds fell across many refuge roads and trails. One remote restroom was destroyed, some shingles were lost, and the bunkhouse roof was damaged, but other refuge buildings were spared major damage. Earthen dikes surrounding refuge impoundments suffered some erosion but there were no major breaches in these dikes. There was one ocean breach, just north of parking lot 1. All beach parking lots were washed over by the storm surge, which compromised the clay base and shell surface. The asphalt surface and shoulders of Beach Road were significantly damaged.

Table 3-3. Notable Chincoteague NWR Storm Events Since the 1800s

1800s	1900 – 1999 (100 years)	2000 – 2012 (13 years)
1878 - September Gale	1933 – August Hurricane	2000 – December Snowstorm
1888 - Great Blizzard	1936 – September Hurricane	2003 – North American Blizzard
	1962 – Ash Wednesday Storm	2005 – North American Blizzard
	1976 – NE U.S. Blizzard	2006 – Late November Nor'easter
	1984 – November Nor'easter	2007 – April Nor'easter
	1991 – 'Perfect Storm'	2009 – November Nor'easter (Nor'Ida)
	1993 – 'Storm of the Century'	2009 – December Nor'easter
	1994 – Christmas Nor'easter	2010 – March Winter Storm
	1996 – North American Blizzard	2010 – November Nor'easter
	1997 – April Fools' Day Blizzard	2010 – December Blizzard
		2011 – January Blizzard
		2011 – Hurricane Irene
		2011 – October Nor'easter
		2012 – Hurricane Sandy

Coastal storms with sustained winds can lead to prolonged flooding of refuge impoundments and roads and increase the erosion of refuge dunes. The surge of storm water landward results in heavy saltwater intrusion of freshwater wetlands and adjacent upland habitats. Long-term geologic changes from these coastal storms include beach erosion, dune erosion, and possible inlet formation from stronger flood and ebb tide surges (USFWS 2011b).

Wind and saltwater intrusion, nearshore channeling, and sedimentation also cause landscape changes. The advent of overwash along barrier coastlines is determined by the height and wave parameters. In general on the east coast, overwash threshold conditions have been steadily increasing since the 1990s. The refuge has been experiencing more frequent nor'easter activity with multiple big coastal storms making landfall during a single season, creating more rapid landscape and coastal changes. For example, the coastal storms of December 10 to 14, 1991, and January 4, 1992, had associated storm surges of up to 8.5 feet above mean high water. After these two storms, overwash and breaching of dunes occurred at scattered locations along the Delmarva Peninsula. This increased occurrence and severity of shoreline regression and overwash are continuously transforming the profile of Assateague Island, as shown in Figure 3-9.

Figure 3-9. Changes in shoreline of Assateague Island, 2006 through 2013, with consistent marking of the same features over time (Photo credit: Patrick J. Hendrickson 2013)

Global Climate Change and Warming

According to NOAA and NASA data, the Earth's average surface temperature has increased by about 1.2 to 1.4°F since 1900 (IPCC 2007). In January of 2008, NOAA reported that seven of the 8 warmest years on record have occurred since 2001, part of a rise in temperatures of more than 1°F since 1900. In 2008, NOAA reported that for the preceding three decades, the rate of warming in global temperatures was approximately three times greater than the century scale trend. Per the latest IPCC report (2012), the earth's surface has been successively warmer than any preceding decade since 1950 (analysis included 1983 to 2012). If greenhouse gases, primarily carbon dioxide, methane, and nitrous oxide, continue to increase, climate models predict that the average temperature at the Earth's surface could increase from 3.2°F to 7.2°F above 1990 levels by the end of this century (IPCC 2007).

The effect of climate change and global warming are anticipated to result in changes in weather/rainfall patterns (fewer but more intense storms), decreases in snow and ice cover, rising sea levels, and stressed ecosystems. For the mid-Atlantic region, this can mean extreme precipitation events, greater likelihood of warmer/dryer summers, and wetter/reduced winter cold. During the past 100 years, the average temperature in the mid-Atlantic region has risen by nearly 1°F, and precipitation has increased by up to 10 percent. Compared with today's temperatures, climate models project that the region's climate may become approximately 2°F warmer by 2030, with an additional 3°F to 8°F average temperature increase by the end of the 21st century. These all would lead to alterations of ecosystems, habitats, and species distributions due to the changes in weather patterns (EPA, NPS, and USFWS 2009).

Global warming, resulting in both melting of glaciers and ice sheets and ocean water thermal expansion, will cause sea levels to rise. Worldwide measurements of sea level show a rise of about 0.17 meters (0.56 feet) during the 20th century (NASA, August 12, 2009). New satellite measurements reveal that the Greenland and West Antarctic ice sheets are shedding about 125 billion tons of ice per year (Solomon 2007). Considering that land less than 10 meters above sea level contains 2 percent of the world's land surface, but 10 percent of its population, major impacts in the United States will be felt by large numbers of people living on the low lying coastlands. We commissioned a study using the sea level rise model simulation SLAMM to predict refuge impacts

from future sea level rise, based on an estimate of a one meter rise in sea level along the Virginia coast line by the year by 2100. This assumption is consistent with Virginia's Climate Change Action Plan (Governor's Commission on Climate Change 2008). Rising sea levels will result in tidal marsh submergence and habitat migration as salt marshes transgress landward and replace tidal freshwater wetlands and brackish marsh, in addition to increased beach and shoreline erosion due to wave activity. The SLAMM analysis further projects that climate change could cause a variety of coastal habitat changes, including increased loss of barrier islands and wetlands; increased risk of shoreline flooding due to sea level rise, storm surge, and extreme overwash events; and alterations of ecosystems and habitats due to changes in weather patterns.

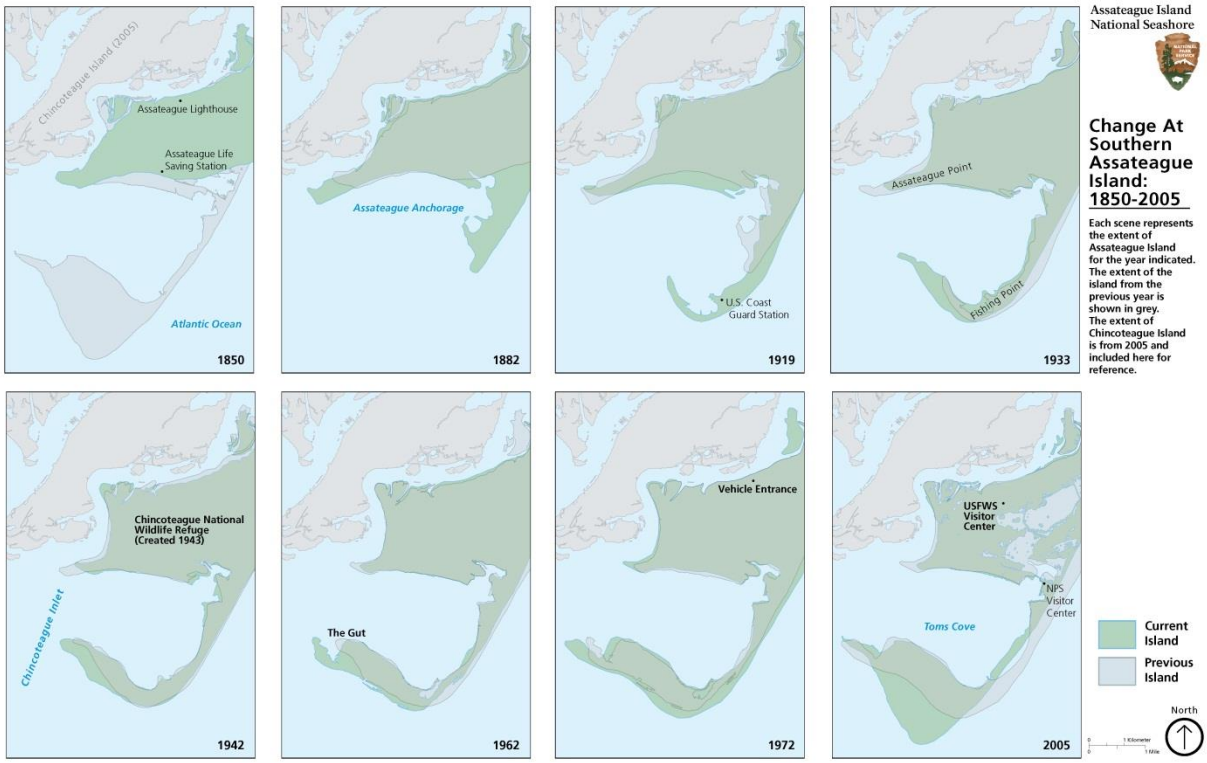
The IPCC estimates that 20 to 30 percent of plant and animal species will be at risk of extinction if temperatures climb more than 1.5° to 2.5°C (Solomon 2007). Warmer air or water temperatures can also impact animal species. For example, evidence suggests that the gender of sea turtles is determined by the surrounding temperature at critical stages in development, with warmer temperatures producing more females. Warmer temperatures could thus create reproductive problems for an already declining species (Mrosovsky and Provancha 1992). A recent study of the effects of climate change on eastern U.S. bird species concluded that as many as 78 bird species could decrease by at least 25 percent, while as many as 33 species could increase in abundance by at least 25 percent (Matthews et al. 2004).

Potential Effects and Shoreline Vulnerability due to Climate Change and Sea Level Rise

Department of the Interior (DOI) Secretarial Order 3226 (2001) states there is a consensus in the international community that global climate change is occurring, and that it should be addressed in Federal governmental decision-making. This Order requires Departmental planning and decision-making to take climate change impacts into account. Additionally, it calls for the incorporation of climate change considerations into long-term planning documents, such as a CCP. It is difficult to predict the specific effects climate change and potential sea level rise will have on the refuge in the future, but past and current events have been documented and analyzed to allow for more informed management. As a barrier island with an elevation of no more than 46 feet (14 meters) at its highest points, Assateague Island will be greatly affected by the predicted changes in sea level associated with global climate change. Furthermore, the refuge is located in a "hotspot" of accelerated sea level rise. For this "hotspot," which spans 1,000 kilometers along the highly populated North American Atlantic coast north of Cape Hatteras, scientists estimate that sea level rise increased at a much higher rate than the global average between 1950 to 1979 and 1980 to 2009 (Sallenger 2012). DOI Secretarial Order 3289 (2009) reiterates this mandate and states that "Management decisions made in response to climate change impacts must be informed by science and require that scientists work in tandem with those managers who are confronting climate change impacts and evaluating options to respond to such impacts."

Meteorological and climatological events, such as hurricanes and sea level rise, pose challenges for refuge management, and continuously morph the landscape of the refuge. To highlight the change in shoreline, Figure 3-10 shows the historic shoreline change of southern Assateague Island. This figure represents how significantly a barrier island can change in a mere 150 years, and specifically shows the variability in the refuge's shoreline due to increased storm activity, continued shoreline erosion, and sedimentary transportation events such as overwash.

Figure 3-10. Shoreline Change for Toms Cove, Assateague Island, from 1850 to 2005 (Assateague Island National Seashore/NPS staff)



Further climate change related stressors will likely enhance impacts on shoreline morphology even more in years to come. Using past climate and weather data, we commissioned a study to project the effects of sea level rise on the barrier islands extending from Ocean City Inlet, Maryland to Fisherman Island, Virginia in the Delmarva Peninsula with a main focus on Chincoteague NWR, incorporating the SLAMM model (Nieves 2009). The study itself used three different model scenarios for sea level rise: the IPCC prediction of 0.7 m by 2100, and a 1 m, and 1.5 m global sea level rise by 2100. Simulations were executed in 25 year increments from the date of available existing conditions (1988 to 2003) until 2100. The study found that the most significant changes would occur on the eastern shore beaches and marshes. A significant conversion of salt marsh to open estuarine water is anticipated for Assateague Island and other barrier islands within the refuge by 2075 or 2100 in the 1.0 and 1.5 meter rise scenarios, respectively. Ocean beach habitat would decline by 80 percent by the year 2100 in the 1.0 meter sea level rise scenario, while estuarine beaches, on the other hand, are projected to gain habitat. Table 3-4 shows the total habitat change percentages for the refuge assuming the 1.0 m sea level rise by 2100 scenario, which the refuge currently uses for management purposes.

Table 3-4. One meter sea level rise scenario by 2100 (Nieves 2009)

	Area of habitat change					Percentage of habitat change				
	Initial Condition	2025	2050	2075	2100	Initial Condition	2025	2050	2075	2100
Dev. Dry Land	3021	3021	3021	3018	3003	0.5%	0%	0%	0%	1%
Undev. Dry Land	164043	153740	148629	142518	133655	28.6%	-6%	-9%	-13%	19%
Swamp	56721	65889	67200	67609	64828	9.9%	16%	18%	19%	14%
Inland Fresh Marsh	8120	8484	8541	8564	8527	1.4%	4%	5%	5%	5%
Tidal Fresh Marsh	635	583	567	521	452	0.1%	-8%	-11%	-18%	-29%
Trans. Salt Marsh	3016	3102	3966	4953	9205	0.5%	3%	32%	64%	205%
Saltmarsh	30374	29728	28798	22076	13055	5.3%	-2%	-5%	-27%	-57%
Estuarine Beach	1304	1275	1721	2405	3940	0.2%	-2%	32%	84%	202%
Tidal Flat	41220	39610	32746	34430	31477	7.2%	-4%	-21%	-16%	-24%
Ocean Beach	1618	1558	1443	1025	329	0.3%	-4%	-11%	-37%	-80%
Rocky Intertidal	1	1	1	0	0	0.0%	-7%	-44%	-78%	-95%
Inland Open Water	1395	1372	1349	1304	1231	0.2%	-2%	-3%	-7%	-12%
Riverine Tidal	489	284	222	75	53	0.1%	-42%	-55%	-85%	-89%
Estuarine Open Water	124230	127702	144259	163248	185390	21.6%	3%	16%	31%	49%
Open Ocean	109667	110426	111124	112206	113765	19.1%	1%	1%	2%	4%
Brackish Marsh	19164	18761	14020	6403	3362	3.3%	-2%	-27%	-67%	-82%
Inland Shore	33	30	30	30	29	0.0%	-10%	-10%	-10%	-10%
Tidal Swamp	9108	8593	6524	3774	1860	1.6%	-6%	-28%	-59%	-80%
Grand Total	574159	574159	574159	574159	574159	100.0%	(-) pct. habitat loss			

As can be derived from the data, most of the habitat diversity on the refuge will be lost or reduced due to shifts in habitat types. The rise in sea level will cause the shoreline and the near shore habitats to recede back and diminish, decreasing near shore habitats such as the ocean beaches and tidal flats. This increased sea level will quickly envelop the coastline, turning most of the current coastal habitats into transitional zones, where the inland fresh water meets with the rising salt water. As can be seen in the table, by 2100 most of the habitat will be open water, estuarine beach, or transitional salt marsh. Most of the smaller diverse habitats will be lost, and these main broader habitats will envelop most of the refuge.

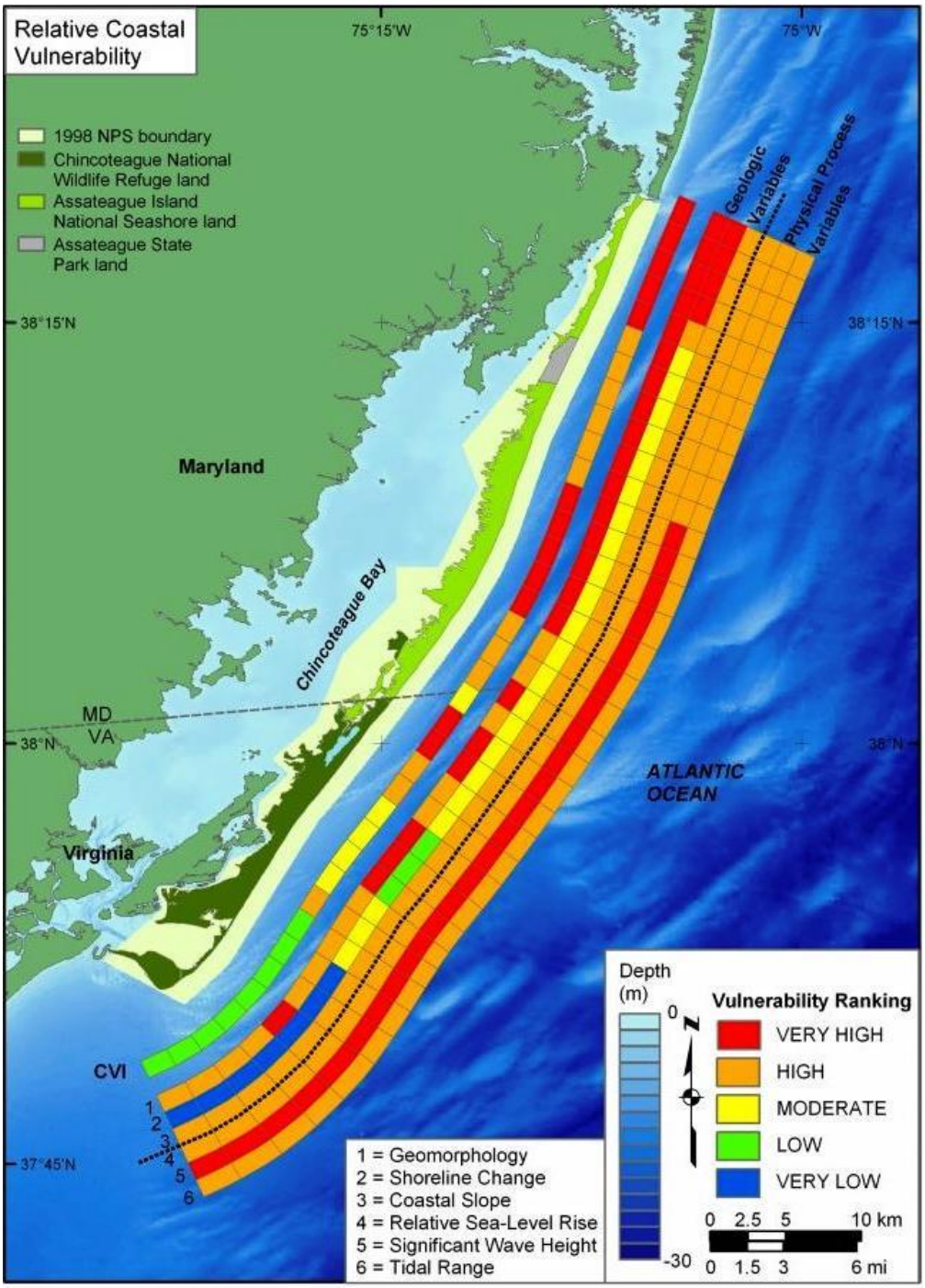
These changes in shoreline and refuge habitat have already been observed in the refuge. Severe overwash events, as documented in the Chincoteague NWR: Recreational Beach Structured Decision Making (SDM) Process Study (2011), have already begun to deposit more sand on the shores of the refuge, and move the shoreline westward. The first photo (Figure 3-11) from 1991 shows the parking area and visitor center that was located behind the artificial dunes. The second photo (2003) shows the deposition of sand after a storm that is building the island to the west.

Figure 3-11. Chincoteague NWR parking area (1991) and Overwash Event (2003) (USFWS 2011b)

Furthermore, a 2004 study by the USGS assessed the coastal vulnerability of Assateague Island to sea level rise based on six variables (geomorphology, shoreline erosion/accretion rate, coastal slope, relative sea level rise rate, mean wave height, and mean tide range). It reports that over 60 percent of the 37 miles of shoreline of Assateague Island are classified as being very highly vulnerable or highly vulnerable to future sea level rise and future storm washover events, as was outlined in the SDM study. The areas within Assateague Island that are the most vulnerable to sea level rise are those with the highest occurrence of overwash and the highest rates of shoreline change. These areas are found predominantly on the north end of the island. Details are given in Figure 3-12. (Pendleton 2004).

Low-lying islands will always face impacts from global climate change, particularly rising sea level and coastal storms. Such occurrences have already been experienced; however, these events may become more frequent and severe within the 15-year time period covered by this CCP, based on recent projections by the IPCC (Solomon 2007). Saline intrusion into the subsurface freshwater lens from sea level rise and saltwater inundation of surface freshwaters from storm surges can alter coastal ecosystems and freshwater marshes resulting in more salt-tolerant aquatic plant communities.

Figure 3-12. Coastal Vulnerability Rankings for Assateague Island (Pendleton 2004)



3.3 Vegetation

From sandy beaches along the island's seaward side to salt marshes on the western bay side, Assateague Island hosts a wide variety of habitats and vegetative communities. A diverse array of environmental conditions—elevation, the availability of water, ranging from fresh to salt, distance from the impacts of the ocean, the movement of sand, storm-driven winds and seas—all work to shape these habitats and vegetative communities, providing unique environs within which a plethora of different species live.

Chincoteague NWR is a dynamic area with constant fluctuations in its shoreline boundaries and habitat acreage. Current vegetation cover is strongly associated with a certain habitat, and is so described in this section. There are five major habitat types found on the refuge (which include three smaller divisions: Assawoman Island, Metompkin Island, and Cedar Island). They are: Beach-Dune habitat (approximately 1,800 acres); Shrub-Early Successional habitat (approximately 2,900 acres); Forested Uplands habitat (approximately 1,800 acres); Impoundments and Freshwater Wetlands habitat (approximately 2,000 acres); and over 5,800 acres of salt marshes.

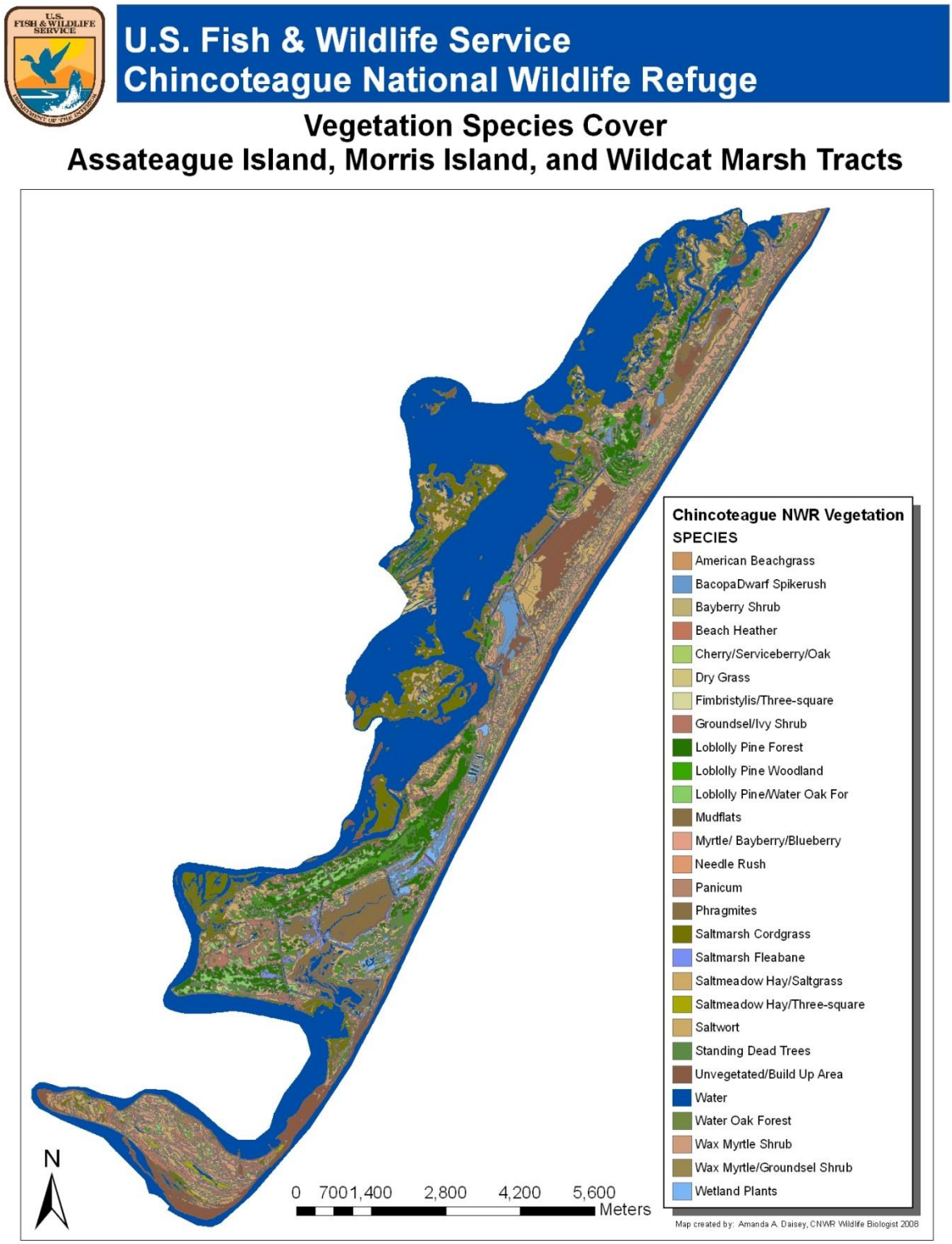
This section describes habitat types and vegetation for the refuge. Habitat type descriptions are separated into the Assateague Island Unit (Figure 3-13), the Southern Barrier Islands Unit of Chincoteague NWR, and Wallops Island NWR. Latin names for vegetation can be found in Appendix L.

3.3.1 Assateague Island Unit

The most dominant vegetation on Assateague Island is the loblolly pine and loblolly pine/hardwoods maritime forest, encompassing much of the upland habitat, with salt marsh grasses encompassing much of the lowland habitats. Associated upland plant species include southern red oak, sweetgum, and sassafras. Understory associates include wild grape, Japanese honeysuckle, greenbriar, and American holly. The predominant vegetation in the open areas includes a variety of grasses, wax myrtle, and groundsel tree. Common fresh marsh vegetation consists of dwarf spike rush, smartweed, fleabane, swamp rose mallow, American three-square, umbrella-grass, saltgrass, beggartick, catttail, and eastern baccharis. Salt marsh vegetation consists mainly of salt marsh cord grass and salt meadow hay.

Seabeach amaranth was federally listed as threatened in 1993 by the USFWS. Seabeach amaranth is an annual plant species that occurs on the upper beach and sparsely vegetated overwash fans and inter-dune areas. This species appears to require extensive areas of barrier island beaches and inlets functioning in a relatively natural and dynamic manner. In the absence of overwash and storms, other plants less tolerant of disturbance colonize the sparsely vegetated areas and ultimately outcompete amaranth. Threats include beach stabilization efforts (particularly the use of beach armoring, such as sea walls and riprap), intensive recreational use, and herbivory (grass eating) by white-tailed deer, sika, and Chincoteague ponies.

Figure 3-13. Chincoteage NWR Vegetation Map (Source USFWS Refuge Staff)



Seabeach amaranth was first documented on the refuge in 1966 by Dr. Elizabeth Higgins as a graduate student, and the species was also present in 1967 and 1972. It was not recorded on the refuge between 1972 and 2001, nor were any surveys documented. In 2001, nine plants were found just south of the Maryland/Virginia border, a year after the NPS began a program to restore the species in Maryland. Since 2001, refuge staff has conducted surveys for seabeach amaranth on the beaches of Assateague Island each August, often in conjunction with NPS personnel. The number of plants identified varies but a peak of 69 plants was documented in 2005.

In addition to seabeach amaranth, Assateague Island supports several other rare plants, in particular: seabeach knotweed, sea purslane, seabeach orach, and seabeach sandwort, which all occupy beach habitats similar to amaranth.

Fragile communities of submerged aquatic vegetation along Assateague's bay side are an important component of the estuarine ecosystem. Beds of sea grasses such as eelgrass and less abundant widgeon grass provide shelter for mollusks such as the Atlantic bay scallop, critical nursery habitat for fish and crustaceans, and foraging grounds for waterfowl, river otters, and other animals. Sea grasses are extremely sensitive to water quality. Excess suspended sediments and algal blooms caused by nutrient enrichment can kill sea grass by blocking sunlight. Boats can also destroy sea grasses in shallow waters when they become grounded or when propellers churn through and tear up the grasses. Boating restrictions help protect against this damage. A southern corridor provides access to the north side of Toms Cove for personal watercraft from nearby Chincoteague Island. Another corridor provides access to the north end of the island close to Ocean City where boat traffic has traditionally been heaviest. All other personal watercraft use within Assateague Island National Seashore is prohibited.

Beach – Dune

This habitat type covers approximately 970 acres, or 10 percent, of the Assateague Island Unit. Its width varies along its 27 kilometers (km) (17 mile) interface with the ocean. Considered pioneer species, beach plants are exposed and adapted to constantly shifting sands, limited fresh water, temperature and wind extremes, and frequent salt water spray and overwash. The entire community can be covered by tidal surges. The beach extends from the intertidal zone into the dunes along the entire east and south sides of Assateague Island. Smaller areas are along Toms Cove and Assateague Point and Channel. The most common beach species are American sea rocket and sea lavender.

The dune habitat serves as a line of defense against storm surges, protecting other habitats from alteration due to salt water intrusion. A gradual transition to the dune grass community occurs beyond the high tide line. Dune grass establishes readily on the stabilized dunes as well as in natural areas. Characteristic species are American beach grass, sea oats, saltmeadow cordgrass, seaside goldenrod, dune sandbur, rough buttonweed, carpetweed, and seabeach evening primrose. Seabeach amaranth occurs in very low numbers.

Shrub-Early Successional

Between the dunes and the upland forest community lies a lower, flat expanse (swales) with a successional shrub community that covers about 2,872 acres (roughly 25 to 30 percent) of the Assateague Island Unit. Deciduous trees, shrubs, and vines are the predominant plant forms. This shrub community is important for migrating and nesting songbirds, as well as to migrating monarch butterflies. The shrub habitat adjacent to the freshwater impoundments and the

transition zone between the forest and salt and fresh water marshes provide important foraging for a variety of neotropical migrant birds. The shrub community composition varies with groundwater supply, elevation, proximity to salt spray, and frequency of tidal inundation. In general, the shrub community vegetation zone extends north and south on barrier flats and backdunes, gradually merging on the east with dunegrasses and on the west with forests or marshes. The majority of shrub habitat is scattered throughout the refuge with most adjacent to the forests, saltmarshes, and impoundments. In the sheltered zone beyond the dunes where fresh water is more plentiful, vegetative cover can reach 80 percent and is predominantly characterized by less salt-tolerant shrubs and thickets. Here, taller plants undergo a natural pruning process, as salt-laden winds blowing over the dunes stunt their growth.

Common species in these areas include wax myrtle and northern bayberry, which provide food and cover for songbirds, small rodents, and rabbits. Other common shrub species include black cherry, serviceberry, blackberry, poison ivy, and greenbrier. Evergreens are less frequent, but include red cedar and American holly. False heather or beach-heath along with jointweed and broom-sedge can be the dominant species in localized areas within the shrub community. These species form large mound-shaped colonies on low interior dunes that are generally very dry and free of salt spray. This plant community is an important dune stabilizer, capturing windblown sands. Most of the shrub species occur to a lesser degree in the forest community.

Forested Uplands

Where Assateague Island is wide enough to allow sufficient protection from the ocean's salt spray and overwash, trees are able to establish a foothold. The forest stands occur on large stable dunes (such as White Hills), generally west of shrub areas and impoundments, indicative of parts of the island that have been stable for several decades. Approximately 1,600 acres (17 percent) of the Assateague Island Unit are classified as upland forest and are comprised almost entirely of loblolly pine, a hardy salt-tolerant and fire-resistant tree. Loblolly pine requires full sunlight to establish new stands, and can produce cone crops in as little as 10 years, although seed production is greater in older trees. Thinning of stands has been shown to increase production of cones and seeds by dominant and co-dominant trees. These forests are important to the survival of the endangered Delmarva fox squirrel and other forest dwelling wildlife, particularly the white-tailed deer, turkey, eastern hognose snake, and many species of woodland migratory birds.

Mixed stands of loblolly pine and hardwood usually contain southern red oak, white oak, and water oak as the most abundant hardwoods. The mixed hardwood forest provides premium Delmarva Peninsula fox squirrel and woodcock habitat. The hardwood stands have developed only in areas where topography and distance from salt water provide maximum protection from aerosol salt spray. Other mixed hardwood species may include red maple, sweet gum, sassafras, black gum, black cherry, American holly, and wax myrtle. Forested wetlands occur on the west side of Snow Goose (B-South) Pool, in the vicinity of the Woodland Trail, and in lowlands near the White Hills. Dominant vegetative species in these areas include red maple, black willow, wax myrtle, and marsh elder.

Forested understory vegetation is usually composed of dogwood, high-bush blueberry, blackberry, greenbrier, poison ivy, common chokecherry, and fox grape. Many of the rarest plants on Assateague Island are found in the forests, including Indian pipe, crested yellow orchid, spotted wintergreen, and partridgeberry.

Approximately 400 acres of the forested uplands on Assateague Island in Virginia were mapped as maritime upland forest community as defined by the Virginia DCR and 50 CFR 84.11 (Berman and Berquist 2007). According to Virginia DCR, maritime upland forests are considered globally rare because of restricted ranges, narrow habitat requirements, and threats from coastal development. Maritime upland forests contain species-poor evergreen and mixed coastal forests, often pine-dominated with an understory of deciduous trees; they grow in well to rapidly drained nutrient poor sandy soils (Berman and Berquist 2007). They occur on old coastal dunes that have been stable long enough to sustain forests, have well-drained sandy soils, and a water table close to the surface (50 CFR 84.11).

Wetlands

The 13 impoundments (roughly 22 to 28 percent of the Assateague Island Unit) are managed to provide submergent and emergent wetland vegetation and mudflats as foraging areas and cover for waterfowl, shorebirds, and other waterbirds. Approximately 2,650 acres of this "habitat type" is contained within the dikes. The discrepancy between this and the 2,012 acreage figure obtained from the cover map is due to shrub encroachment on the edges, which was mapped as shrub/early successional. Since many impoundments tend to be brackish due to storm overwash and salty soils, they are inhabited by plants with some salt tolerance. Characteristic plants include dwarf spike rush, salt marsh fleabane, Bacopa, sago pondweed, American three-square, saltgrass, Bidens, smartweed, umbrella-grass, and salt meadow grass. Non-native Phragmites grows in many of the impoundments and other wetland areas. This invasive plant has been the target of mechanical and chemical control efforts.

Wax myrtle and loblolly pine encroach into some of the impoundments where these woody species are not regularly controlled. Currently, Sow Pond, Ragged Point, Pintail Pool (D Pool), South Wash Flats, and NWF have expanding areas of woody vegetation that will require management to maintain open shallow water habitat favored by shorebirds and some waterfowl. On the other hand, flooded myrtle habitat is used by wintering black ducks, and landbirds use shrub habitat on impoundment edges for breeding, winter, and migration habitat.

Forested wetlands occur on the west side of Snow Goose (B-South) Pool, in the vicinity of the Woodland Trail, and in lowlands near the White Hills. Dominant species include red maple, black willow, wax myrtle, ferns, and blueberries.

A more open transitional freshwater marsh that borders uplands and salt marshes on the bayside of Assateague Island includes groundsel tree, cattails, wax myrtle, swamp rose, and marsh elder. Approximately 108 acres of wetlands also occur on Toms Cove Hook on the flats and in low areas between the beach ridges and dunes that pond collect rainwater. A few other small natural freshwater marshes occur behind the dunes of the northern beach.

Salt Marsh

Approximately 2,875 acres of salt marshes are located along the western boundaries of the Assateague Island Unit. Tidal flooding influences the distribution of salt marsh plants. Salt marsh cordgrass is the dominant species in the low marsh, the zone between mean high tide and mean low tide. Salt meadow cordgrass (also called salt meadow hay), saltgrass, and saltwort grow in the less frequently flooded high marsh. Northern sea lavender and marsh elder occur at upper levels, along the marsh/upland edge.

3.3.2 Southern Island Units

Salt marsh habitat covers approximately 95 percent (406 acres) of the Morris Island Unit and approximately 87 percent (485 acres) of the Wildcat Marsh Unit. Salt marsh cord grass, salt meadow cordgrass, and saltwort are the major vegetation species. Upland vegetation on Morris Island is limited to a few scattered sites (21 acres) of loblolly pine, wax myrtle, black cherry, and sassafras. Approximately 13 percent (73 acres) of the southern part of Wildcat Marsh is an upland forest consisting of loblolly pine, oak, and typical understory associates. Wax myrtle is scattered throughout the area.

Assawoman and Metompkin islands are barrier islands with habitat types consisting of beach, dunes, and extensive salt marshes to the west of the islands. The predominant species in the marsh include salt marsh cordgrass and salt meadow hay. On Metompkin, the marsh extends to the mainland, although it is intersected by numerous creeks and channels. The remainder of the island is predominantly sparse grasslands with little woody growth. Assawoman Island also contains extensive salt marshes, particularly in the northern half of the island. A cobble-laden washover area, located at the northern tip and formed by the sealing of Assawoman Inlet, provides good habitat for nesting birds. Pockets of woody shrubs occur in depressions between the beach front and the westward marshes. Plants found here include wax myrtle, bayberry and groundsel bush.

Cedar Island is dominated by beach and dune habitats on the ocean side and a brackish marsh dominated by salt meadow cordgrass on the bay side. A small thicket dominated by eastern red cedar and poison ivy occurs on the north end of the island. It is adjacent to the beach and is eroding rapidly. The north end also supports most of the island's other plant diversity. Dead shrubs and some low-growing vegetation are present in overwash areas. Other habitat types found on Cedar Island include a salt flat to the south and mudflats that are exposed at low tide.

3.3.3 Wallops Island NWR

Wallops Island NWR is composed of 195 acres of salt marsh, 121 acres of forest, and 57 acres of old-field/early successional forests. Loblolly pine is the dominant species in the forest habitat and secondary components include: tulip poplar, red maple, southern red oak, wild cherry, dogwood, sassafras, and sweet gum. Understory includes: American holly, spicebush, Devil's walkingstick, and greenbrier. Transition zones between the marsh and woodland are dominated by groundsel tree and wax myrtle. The salt marsh is dominated by cordgrasses.

A Simoneaston Bay sea-level fen, named the Lucky Boy Fen, is found on Wallops Island NWR. Sea level fens are nutrient-poor, maritime seepage wetlands, confined to a few sites within the mid-Atlantic region that have an unusual combination of environmental conditions (DCR 2001). The sea level fen is a globally significant (ranked as "G1" or critically imperiled) community type (Fleming and Patterson 2010); only four occur in Virginia, all of them in Accomack County (DCR 2001). Lucky Boy Fen is located just above highest tide levels, at the base of a slope where abundant groundwater discharges. It is less than ½-half acre in size, but supports six rare plant species.

3.4 Wildlife

Despite the often harsh conditions that occur in a coastal environment, a wide variety of wildlife species thrive on the refuge. Each of the islands' different habitats supports a multitude of birds, mammals, reptiles, amphibians, and invertebrates. In addition, the coastal waters that surround

the refuge teem with life. The sheltered, nutrient-rich waters of the estuary formed by the islands provide breeding and spawning habitat for many aquatic species, and important feeding areas for birds. Wildlife species in the refuge are described below. Latin names for wildlife can be found in Appendix L.

3.4.1 Federal and State Threatened and Endangered Species

Although the refuge habitat is used by several protected species, the only resident Federal endangered species is the Delmarva Peninsula fox squirrel. Other known Federal endangered or threatened species that can be found on the refuge but that are not resident include the piping plover, roseate tern, and the leatherback and loggerhead sea turtles. After release of the draft CCP/EIS, the red knot, went from the candidate list proposed to be listed as threatened, to threatened under the ESA. The red knot uses Chincoteague NWR beaches during spring and fall migration.

Wilson's plover is on Virginia's State endangered bird list. State-threatened birds that are present or breed on the refuge include the gulled tern, upland sandpiper, and the peregrine falcon. In 2012, the Board of the VDGIF decided to remove the bald eagle from the Virginia State list of threatened and endangered species effective January 1, 2013.

Several Federal listed threatened and/or endangered species are found in the study area, although not all of them are resident to the refuge. A full list of threatened and endangered flora and fauna that are found in the vicinity of the refuge is provided in Appendix L. The species that are most pertinent to the refuge are described in detail below.

Delmarva Peninsula fox squirrel

The Delmarva Peninsula fox squirrel is both a Federal- and State-listed endangered species inhabiting the Chincoteague NWR's loblolly pine forests. Although the Delmarva Peninsula fox squirrel has been proposed for delisting from the endangered species list since the draft CCP/EIS was published, it has not been finalized yet. Fox squirrels can be commonly seen in the headquarters area and around the Woodland Trail. Their coloring is similar to the gray squirrel, but the fox squirrel is larger with a bushier tail and is more terrestrial than the gray squirrel.

The Delmarva Peninsula fox squirrel's original range stretched from central New Jersey south through eastern Pennsylvania and down the length of the Delmarva Peninsula. As woodland has been cleared for farming and altered by forestry, available fox squirrel habitat has dwindled, and the known population has been reduced to several sites in Maryland, Delaware, and Chincoteague NWR in Virginia. The refuge population was translocated here in the early l970s. Over the past few years their numbers on the refuge have stabilized.

On Chincoteague NWR, Delmarva Peninsula fox squirrels live in forest stands predominated by mature loblolly pines. In other parts of its range, the fox squirrel is usually found in mixed stands of mature hardwoods where a variety of mast-producing trees ensure a reliable food source. With its terrestrial habits, the fox squirrel is adapted to a park-like, open understory and is rarely found in dense underbrush, although production in areas with a developed understory has been observed on Chincoteague NWR. Because they spend so much time on the ground, road accidents are a mortality factor of the Delmarva Peninsula fox squirrel. Major natural predators are red fox, raccoon, and great horned owl.

Refuge forest management and predator control objectives are designed to provide optimum fox squirrel habitat. Specific practices include:

- Maintain open understory in specified areas;
- Provide nesting boxes to supplement natural tree cavities;
- Reduce competition from gray squirrels;
- Protect from hunting and natural predation;
- Supply reliable food source through management of vegetation.

Marine Mammals

Federal endangered marine mammals with ranges that encompass the waters of Assateague Island include: five species of baleen whales (humpback, gin, sei, blue, and northern right); one toothed whale (sperm); and, one sirenian (West Indian manatee). Anecdotal observations suggest that these species visit the Island's waters; however, most do so only as occasional transients or seasonal migrants. The species most at risk is the northern right whale, with a North Atlantic population of approximately 200. A number of right whales winter along the Assateague Island coastline and can occasionally be seen from the beach.

Sea Turtles

Five species of Federal-listed sea turtles use Assateague Island's ocean and bay waters. The leatherback sea turtle, Kemp's Ridley sea turtle, and the hawkbill sea turtle are Federal endangered species. The loggerhead sea turtle and green sea turtle are Federal-threatened. In Virginia, the state status is the same as the Federal status for these species.

Piping Plover

The piping plover, a Federal- and State-threatened species since January 1986, nests on sandy or cobble beaches and overwash areas. The eastern coast of Virginia is a significant area for nesting piping plovers, supporting approximately 20 percent of the breeding population on the U.S. Atlantic Coast. Chincoteague NWR is one of the most important plover nesting areas of any of the Virginia barrier islands and supports one of the largest concentrations of piping plovers along the Atlantic coast. In order to protect this species, the Chincoteague NWR closes certain critical nesting areas to public entry.

In Virginia, piping plovers begin displaying territorial behavior and their elaborate courtship rituals in mid-March. This is followed by egg-laying in mid-April. Each pair forms a shallow depression in the sand to serve as a nest in which usually four eggs are laid. The eggs hatch in about 25 days, and the downy young are soon able to follow their parents in foraging for marine worms, crustaceans, and insects, which they pluck from sand and mudflats in the intertidal zone. Both eggs and young are so well-camouflaged that they are apt to go undetected. When predators and other intruders come close, the young squat motionless on the sand while the parents attempt to attract the attention of the intruders to themselves, often by feigning a broken wing. Surviving young fly within about 30 days of hatching. Storm tides, predators, or human activity often disrupt nesting before the eggs hatch. When this happens, fledglings from late nesting efforts may not fly until mid-August. Plovers commonly gather in groups on undisturbed beaches prior to their southward migration. Feeding occurs along the intertidal zone and on sand flats and mudflats. The plover's diet consists mainly of worms, crustaceans, mollusks, and other invertebrates.

Beaches on Assateague (including the Hook, Overwash, and Wild Beach), Assawoman, Metompkin, and Cedar islands are managed and intensively monitored for nesting shorebirds

including the American oystercatcher, terns, and piping plover. The NWF impoundment is also intensely managed for piping plover nesting habitat as mitigation for the loss of habitat at the recreational beach. The number of piping plover nesting pairs on Chincoteague NWR has increased from 50 pairs in 1987 to 100 or more pairs in recent years (2005 to 2010). The number of piping plover chicks fledged increased steadily between 1987 (when monitoring began) and 2004 (with a peak of 224 fledged chicks), declined from 2005 to 2008, and increased slightly (132 chicks fledged) in 2009 and 2010. Weather events and predation affect fledgling success. Productivity has reached or exceeded the Recovery Plan goal of 1.5 chicks/pair in 5 of the last 10 years (USFWS 1995). Prior to 2007, Assateague Island consistently had the highest number of nesting plover pairs, but in recent years (2007 to 2009), Cedar and Assawoman islands have had more breeding pairs and higher fledgling success. Increased flooding events due to high tides on the Hook and Overwash during the breeding season, and erosion of Wild Beach are factors.

The following factors have contributed to the decline of the piping plover along the Atlantic Coast and depress plover production at Chincoteague NWR:

- Human disturbance can curtail breeding success. Pedestrians and off-road vehicles may cause plover parents to desert the nest, exposing eggs or chicks to the summer sun and predators, not to mention the possibility of the vehicles crushing the well-camouflaged nests or young. Interruption of feeding may stress juvenile birds during critical periods in their development.
- Predation from ghost crabs and foxes is a significant factor in survival. Six total nests on Assateague Island were disturbed by predators in 2011 (Refuge biology data), resulting in significant loss of eggs. However, in 2011, the most significant loss of eggs (a total of 42) was due to weather and tide, with the nests being over washed during full or new moon tide cycles (USFWS 2011a)).

Monitoring and management efforts for the 2011 nesting season (USFWS 2011a) included:

- Pre-season surveys were conducted opportunistically beginning in March; staff surveyed all shorebird breeding areas for plover and other nesting shorebird species arrival, establishment of territories, courtship display, and preliminary nest scrapes. Initial surveys allowed observers to estimate the number of potential nesting plover and shorebird pairs for the season. More intense monitoring began in mid-April when territorial pairs were firmly documented.
- Using binoculars and spotting scopes, staff observed individual nesting shorebirds or pairs from a vehicle or dune. As mating pairs were identified, staff walked through nesting areas at a slow pace looking for scrapes and bird tracks. Once the nest was located, the observer placed a paint stick 10 meters (m) from the nest and recorded the location. Paint sticks allowed observers to identify and observe a nest from a distance without disturbing the incubating adults. Weather conditions, time, and potential stress on the birds was considered while nest searching. Nests were located from late April through early July 2011.
- Brood monitoring (determining the location and number of chicks in each brood) was attempted 7 days a week on Assateague and Assawoman Islands and 4 days on Cedar Island. Metompkin Island was monitored weekly by Chincoteague NWR staff. NASA staff attempted brood monitoring on Wallops Island three mornings a week. Brood monitoring was accomplished by observations of chicks from a vehicle using spotting scopes or by foot. Metompkin and Cedar islands are not accessible by vehicle. Staff traveled to and from the

islands by boat. Shorebird surveys, nest searches, and brood monitoring were conducted by foot. To reduce brood disturbance, chick observations lasted only long enough to count the chick numbers. Brood monitoring was not conducted in extreme weather conditions such as mid-day heat, rain, or high wind.

- Staff used invasive plant management, crushed shells, pony grazing, ditching, and water pumps as tools to improve shorebird nesting habitat on Chincoteague NWR. A portable diesel water pump was used to reduce the level of water held on the NWF shorebird breeding area into the South Wash Flats impoundment during breeding season. This season, maintenance staff placed crushed shells on the flats as a continuation of the nesting island creation on the area. Due to dry weather conditions and previous management, the maintenance staff operated the pump in February for 16 hours, a considerable lower amount compared to last year (335 hours).
- As part of the invasive plant management to improve shorebird nesting habitat, USFWS along with cooperating agencies sprayed patches of Phragmites along the Virginia barrier island system, in September 2009 and 2010. Due to the success of this effort, no treatment occurred in 2011.
- Predator management activities began on Assateague Island from February through June and on Assawoman Island from January to May confined to areas known to be piping plover habitat. Chincoteague NWR possesses a VDGIF Scientific Collections permit to conduct mammalian predator management on refuge lands targeting red fox, raccoon, mink, and opossum.
- Predator exclosures were also used on the refuge to help protect nesting birds and eggs. Exclosures used on the Hook, Overwash, Public Beach, and Wild Beach formed a 3.7 m diameter around nests. Six 1.5 m pieces of 12.7 mm diameter rebar were evenly spaced around the perimeter and driven into the ground to secure the welded wire in place.

Loggerhead sea turtle

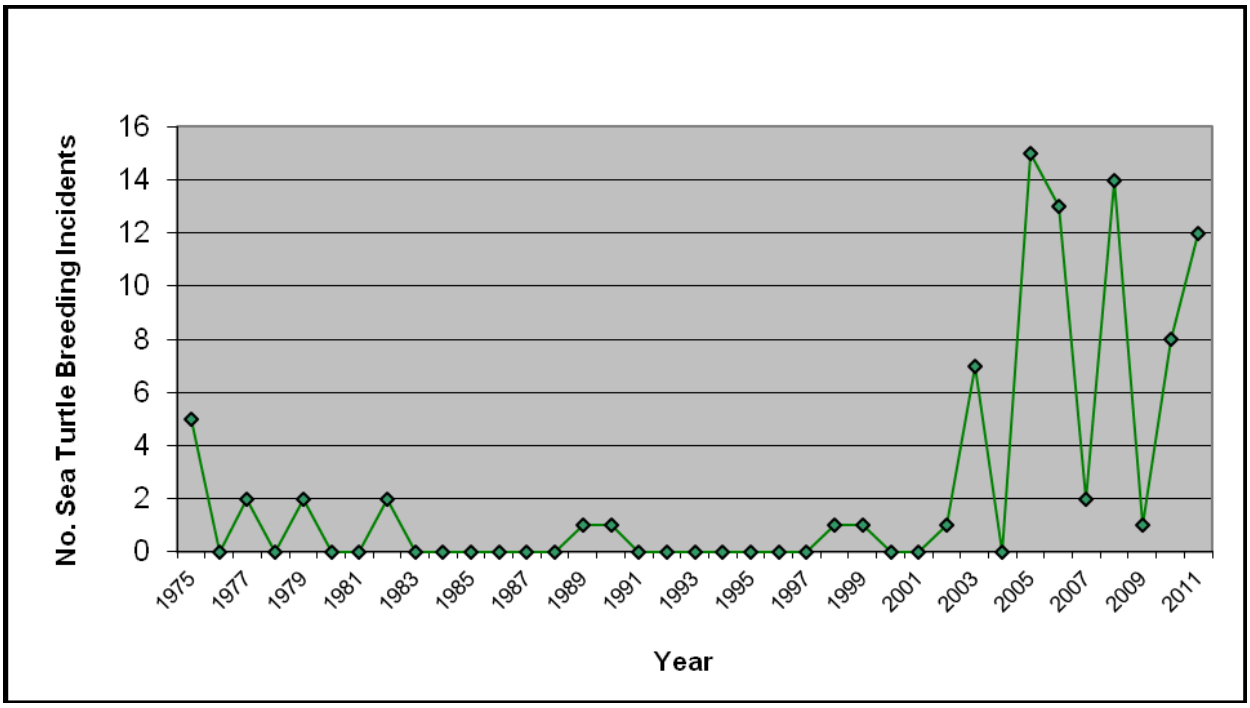
The Federal- and State-threatened loggerhead sea turtle nests on Assateague Island, which is the northern extent of its breeding range. Crawl and nesting activity occurs June through August, but activity tends to occur every other year according to refuge data. Because incubation takes longer (90 or more days) at this latitude, the hatch window is August through October. Nesting activity on Assateague Island and Wallops Island has risen noticeably in recent years, perhaps the result of a loggerhead translocation project. From 1969 to 1979, sea turtle eggs from nests laid on Cape Island of Cape Romain NWR, South Carolina were translocated to Chincoteague NWR. During this time, and the two decades following (1970 to 1999), staff recorded 16 crawls on Assateague Island and Wallops Island; 10 resulted in nests and 6 were false crawls, meaning no nest was made. Loggerhead nesting activity from 2000 to 2010 had a total of 62 crawls; 22 resulted in nests and 40 were false crawls. Loggerhead sea turtles take 30 years to reach maturity, so females that were part of the transplant project may now be returning to their hatch and release sites.

Chincoteague NWR staff monitors for and manages sea turtle crawls and nests on the Virginia portion of Assateague Island and assists when needed on NASA's Wallops Island and the Maryland portion of Assateague Island, in accordance with the Chincoteague NWR Intra-Service Section 7 and Biological Opinion (USFWS 2008b). Chincoteague NWR maintained records of all crawl, nesting, and hatching activity (Figure 3-14).

During the 2011 nesting season, 12 loggerhead sea turtle crawls were identified on Assateague Island's Maryland and Virginia sides combined; 2 crawls with no confirmed nesting in Maryland and 10 crawls with 5 confirmed nests on Chincoteague NWR in Virginia. All nests received

predator screening and barriers to deter walking and driving near or on the nests (USFWS 2008b). Ropes and poles were placed around Wild Beach 01 and Wild Beach 02 nests as they were in areas not already closed to public access. During routine monitoring, Chincoteague NWR biological staff identified and took precautions for potential nest disturbances. Only one of Chincoteague NWR's 5 nests exhibited signs of hatching. Wild Beach 01 began a trickle style hatch on August 8, 13 days into its hatch window. Twenty-three hatchlings were confirmed to have emerged from the nest, but a success rate is indeterminable due to impacts from Hurricane Irene. The Overwash reopened to public access on August 12, prior to which, symbolic ropes and poles were erected around the Overwash 01 nest. Over Sand Vehicles users were instructed to drive west of the nest. Similar precautions were taken for Hook 02 nest following the opening of the Hook to OSVs on September 1.

Figure 3-14. Sea Turtle Breeding Activity (Crawls and Nests), Assateague Island and NASA Wallops Island, 1974 to 2011 (Source USFWS 2011a)



*2010 – Includes one Assateague Island National Seashore nest.

3.4.2 Birds

The refuge is renowned for its abundant, diverse bird life. Situated on the Atlantic migratory flyway, the refuge provides crucial migratory stopover habitat for many species of shorebirds and waterfowl in the spring and fall. Shorebirds by the tens of thousands use Assateague Island's ocean beaches, impoundments, and other intertidal habitats to forage and rest. Shrub habitats behind the dunes provide important resting and feeding habitat for southbound neotropical migratory songbirds including warblers, flycatchers, and thrushes. Assateague Island also offers important winter habitat for numerous waterfowl and breeding habitat during spring and summer for colonial waterbirds and ground-nesting shorebirds such as the threatened piping plover. More than 320 species are known to use the refuge regularly for nesting and brood rearing, feeding, resting and staging during migration, or wintering. Most conspicuous to visitors are the

waterfowl, shorebirds, wading birds, and raptors. A full listing of bird species frequenting the refuge is given in Appendix L.

Waterfowl

Because the refuge lies strategically within the Atlantic flyway, dozens of waterfowl species stop to feed and rest on the refuge during the spring and fall migration seasons. The maximum number of waterfowl using refuge impoundments usually occurs in November, but occasionally peak numbers occur in December due to drought or other factors. The refuge supports wintering greater snow geese, Canada geese, American black ducks, mallards, green-winged teal, northern pintail, northern shoveler, gadwall, American widgeon, bufflehead, red-breasted merganser, ruddy duck, tundra swan, and others. Assateague Channel and Toms Cove provide critical winter feeding habitat for Atlantic brant, which also use refuge impoundments for fresh water and resting.

Recorded numbers of waterfowl on the refuge can be seen in Table 3-5, but no negative or positive trend in overall waterfowl numbers is apparent in the past two decades.

Table 3-5 Chincoteague NWR Waterfowl Maximum Population Estimates from 1989 to 2009

Year (Winter of)	November	December	Month Peak Occurred
1989/90	8,710	4,739	Nov
1990/91	8,917	14,879	Dec
1991/92	13,414	17,452	Dec
1992/93	18,282	19,680	Dec
1993/94	22,824	14,504	Nov
1994/95	33,025	23,549	Nov
1995/96	28,973	35,437	Dec
1996/97	51,790	24,432	Nov
1997/98	40,559	51,349	Dec
1998/99	11,494	19,438	Dec
1999/2000	25,711	22,465	Nov
2000/01	16,345	11,766	Nov
2001/02	8,062	8,274	Dec
2002/03	49,818	16,937	Nov
2003/04	44,395	10,932	Nov
2004/05	Unavailable	23,077	Dec
2005/06	47,776	27,711	Nov
2006/07	23,444	32,734	Dec
2007/08	3,616	3,904	Dec
2008/09	56,326	36,222	Nov
20-yr Average	25,674	20,974	

Impoundments are managed for waterfowl to provide invertebrate and plant food sources, loafing cover, and winter thermo-regulatory cover. Vegetation is kept at an early successional stage by a combination of mowing, disking, prescribed fire, and chemical treatments (for invasive plants such as Phragmites). Water levels are manipulated in spring to provide moist soil conditions conducive

to production of preferred waterfowl food plants. Dewatering of impoundments occurs mid-March through mid-June depending on the desired plant response and rainfall. Earlier draw-downs favor sedges, smartweeds, and bulrushes, while later drawdowns favor grasses. Late summer re-flooding provides desirable feeding sites for early fall migrants, particularly shorebirds. However, this is only possible with adequate rainfall. Fall re-flooding produces feeding conditions conducive to later migrants and to wintering waterfowl. Maintaining certain impoundments with high water levels year round, and flooding very large impoundments during the fall migration, creates roosting and loafing sites. Thermo-regulatory areas for waterfowl are maintained by allowing woody plants to remain within certain impoundments, or by raising the water level to flood wooded areas.

Black duck management is a high priority throughout this species' range because of declining populations and hybridization with mallards. Wintering habitat quality on the refuge is enhanced by controlling Phragmites and wax myrtle in favor of vegetation with higher waterfowl food value, such as three square, spikerush, and red root flat-sedge. Refuge black duck populations peak during fall migration when 1,100 to 1,400 are typically counted during November impoundment surveys. Black ducks in winter use tidal salt marsh and impoundments to a lesser extent.

Snow goose populations have recovered significantly since the 1930s and 1940s, when they were considered an imperiled species. The refuge's current mid-winter snow goose population averages around 6,000 to 12,000 geese but can range as high as 50,000 for a few weeks. These birds rest in the protected refuge impoundments, and regularly feed in adjacent salt marshes and in agricultural fields on the mainland. Occasionally geese feeding activity is concentrated in particular salt marsh locations, undesirably uprooting salt marsh cordgrass and creating muddy devegetated "eat-out" areas.

Chincoteague is not considered a significant waterfowl production refuge, and production data is not collected. However, during the 1980s, duck and goose production was emphasized on this refuge and many others throughout the Refuge System due to extended prairie drought and declining duck numbers. Intensive management activities to enhance waterfowl nesting no longer occur. Usually, a few broods of gadwall, mallards, black ducks, and wood ducks are present each year. Resident geese and non-native mute swans are selectively removed from Chincoteague NWR because they damage habitat on which migrant and wintering species depend.

Wading Marsh and Waterbirds

A variety of wading birds inhabit the tidal creeks and moist soil management units of the refuge to include the glossy ibis, great egrets, snowy egrets, green herons, little blue herons, tri-colored herons, black-crowned night herons, and cattle egrets, as well as several rail species. Being fairly large, beautiful, and plentiful along refuge trails, these birds offer visitors with excellent viewing and photography moments, particularly during the spring and summer when species of egret, heron, and ibis frequent the impoundment borrow ditches, eating small finfish and eels. Colonial nesting birds such as heron, egret, and ibis commonly nest on salt marsh islands in Chincoteague Bay. Other rookeries are located in the outer marsh fringe between Chincoteague Island and the mainland. Grebes and loons winter at the refuge, resting and feeding on adjacent waters. The eastern brown pelican (whose populations have recovered from population declines due to the use of the pesticide dichlorodiphenyltrichloroethane (DDT) and are now no longer endangered) frequent the refuge's intertidal zones, the ocean, and Assateague Channel. Pelicans nest in coastal areas south of the refuge; however, over the past few years they have nested progressively northward.

Shorebirds, Gulls, and Terns

Chincoteague NWR is one of the country's top five shorebird migration staging areas east of the Rocky Mountains (USFWS 1993a). It is designated a site of international importance by the WHSRN. Peak shorebird numbers during spring migration occur in May. The fall migration usually peaks in August and spans the period of July to October.

Spring migration begins with the arrival of piping plovers in March, but there are few other signs of migration before mid-April. During early spring migration, defined as the period of April 7 to May 6, 1,000 to 4,000 shorebirds may be present on Assateague Island habitats. The great majority are dunlins (50 percent) and sanderlings (22 percent), but short-billed dowitchers, black-bellied plovers, willets, and whimbrel are also present (Wilds 2007 and Refuge unpubl. data). During late spring migration, defined as the period of May 7 to June 6, between 6,000 and 26,000 (typically 12,000 to 13,000) birds are present on Assateague Island. The majority (46 percent) are semipalmated sandpipers, but good numbers of dowitchers, sanderlings, least sandpipers, dunlin, and ruddy turnstones are also present (Wilds 2007 and Refuge unpublished data).

Fall migration begins around July 1 with the arrival of short-billed dowitchers. Soon thereafter greater and lesser yellowlegs and least and semipalmated sandpipers arrive, the latter species making up the vast majority (around 40 percent) of shorebird numbers present July through September (Wilds 2007). Virtually all migrants present in July are adults. Hatching year migrants are not common until the last third of August, and by the last third of September, juveniles usually comprise the only shorebirds around, except for adults of shorebird species that overwinter.

Red knot, newly listed as threatened under the ESA, uses Chincoteague NWR beaches during spring and fall migration, with peak spring numbers occurring in the last half of May and peak fall numbers occurring in August (Smith et al. 2008a), as confirmed by refuge data. Since the 1980s, the population of red knots has declined 68 to 80 percent; the severe decrease in a major food item during migration—horseshoe crab eggs in Delaware Bay—is a suspected cause (Cohen et al. 2009). A significant proportion (25 to 30 percent) of the population of red knots (estimate 10,000 to 13,000) use Virginia's barrier islands during spring migration (Cohen et al. 2009). These recent findings that Virginia barrier islands support migratory red knot population add importance to Chincoteague NWR's role in red knot conservation.

Shorebirds were historically reported to occur in "huge numbers," but hunting for sport and food during the late 1800s and early 1900s resulted in decreases in populations of many species of shorebirds. Although hunting has been illegal for all but two species of shorebirds since 1916, many populations of shorebirds are still declining today. Many of the negative shorebird population trends suggest habitat degradation (50 percent of U.S. wetlands have been lost or degraded), depletion of critical food supplies (over-harvest of Delaware horseshoe crabs may be the most recent example), or other factors at work" (Harrington 1999). The United States Shorebird Conservation Plan identifies a number of shorebird characteristics that pose "conservation challenges" including: (1) long distance migration; (2) low productivity and resulting slow population recovery; (3) concentration of populations and increased vulnerability to environmental occurrences; (4) dispersed and ephemeral habitat; (5) loss of habitat; (6) population changes, and (7) the need to conserve across international borders (Brown et al 2001).

Avian migration is largely governed by endogenous rhythms, but annual variations in schedules may occur due to sex and age composition of flocks (Holmgren et al. 1993, Nebel et al. 2000), and weather, tides, and prey availability at stopover sites (Akesson and Hedenstrom 2000, Alerstam

2003). Virginia stopover site has been of historic importance in supporting red knots during spring migration and is not simply an ephemerally used satellite site to Delaware Bay (Cohen et al. 2009). The diet of red knots in Virginia includes coquina clams (Donax variabilis) and blue mussels (Mytilus edulis; Truitt et al. 2001), as was also the case historically (MacKay 1893), and lacks the horseshoe crab (Limulus polyphemus) eggs that are a staple in the Delaware Bay. Furthermore, unlike Delaware Bay, the Virginia habitat consists of high–wave-energy ocean shoreline, similar to much of the rest of the historic stopover range (Cohen et al. 2009). As many as 10,000 knots also stage on the outer barrier islands along the Virginia coast (Watts and Truitt 2000). Red knots tagged in Argentina, Brazil, and Chile stopped in Virginia in 2007 (Smith et al. 2008) as well as in Delaware and New Jersey, providing evidence that both stopover sites hosted birds from the southern wintering sites (Cohen et al. 2009).

Stopover duration for knots in Virginia from 2006 to 2010 was shorter, on average, than for Delaware Bay. The duration in Virginia was 7 to 8 days through May 25, and increased to 9 to 12 days from May 26 to June 6. Red knots exhibited two peaks in the duration of stopover. The first occurred during the first through third week of May, and the second occurred from the last week in May to the first week in June. The pattern of stopover duration in Virginia may be driven by abundance of benthic prey. In 2007, prey peaked at the end of May through early June (Cohen et al. 2009). Arrival to Virginia appears to be constant throughout stopover, while changes in fidelity rates (0.76 to 0.84) mirror peaks in total stopover duration (Duerr et al. 2011). Analysis of mark-resight data on an annual basis (Cohen et al. 2009) provided evidence that red knots from Virginia move between Virginia and one or more other spring locations. Movement from Virginia to an unobserved location (60 percent) was greater than fidelity to Virginia (40 percent). However, this movement was not permanent, as many (48 percent) returned in subsequent years (Duerr et al. 2011).

Virginia supports the second largest number of red knots in the Eastern U.S. during their final stopover during the northward migration in spring (Duerr et al. 2011). Although numbers of animals that use an area is not an indication of habitat quality (Van Horne 1983), survival of those animals is a valid indicator of quality. The Virginia annual survival (0.87) is higher than the estimates for knots from Tierra del Fuego and Delaware Bay prior to (0.84) and after (0.54) a population decline in 2000 (Baker et al. 2004, Duerr et al. 2011).

The barrier islands along the Delmarva Peninsula in Virginia provide high quality habitat for migrating red knots. This area contributes to high survival, and supports tens of thousands of birds. Early preservation of the barrier islands and lagoon systems in Virginia contribute to the long-term survival of the rufa subspecies, potentially helping to avert steep short-term declines that were predicted (Baker et al. 2004) for Delaware Bay. Knots using Virginia and Delaware Bay constitute a single population that includes red knots from throughout their winter range (Duerr et al. 2011).

Migrant shorebirds use Assateague Island beaches, tidal flats, and impoundments. Shoveler Pool (B-North Pool), Snow Goose Pool (B-South Pool), Swan Cove Pool (F Pool), Black Duck Pool (A Pool), Old Fields, South Wash Flats, and NWF are the most important for shorebirds (Wilds 2007), as confirmed by refuge data. Pintail and Gadwall (D and E Pools), Sow Pond, and Ragged Point typically have little or no shorebird use. The Hook is the most important beach area on Assateague Island for migrant and nesting shorebirds (Refuge unpublished data).

Refuge staff have cooperated with the VDGIF and TNC to monitor American oystercatcher population size and breeding success since 2001. In 2008, the refuge supported 25 percent (100) of the total number (395) of nesting pairs on Virginia's barrier islands. This amounts to 14 percent of the State's total number of breeding pairs (731). Cedar Island has the most breeding pairs on the refuge, followed by Assawoman and Assateague Islands. Metompkin Island had the largest population (95 breeding pairs) of oystercatchers on any of Virginia's barrier islands, however only 14 pairs nested on the refuge portion. Refuge staff also conduct boat-based breeding and fall/winter roost surveys of oystercatchers in Chincoteague Bay, when staffing allows.

The refuge also provides excellent nesting habitat for colonial and other beach nesting birds. Colonial species include common terns, least terns, gull-billed terns, and black skimmers. Wilson's and piping plovers nest on beach ridges and overwash areas (Assateague Island is the northern limit of Wilson's plover breeding range). Intertidal sand and mud flats on the cove side of Toms Cove Hook contain horseshoe crab eggs and other high quality food during the entire shorebird season. Willets and oystercatchers nest on the cove side beach and around the natural freshwater marsh in the Hook interior. Oystercatchers also nest in the dunes and recently-vegetated areas near Fishing Point.

Herring, ring-billed, and laughing gulls are the three gull species commonly seen during summer months. Great black-backed gulls have recently expanded their range southward, and can be found on the refuge yearlong. Gulls nest along the causeway connecting Chincoteague Island to the mainland. They feed and rest along refuge beaches and in impoundments.

In regards to numbers of shorebirds using an area during the southward migration, Chincoteague NWR ranks fourth among 454 sites east of the Rockies where a census was taken in the U.S., and is important for many species on an international scale. The refuge ranked second in diversity of shorebird species from among all 450 sites in the International Shorebird Survey network (Schulte and Chan 1985, Manomet 2008), and the barrier islands of Virginia and Maryland were dedicated as part of the International Shorebird Reserve.

Raptors

Many raptors are known to be present on or adjacent to the refuge, with the American kestrel, osprey, black vulture, red-tailed hawk, bald eagle, and great horned owl among the most common species.

Bald eagles were de-listed from the Federal ESA in 2007 and de-listed from the Virginia list as of January 1, 2013. The three known bald eagle nests on Chincoteague NWR are checked for activity in March and May each year by VDGIF; they are currently located in a loblolly pine tree at Black Duck Pool (A Pool), Great Neck (directly west of Old Fields), and Wallops Island.

Assateague Island is a major resting and feeding area for peregrine falcons during fall migration. They hunt shorebirds and other prey and use the beach as a resting area. In 1980, a peregrine hacking tower was erected on the NWF. Hacking is a falconry technique in which chicks are placed in artificial nests and fed until they are ready to fly. Eight falcon chicks were hacked from the tower in 1980 and 1981. The first successful nesting of peregrine falcons in Virginia after the DDT era occurred on the NWF tower in 1982, and pairs nesting on this tower produced a total of 54 fledglings between 1982 and 2003. Between 2004 and 2008, pairs occupied the tower, but nesting was assumed to be unsuccessful based on behavior and aerial surveys. In 2008, the tower was climbed for the first time in several years, and evidence of mammalian predation (probably

raccoon) on the eggs was found, and the predator guards were in disrepair. The tower was removed prior to the 2009 breeding season because of conflicts with piping plover management objectives on the NWF and a Statewide decision to not repair or maintain existing peregrine towers located in important shorebird areas within the seaside lagoon system. The peregrine hacking tower on Metompkin Island was removed in 2010 for this reason (Watts et al. 2008).

Ospreys fish in refuge marshes and Swan Cove Pool (F Pool), northern harriers hunt in marshes and impoundments, and red-tailed hawks nest in forests. Three species of owls are year-round residents. Eastern screech owls nest in Delmarva Peninsula fox squirrel and wood duck nest boxes, as well as in natural cavities. Barn owls often nest in hunting blinds on adjacent marshes. Great horned owls prey on rabbits, Delmarva Peninsula fox squirrels, and shorebirds. Southbound migrating hawks stop to rest and feed on the refuge during fall migration as they fly over the Delmarva Peninsula. Large numbers of hawks stop to rest and feed during their fall migration, including kestrels, merlins, sharp-shinned hawks, and Cooper's hawks. Turkey vultures are occasionally seen roosting in trees or flying over the refuge in search of carrion. The known raptor migration through the area occurs in September and October.

Landbirds

From 1999 to 2009, refuge volunteer Dr. Richard (Dick) Roberts monitored landbird habitat use through mist netting and banding. During these 10 years, Dr. Roberts sampled 14 different areas on Chincoteague NWR, comprising shrub/early successional, forested uplands, and shrub/pine edge habitats. Some areas have been sampled for 5 consecutive years or more, others for 3 years or fewer (Roberts 2009). Nets were operated year-round, weather permitting. Overall goals of this monitoring were to:

- Collect baseline data on species using refuge habitats as a basis for management decisions;
- Identify habitats being used by species of special concern;
- Document/confirm nesting and migrating species;
- Document the occurrence of rare or unusual species; and
- Conduct environmental education.

In shrub habitat dominated by wax myrtle/bayberry vegetation adjacent to the South Wash Flats impoundment, 72 species were captured during the 5-year sample period. Evidence of breeding of common yellowthroats, gray catbirds, and prairie warblers was found. The latter is a highest priority BCC for BCR 30, and gray catbird is a medium priority BCR 30 species (USFWS 2008c). Yellow-rumped (myrtle) warblers depend upon this habitat extensively during migration and winter. BCR Highest or High Priority Species that have been banded in this habitat during breeding or migration include (in order of relative abundance): field sparrow, prairie warbler, brown thrasher, eastern towhee, great crested flycatcher, Baltimore oriole, eastern kingbird, worm-eating warbler, and northern flicker. Medium priority BCR 30 species captured in this habitat in order of relative abundance are gray catbird, Canada warbler, and blackburnian warbler.

Dr. Roberts considers shrub habitats behind beach dunes, such as that typified by his study site adjacent to Toms Cove Visitor Center, essential stopover habitat for southbound fall migrants. This habitat is particularly important to juvenile birds (and hence recruitment into the population), since 85 to 90 percent of birds migrating southbound through the mid-Atlantic coast are hatch-year birds (2009). This vegetation on the lee side of the dunes appears to provide

important refuge to birds inexperienced in navigation that may otherwise be blown out to sea without somewhere to shelter and re-fuel (Roberts 2009). BCR Highest or High Priority Species that have been captured in migration during 5 years of mist-netting in this site include (in order of relative abundance): field sparrow, black-and-white warbler, eastern towhee, eastern kingbird, prairie warbler, Louisiana waterthrush, Baltimore oriole. Gray catbird, a medium priority BCR 30 species, was captured in this study site, but at relatively low numbers compared to other sites.

Mist-netting/banding sites in forest habitat have been operated for 1 to 3-year periods in approximately six locations along the Woodland Trail and Wildlife Loop to measure response to habitat modifications such as pine bark beetle outbreaks and prescribed burns. The following BCR Highest or High Priority Species have been among the 75 species captured in this habitat in order of relative abundance: brown thrasher, field sparrow, northern flicker, eastern towhee, black-and-white warbler, Baltimore oriole, great-crested flycatcher, prairie warbler, eastern kingbird, and worm-eating warbler. Medium priority BCR 30 species captured in this habitat in order of relative abundance are gray catbird, brown-headed nuthatch, and red-headed woodpecker.

The longest consecutive mist netting/banding site operated by Dr. Roberts (2001 to 2009) is adjacent to the Woodland Trail parking lot. It is located on the edge between forested uplands and salt marsh habitat and contains more understory shrubs (myrtle, bayberry, greenbrier, and other berry-producing shrubs) than typical mature loblolly pine forest on Assateague Island. Bird species diversity was high: 87 species captured in a 9-year period. Gray catbird, a medium priority BCR 30 species, has the highest number of captures here compared to any other site. The following BCR Highest or High Priority Species have been captured at this site (in order of relative abundance): black and white warbler, eastern towhee, Baltimore oriole, prairie warbler, eastern kingbird, northern flicker, field sparrow, and worm-eating warbler (Roberts 2009).

The mist-netting study has provided valuable data, particularly for skulking species, non-singing migrants, and wintering birds. However, canopy birds and larger species such as crows and bobwhite are under-represented. A BBS conducted for 10 years between 1996 and 2006, provides additional data on the refuge's landbird population. Two BBS routes of 30 points each, spaced 0.5 miles apart, in myrtle shrub and loblolly pine forest (total = 60 points) were run during the second week of June using slightly modified BBS protocols (Chincoteague NWR 1996).

Appendix L lists the 20 most abundant birds (in order of relative abundance) observed in each of the two habitats (myrtle shrub and loblolly pine forest) during the 10-year BBS period. Ten BCR 30 Priority Species breed on the refuge: gray catbird, northern bobwhite, and brown thrasher—found in both habitats; field sparrow, eastern kingbird, and prairie warbler—found in myrtle shrub; and eastern towhee, great-crested flycatcher, northern flicker, and brown-headed nuthatch—found in loblolly pine forest.

Appendix L also compares the BBS results with Dr. Robert's 20 most abundant mist-net captures (1999 to 2007). Only 9 species were on the top 20 in both the BBS and the mist net study: gray catbird, common yellowthroat, song sparrow, house wren, northern cardinal, common grackle, Carolina wren, field sparrow, and yellow-breasted chat. Birds that appear on Dr. Robert's "Top 20" and not on the BBS are generally wintering or migrant birds. For example, the most numerous wintering and migrant bird on the refuge—yellow-rumped warbler—was not encountered at all on the BBS. Birds that appear on the BBS "Top 20" and not on Dr. Robert's

study are canopy birds such as eastern wood peewee, brown-headed nuthatch, and great-crested flycatcher, or species too large to be captured in passerine mist nets such as crows and bobwhite.

Upland Game Birds

Based on the 10-year BBS noted above, northern bobwhite quail are widespread with a stable to increasing population trend on the refuge. They were detected on 29 of 30 possible points in myrtle shrub vegetation over the 10-year period, and on average detected on 40 percent of the points each year. Quail were detected on all 30 points in loblolly pine vegetation at one time or another during the 10-year survey and on average detected on 36 percent of the points each year. According to refuge data records, the number of quail counted in both the myrtle shrub and loblolly forest BBS routes has increased between 1996 and 2006 (unpubl. data, Refuge files).

Four American woodcock singing-ground survey routes (totaling 40 survey points) encompass all suitable woodcock habitat on the refuge accessible by road. Routes have been run intermittently in 8 of the past 20 years, beginning in 1990. A maximum of 15 woodcock were detected during the 2000 survey, and the most recent survey in 2009 counted 5 woodcock. Birds have been counted on each route with the exception of the North Service Road. Beach Road/Woodland Trail has had the highest number of detections and been the most consistent in having woodcock over the years. The Swan Cove Trail/Wildlife Loop did not have any woodcock during the first 10 years of the survey but has had more woodcock than any other route during the most recent decade. It was the only area with woodcock in 2009. No long-term trend can be determined from the data except that higher numbers of woodcock were counted during the first half of March, irrespective of the year. Counts after March 21 generally detect fewer birds, perhaps indicating that Chincoteague NWR is more important to migrating or wintering woodcock than breeding birds. Wallops Island NWR appears to have suitable habitat but lacks survey data.

The first turkeys on Assateague Island were sighted in March 2005 by an employed law enforcement officer. Coincidentally, the NPS staff reported turkeys on the north end of Assateague Island around the same time. Turkeys are regularly encountered on the bi-weekly waterfowl survey. The population size of turkeys is unknown, but a flock no greater than 20 birds (adults and juveniles) was observed in December 2009 (Buffa 2009). Turkeys are thought to be at least stable and probably increasing, according to refuge data. Turkeys are also frequently sighted on Wallops Island NWR.

3.4.3 Fish and Other Aquatic Species

A full list of fish species collected on the refuge during the refuge's Fish Survey is listed in Appendix L.

Finfish

The refuge and surrounding area has a diverse assemblage of fish species that inhabit the impoundments and is somewhat tolerant of fluctuating water salinity. During droughts and periods of water level drawdown, fish are confined to borrow ditches, where they are an easy food source for wading birds, skimmers, terns, and osprey. Species include the sheepshead minnow, rainwater killifish, striped killifish, mummichog, banded killifish, tidewater silverside, threespine and fourspine stickle-back, white and yellowperch, and American eel.

Myriads of fish spawn and feed in the nutrient rich, protected waters on Assateague Island's bay side. Marine finfish of primary recreational or commercial importance in the refuge vicinity

include the black drum, red drum or channel bass, bluefish, winter and summer flounder, menhaden, spot, Atlantic croaker, weakfish, mullet, and spotted sea trout. Other common species are puffer, rockfish, spotfin killifish, king fish, and sand tiger shark.

Since 1972, the Maryland DNR Critical Area Commission for the Chesapeake and Atlantic Coastal Bays has documented a decrease in the abundance of forage species such as bay anchovy, menhaden, spot, and Atlantic silverside in Assateague Island's bayside waters. Small forage fish are most susceptible to fish kills when summer algal blooms create anaerobic conditions in shallow bays and canals. Other finfish populations in Chincoteague and Sinepuxent Bays appear relatively stable. Summer flounder, however, are still recovering from a 1989 population crash. Declining populations of forage fish commonly eaten by the flounder may be slowing recovery rates. Disease also presents a threat of unknown magnitude as different species of fish in the bays periodically show symptoms such as lesions. Scientists are currently attempting to better understand these afflictions and how they may be related to observed changes in water quality.

Other Marine Resources

Historically, the mollusks and crustaceans of Assateague's bayside waters were an important food source for American Indians and a commercial resource for local communities dating back to the earliest settlers. Oysters were abundant in Assateague Island's bays until the mid-1930s, when construction of the Ocean City inlet and jetty system dramatically altered the salinity regime and the abundance of native predators. Coupled with chronic overharvesting and the introduction of two aggressive single-celled oyster parasites during the 1950s (multinucleated sphere X (MSX) and dermo), the oyster population plummeted and is now in danger of disappearing altogether. Presently, Virginia oysters are grown commercially on leased beds below the low tide mark in Toms Cove and along Assateague Channel. A few "wild oysters" may be found along the low marsh edge and the banks of Toms Cove (as well as some ribbed mussels that cling to banks of low tidal marsh creeks.)

The mollusk community was further disrupted during the mid-20th century by the virtual disappearance of eelgrass resulting from a viral disease that affected sea grasses worldwide. Atlantic bay scallops, once regionally abundant, were nearly extirpated by the outbreak. With the resurgence of eelgrass during the 1980s and 1990s, scallops have begun to repopulate the bays, though numbers remain very low. Quahogs, or hard shell clams, which live in bayside sand and mudflats, showed greater resistance to the forces driving population decline in other mollusk species and remain an important component of the estuarine ecosystem. Introduction of the hydraulic clam dredge during the 1960s increased harvest efficiencies and fueled the development of commercial clam industries in Maryland and Virginia. Unfortunately, hydraulic clam dredging damages sea grass beds and other bottom habitats, reducing habitat value and altering community structure.

Blue crabs are also abundant in cove and bay waters adjacent to the refuge. Crabs can also be found in Swan Cove Pool (F Pool) on the refuge, where crabbing is a popular activity of summer visitors. Blue crabs are food for wading birds, otters, and raccoon; and harvest of hard- and soft-shelled blue crabs is important both recreationally and commercially, which takes place in the National Seashore waterway. After declines in the 1950s and increases through the 1970s and 1980s, crab populations currently seem stable

Ghost crabs are small omnivores that burrow in the less-traveled sections of the refuge beach, eating detritus and dead organisms that wash up in tidal drift. They also prey on eggs and young chicks of beach nesting birds. Their predators include raccoon, fox, gulls, and various shorebirds.

The horseshoe crab is an endemic species found on the east coast of the U.S., with the center of abundance between New Jersey and Virginia. This species spawns in the spring during new and full moon periods starting the end of April and lasting into June. This period of time coincides with the spring migration of shorebirds. Migration is an extremely energetic undertaking for these birds and their success or failure is dependent upon finding sufficient energy (food) to complete migration and then to breed. Studies have shown that horseshoe crab eggs that wash up on beaches after a spawning cycle are known to supply some or the entire energy requirement to complete migration. The Chincoteague NWR location along the Atlantic flyway makes it a vital resting and feeding spot for a large number of migrating shorebirds.

American horseshoe crab is one of four extant species of horseshoe crabs; it is the only North American representative (Shuster 1982). Horseshoe crabs are slow to reach sexual maturity (USFWS 2006; Shuster 1982). Although female horseshoe crabs lay thousands of eggs each spawning attempt, it is unknown how many of these eggs result in mature, reproducing crabs.

3.4.4 Mammals

The refuge supports relatively few native, terrestrial mammalian species. Among the more common terrestrial species are white-tailed deer and cottontail rabbit. Less common mammals include muskrat, river otter, opossum, gray squirrel, and three species of bat. Mammal diversity ranges from a variety of rodents and shrews to large marine mammals—the latter including the bottlenose dolphin and several species of whale that feed in the island's offshore waters.

Assateague Island and Chincoteague NWR are perhaps more noted for their exotic mammals (sika and Chincoteague ponies—see below) than for their native mammals. The endangered Delmarva Peninsula fox squirrel was introduced to Chincoteague NWR as part of a regional recovery effort (see “Federal Endangered Species” section above). Red fox, which is not native to barrier islands, impacts piping plovers and other ground-nesting birds on Assateague and Assawoman Islands. Red fox and raccoon are selectively controlled through a trapping program to minimize their predation on nesting piping plovers, American oystercatchers, terns, and skimmers (USDA 2005).

Deer

White-tailed deer are the largest native land mammals on the refuge. They are abundant in wooded areas and upland meadows, but they are also attracted to sites where dead trees have been cleared and tender regenerating forest vegetation is plentiful. They are managed through a regulated hunt program on Assateague Island, Wildcat Marsh, and Wallops Island NWR to maintain populations at levels that are commensurate with refuge habitat objectives, and to provide recreational hunting opportunities (USFWS 2007d and 2007e). The refuge partners with NPS on monitoring population size. Some white-tailed deer also use Cedar and Assawoman islands, as evidenced by tracks and scat.

Sika

Sika, a species native to east Asia and Japan, were released on the northern end of Assateague (MD) in the 1920s when the island was privately owned (Flyger 1960). They increased in number

and expanded their range to occupy the entire island, and sika were well established on the Virginia end of the island when Chincoteague NWR was established in 1943. By 1963, refuge records estimated the sika population at 1,300 and reported that a browse line was becoming evident on refuge vegetation, indicating an over-population. Public hunting, started in 1964, has continued to the present in order to reduce the abundance of an exotic animal, preventing habitat degradation, and providing a public recreational opportunity. The refuge also uses depopulation permits from the VDGIF to control the population.

The population of sika on the Chincoteague NWR portion of Assateague Island was estimated at 1,000 animals in the mid-1990s using a model combined with spotlight surveys (Bicksler et al. 1995). The minimum population estimate for sika in the fall of 2007 and 2008 was 600 animals based on Chincoteague NWR harvest data and the Downing population reconstruction model (Davis et al. 2007). Each year harvest data and staff observations of habitat conditions are evaluated to determine season lengths, hunt areas, and bag limits needed to control the herd and keep deer and elk from causing resource damage. The refuge also partners with NPS on monitoring population size.

Chincoteague Ponies

The origin of the ponies is unknown, although there are several theories. One popular legend is that a Spanish galleon carrying a cargo of ponies sank off Assateague in the 1700s, and some of the ponies were able to swim to shore. Another theory is that the "Chincoteague Ponies" are descendants of colonial horses brought to Assateague Island in the l7th century by Eastern Shore planters when crop damage caused by free roaming animals led colonial legislatures to enact laws requiring fencing and taxes on livestock. The modern-day descendants of those domestic horses are wild and have adapted to their environment. The year 1925 marked the first year that Chincoteague Volunteer Fire Company members, later dubbed "saltwater cowboys," herded the ponies to the Assateague Channel and swam them to nearby Chincoteague Island for auction. This event is now known as the annual pony swim and auction. The land used for the ponies' herding became part of the Chincoteague NWR with its creation in 1943, so the USFWS issued the Fire Company a SUP to allow no more than 150 head of horses to graze in designated areas of the refuge, a permit that is still in effect today.

The ponies' status as managed grazing livestock, and their strong cultural tie to the community, is often at odds with their adverse effects on the island's habitats such as salt marshes and forests. Consequently, managing their populations is needed to maintain a balance with the island's ecosystem and remain compatible with refuge purposes. A fence along the Virginia/Maryland State line (the northern refuge boundary) separates the island's ponies into two herds. There are approximately 130 adult ponies on the southern Virginia end of the island. The Virginia herd is managed by the Chincoteague Volunteer Fire Company and is grazed in two designated compartments on the refuge, known as the North and South Pony Units.

Marine Mammals

Marine mammals are often sighted in waters around the refuge, and occasionally wash onto shore. With the exception of several common dolphins and seals, most marine mammals occur as occasional transients or seasonal migrants. Documented marine mammals in the ocean and bayside waters surrounding Assateague Island include six species of baleen whales, of which five are endangered; 16 species of toothed whales (including dolphins), one of which is endangered; and the West Indian manatee, which is also endangered. Other recorded species include: harbor

seals; Risso's dolphins, long-finned pilot whales, humpback whales, fin-backed whales, sperm whales, pygmy sperm whales, spotted and Atlantic bottle-nosed porpoises, and common dolphins. Most at risk is the northern right whale, with a North Atlantic population of perhaps only 200 individuals.

3.4.5 Reptiles and Amphibians

Reptile and amphibian diversity on the refuge is relatively limited owing to the island's isolation and harsh environmental conditions. (A full list of reptiles and amphibians occurring on Chincoteague NWR is included in Appendix L). Several species of reptiles possess morphological adaptations necessary to survive the varying and sometimes harsh conditions of barrier island life. Many reptiles, for instance, have tough skins that exclude salt and retain moisture. Still others exhibit behavioral adaptations that limit their exposure to severe temperature or salinity. Due to their highly permeable skins, most amphibians cannot tolerate the infusion of salt that occurs when submersed in seawater. Another major limiting factor is the relative scarcity of fresh water habitats available on the island. Assateague Island's amphibian species require fresh water to reproduce, but vary in the amount of moisture they require for day-to-day survival. Fowler's toads can actually tolerate low levels of salinity and are able to absorb moisture from their environment directly through their skin. This decreased dependence on fresh water explains their larger range and ability to survive in most of island's habitats.

Documented reptile and amphibian species on Assateague Island include 11 turtles, 7 frogs and toads, 7 nonvenomous snakes, and 1 lizard; of which approximately 20 of these reptile and amphibian species are assumed to be present on the Chincoteague NWR. Reptiles most likely to be observed on the refuge are: eastern box turtle, Northern diamond back terrapin, eastern mud turtle, eastern hognose snake, black rat snake, and northern water snake. Chincoteague's commonly observed amphibians include Fowler's toad, southern leopard frog, bull frog, and green tree frog.

Reptiles

Eastern box turtles, painted turtles, and mud turtles are seen occasionally in the fresh water impoundments, as are snapping turtles, which can grow quite large and prey on fish, frogs, and young waterfowl. Northern diamondback terrapin inhabit the salt marsh and more brackish impoundments. One freshwater species, the spotted turtle, is known to live only in a small group of ponds located in the oldest part of the island.

The northern diamondback terrapin dwells in refuge salt marshes. Female terrapins lay eggs on beach habitats (i.e., berms, dunes, and washover sand flats) of Assateague, Assawoman, Cedar, and Metompkin Islands from early June through early August (Feinberg and Burke 2003). A 3-year study (2006 to 2008) of terrapins nesting on south Cedar Island found that egg-laying peaks in June and tapers off in late July; predation followed by wash-out are the leading causes of mortality (Boettcher, unpubl. data). Predators (ghost crabs and red fox) destroyed 94 percent of nests in 2006 and only 38 percent in 2007, following the implementation of a predator control program (Boettcher, unpubl. data). Raccoons were not present on Cedar Island during this study, but are considered major predators where they occur on barrier islands (Feinburg and Burke 2003). Therefore, predator control programs to protect beach nesting birds also benefit terrapins.

No venomous snakes are known to inhabit Assateague Island. The most commonly seen snakes are the eastern hognose snakes, which prefer sandy woods, fields, and dune areas; and black rat

snakes, which grow to 5 feet long, are excellent climbers, and live in high tree cavities. The less common northern water snake is also an excellent tree climber and is seen in the impoundments.

Northern fence lizards are very rare on the island and have not been observed in recent years.

As mentioned in Section 3.4.1, four species of Federal listed sea turtles use Assateague Island's ocean and bay waters, and presumably the coastal waters of the refuge: leatherback sea turtle, Kemp's ridley sea turtle, loggerhead sea turtle, and green sea turtle.

Amphibians

Of the six frog and toad species, four were commonly encountered by Toadvine (2000) and during aural call count surveys conducted by refuge staff in 2003, 2004, and 2005: Fowler's toad, southern leopard frog, green tree frog, and bullfrog. The New Jersey chorus frog (last observed in 1970s at one location near the lighthouse), and green frog (not reported since Conant 1990) may no longer be present on the island. Green frogs occupy permanent bodies of freshwater, and several periods of drought in the 1990s may have eliminated habitat on Assateague Island (Toadvine 2000). Re-colonization is still a possibility (Mitchell et al. 1993 and Conant et al. 1990).

The red-back salamander may be becoming more common on the refuge. Few individuals were found by Toadvine (2000) and Mitchell et al. (1993). A quick survey using the White Hills Delmarva Peninsula fox squirrel trap line as a sampling transect line in December 2008 found these salamanders to be common under mixed hardwood/loblolly pines with adequate leaf litter, and absent under pure loblolly pine stands with relatively dry sandy substrate and no litter.

3.4.6 Invertebrates

Invertebrates are the most diverse and abundant animals in natural ecosystems, but their importance in sustaining those systems is not commonly understood or appreciated. Chincoteague NWR is home to several types of invertebrates, as well as used as a resting area for other migrating species. Invertebrate conservation and management depends on sound knowledge of the distribution, biology, and food web dynamics of individual species and ecosystem interrelations which all have far-reaching implications for migratory bird management. Both terrestrial and aquatic invertebrate communities are very important components within the Chincoteague NWR ecosystem and more than outweigh all the taxa combined in species richness, abundance, and biomass. Invertebrates serve vital functions as pollinators and detritivores (facilitating decomposition of matter and returning nutrients to the soil), and are critical food resources for birds, insectivorous mammals, fish, reptiles, and amphibians. They play predominant roles in all ecosystem processes and are necessary links in all food webs in refuge biological communities. Invertebrates represent critical elements of biological integrity, diversity, and environmental health, and are essential to the maintenance of ecosystem services. Few formal surveys on invertebrates have been conducted on the refuge, but casual observations show a rich diversity of terrestrial insects such as spiders, beetles, ants, dragonflies, butterflies, moths, flies, wasps, and bees, and certainly a healthy population of ticks, chiggers, and mosquitoes. Although not prudent to highlight all invertebrate types individually, there are some that require specific discussion due to their importance to the refuge and visitor experiences.

Bees are among the most common flower visitors of the refuge, acting as important pollinators through their nectar feeding. According to a 2006 bee collection survey, Chincoteague NWR is

home to at least 41 species of bees. The majority of the species were recorded in areas of deep sandy soil, and wherever flowers could be found (USGS 2006).

The northeastern beach tiger beetle, a State and federally threatened species, inhabits beaches on the Chesapeake Bay and parts of the Atlantic coast, and is one of four subspecies of the eastern beach tiger beetle. Broad sandy beaches provide the best habitat for these beetles. Adults live in the zone between the high-tide line and the dunes; larvae inhabit burrows in the upper intertidal zone. These beetles have learned to adapt to this active habitat that is constantly disturbed by erosion and weather, and their presence is an indicator of a healthy beach. Adult beetles roam and fly over the sand foraging for other insects and small crustaceans, and also scavenge dead fish and crabs. Surveys for northeastern beach tiger beetle have been conducted on the refuge, but none have been found.

Eastern beach tiger beetles (with the exception of the northeastern subspecies) are greatest on the refuge during the months of June through August, which is their breeding season and during which the females lay eggs in shallow burrows on the beach. As a species, the eastern beach tiger beetle is rated by Nature Serve as common and globally secure, but the northeastern subspecies is ranked imperiled both globally and at the State level. The USFWS has developed a conservation and recovery plan for sites inhabited by the beetle. Key components of that plan include monitoring populations, protecting beach habitat from foot and vehicular traffic, and educating landowners and the public about the endangered beetle (VNHP 2008).

Assateague Island is a critical stopover area for fall-migrating monarch butterflies migrating south from Canada and New England to Mexico, with sometimes as many as 100,000 monarchs counted migrating over the beach dunes. Refuge habitats provide an abundance of nectar sources such as seaside goldenrod, climbing hempweed, Biden, groundsel-tree, and horsemint, which fuel the monarch's journey to wintering sites in Mexico. Important night-roosting sites are located in thickets of bayberry, wax myrtle, groundsel-tree, loblolly pine, and eastern red-cedar in the vicinity of Toms Cove and along the Service Road. The largest night roost recorded at Chincoteague NWR has over 30,000 monarchs clustering in the branches of a wild cherry tree (Gibbs 2008).

Peak migration usually occurs during the last week of September and the first week in October, with a second wave occurring during mid-October in some years. In most years, there are three peaks or "waves" of monarchs. Monarchs at Chincoteague NWR typically stay a maximum of 5 days, nectaring on the flowers to build up enough fat to sustain them on the rest of their journey to Mexico. The waves most often occur after the passing of a cold front, and large waves also occur after hurricanes (Gibbs 2008).

Several insect pests are common on the refuge, most notably the mosquito and the southern pine beetle. Although no formal surveys for mosquitos have been done on a refuge specific level, their existence has been noted and is incorporated within the refuge management practices for mitigating in areas of high public visitation when needed.

The southern pine beetle is a native species that has likely been present on the Delmarva Peninsula since the last ice age. Adult beetles are 0.08 to 0.16 inches (2 to 4 mm) in length with short legs and cylindrical bodies and are brown to black in color. The southern pine beetle is one of the most destructive insect enemies in the southern United States, Mexico, and Central America for pine trees. Adult beetles locate a host tree during their breeding cycle and bore into it. The

beetles then release pheromones used to attract a mate; as the species breed and more beetles bore into the tree, eggs are deposited and egg galleries form inside the tree, which then hatch into young beetles. When they have developed into adult beetles, they leave the host tree in search of other trees to colonize and infect, repeating the cycle in a different tree. This continued boring and feeding on the tree by adults and broods will ultimately kill a tree, and the area of destruction can quickly increase if the population is not controlled. Certain management methods, such as "fell in" method of management in which the infested trees are cut down and pushed to the center of the infested area, or burning certain areas, are practiced on the refuge to help control the beetle population.

3.4.7 Invasive/Exotic Species of Concern

Harsh environmental conditions such as exposure to saltwater spray and periodic storm overwash help prevent the introduction and spread of invasive/exotic plant species. By far the invasive plant causing the most resource impacts on Assateague Island is the common reed, Phragmites. It accounts for the majority of the acreage estimated to be affected by invasive plants, and occurs on all of the barrier islands on Chincoteague NWR as well as Wallops Island NWR. Phragmites outcompetes native wetland vegetation and provides little or no food or shelter for most wildlife. Phragmites can also eliminate small intertidal channels and obliterate pool habitat that offers natural refuge and feeding grounds for wildlife. The USFWS has been cooperating with other state and private landowners on the Delmarva Peninsula's eastern shore to eradicate Phragmites using herbicide and other control techniques. Other invasive species on Chincoteague NWR include Asiatic sand sedge, climbing fern, Japanese stilt-grass, Japanese wisteria, and Japanese Honeysuckle.

Autumn olive, a non-native tree, was widely planted for wildlife habitat "improvement" in the 1960s and 1970s. It was planted along the edges of Wallops Island NWR as one of the refuge's early management actions, but has spread to additional areas and is now considered an invasive exotic.

An invasive marine species potentially threatening the refuge's aquatic habitat is dead man's fingers, a macro algae or seaweed that arrived in New York in 1957 and has been making its way south along the coast. In parts of the northeast, dead man's fingers has outcompeted native algae species and overrun shellfish beds by monopolizing limited space on suitable substrate in intertidal areas.

Non-native faunal species in refuge estuaries and intertidal zones may prove to be a formidable threat. Several invasive species have recently established themselves in portions of the bays, particularly along shorelines armored with rock such as bridge abutments and jetties. Three species of crabs—green crabs, Asian shore crabs, and possibly Chinese mitten crabs—may threaten native species and ecosystem health. Asian shore crabs were transported to the Atlantic via ship ballast water in the 1950s, while green crabs were probably introduced as bait for tautog, a fish popular with anglers.

Other non-native species of concern include nutria, a large South American aquatic rodent capable of devastating tidal marshes and other wetland habitats. Fortunately, the spread of nutria up the Atlantic seaboard has not yet reached Assateague Island, although occasional sightings have been made on the adjacent mainland. Although native to North America, nonmigratory Canada geese present a continuing challenge as regional populations are rapidly expanding and causing a variety of conflicts with both humans and native wildlife.

3.5 Socioeconomic Setting

This section provides a summary of information from the baseline report, *Chincoteague National Wildlife Refuge Economic Analysis in support of Comprehensive Conservation Plan* (USFWS 2012e), a full version of which is in Appendix M, as well as an analysis of environmental justice characteristics.

3.5.1 Socio-Demographic Characteristics

According to the U.S. Census Bureau, the population of Chincoteague grew 21 percent (from 3,572 to 4,317 individuals) between 1990 and 2000, but declined 32 percent (to 2,941 residents) between 2000 and 2010 (U.S. Census Bureau 2010). In comparison, Accomack County's population declined by 13.4 percent over the same time period, while the total population for the Commonwealth of Virginia increased by 13 percent, an amount greater than U.S. population growth. Table 3-6 shows the comparison between these geographical entities.

Table 3-6 Change in Population, 2010 and 2000

Year	Chincoteague Town	Accomack County	Virginia	U.S.
2010	2,941	33,164	8,001,024	308,745,538
2000	4,317	38,305	7,078,515	281,421,906
Percent (%) Change	-31.9%	-13.4%	13.0%	9.7%

U.S. Census Bureau, 2010 and 2000 Demographic Profile Data, DP-1. Accessed at www.factfinder2.census.gov on March 20, 2012

Chincoteague has nearly three times the number of housing units as total households, reflecting the town's linkages to the tourism-based industry. The Census reports that nearly 60 percent of all vacant housing units were built for seasonal, recreational, or occasional use, compared to a state average of 2.4 percent.

Demographically, the town of Chincoteague is older and less racially and ethnically diverse than the surrounding county, State, and nation. Chincoteague has 1,417 households. Over 40 percent of these households are made of up individuals 65 years and older, reflecting Chincoteague's popularity as a retirement destination, and over 95 percent of residents are white. Both of these figures are higher than county, State, and national characteristics. Chincoteague's average household size of 2.06 is slightly smaller than that of the county, State, or nation. Over 83 percent of Chincoteague residents have a high school degree or higher, which is close to the national average of 85 percent. Compared to the county, Chincoteague has a higher percentage of residents with a bachelor's, graduate, or professional degree (13.7 percent vs. 10.3 percent). Only 16.6 percent of Chincoteague residents have not achieved a high school diploma, which is less than the county but more than the state (13.9 percent) and national (14.9 percent) averages.

The average earnings for people 25 years and over is less in Chincoteague than in other areas. Specifically, the average earnings for a town resident is $23,000 compared to $27,406 for a county resident, $39,409 for a State resident, and $34,665 for an average national resident. However, these estimates are heavily influenced by the lower earnings power of town residents with only a high school diploma or less. Town residents with a bachelor's degree or higher earn more on average than a resident of the county or nation (but not the State). Regardless of educational attainment, however, a higher percentage of Chincoteague residents experience poverty

compared to State or national residents. Table 3-7 presents an overview of poverty status and earnings.

Table 3-7. Poverty Status and Earnings

Category	Chincoteague, Virginia	Accomack County, Virginia	Virginia	United States
	Total Estimate	Total Estimate	Total Estimate	Total Estimate
Poverty Rate For The Population 25 Years And Over For Whom Poverty Status Is Determined By Educational Attainment Level				
Less than high school graduate	30.7%	28.0%	21.3%	24.7%
High school graduate (includes equivalency)	22.8%	13.2%	9.6%	12.0%
Some college or associate's degree	9.4%	12.2%	6.2%	8.4%
Bachelor's degree or higher	5.4%	3.6%	2.5%	3.8%
Median Earnings In The Past 12 Months (In 2010 Inflation-Adjusted Dollars)				
Population 25 years and over with earnings	23,000	27,406	39,409	34,665
Less than high school graduate	12,852	16,634	21,001	19,492
High school graduate (includes equivalency)	15,729	25,979	29,064	27,281
Some college or associate's degree	28,495	27,535	36,137	33,593
Bachelor's degree	52,417	40,809	53,522	48,485
Graduate or professional degree	66,563	50,898	75,613	63,612
Source: U.S. Census, American Community Survey 5 year estimates, 2006 to 2010.				

3.5.2 Economic Characteristics of Chincoteague and Accomack County

The town of Chincoteague has several sources of economic activity, including tourism (both refuge-related and other outdoor-based recreation opportunities), commercial fishing and seafood manufacturing, and impacts from the nearby NASA Wallops Island Flight Facility. This section will summarize some general economic characteristics for Chincoteague and discuss tourist-related characteristics of the economy, the commercial and seafood manufacturing sectors and the impacts of the NASA Wallops Island Flight Facility.

Employment

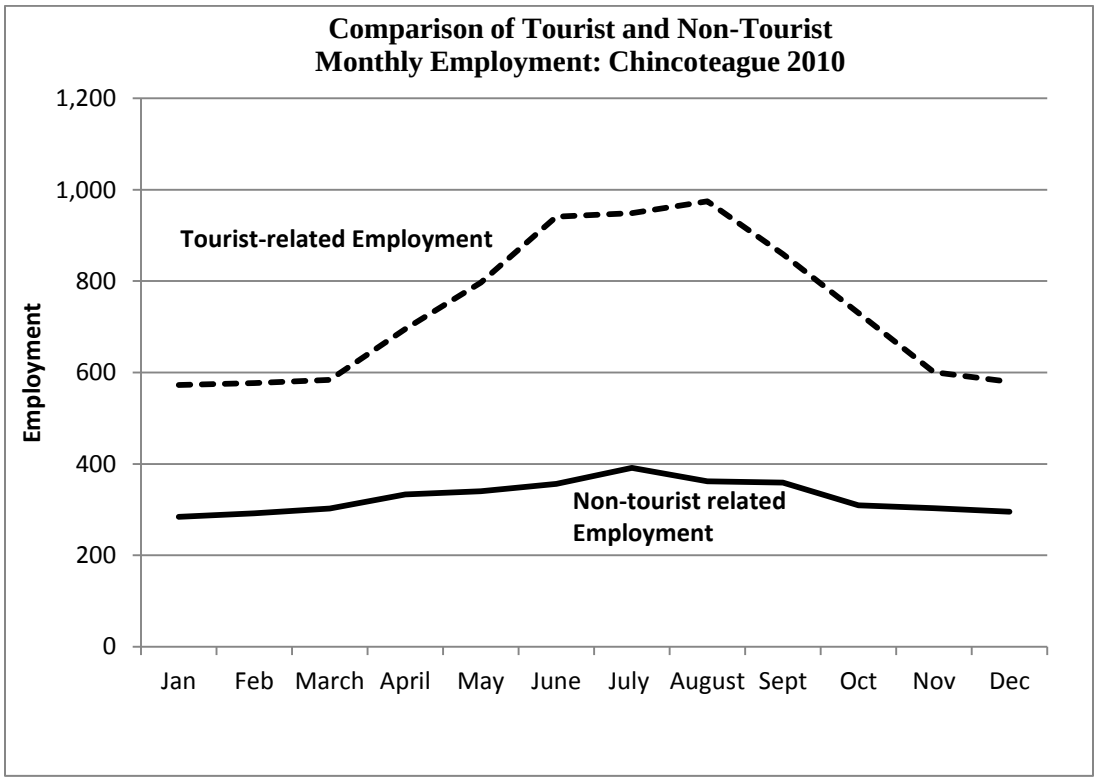
The Census estimates that during the year 2010, there were a total of 1,363 people employed in the town of Chincoteague. Roughly two-thirds were employed year-round while a third was seasonally employed. The three largest employment sectors, accommodation and food services, retail trade, and health care and social assistance, accounted for almost 75 percent of total wage and salary employment. The accommodation and food services sector accounted for 47 businesses, the retail trade sector accounted for 31, the construction sector for 15, and the real estate, rental

and leasing sector for 11. These four sectors accounted for 70 percent of all businesses which hired workers in 2010.

Chincoteague also has a substantial number of self-employed, as evidenced by the number of business licenses issued in 2011 compared with the number of businesses which employed at least one person during the year. In 2011, Chincoteague issued 1,269 business licenses, of which 149 employed at least one person, 700+ were for tourist rental homes, and approximately 416 were for other types of self-employment aside from tourist rental homes.

Chincoteague relies to a significant degree on tourism for town income. Tourism is not constant throughout the year, the summer months have the highest concentration of visitors and the winter months, the lowest. Consequently, much of the employment in Chincoteague follows a similar pattern. Total employment is lowest in January and highest in July, ranging from 857 to 1,340. Tourist-related employment ranges from 573 in January to 975 in August, representing an increase of 70 percent. In contrast, non-tourist related employment ranges from 284 in January to 391 in July, an increase of 38 percent. Figure 3-15 shows a monthly graph of tourist and non-tourist employment in 2010.

Figure 3-15. Comparison of Tourist and Non-Tourist Monthly Employment. Source: Virginia Employment Commission 2011



Real Estate

In terms of the real estate, rental and leasing sector, in the year 2010 there were a total of 2,775 combined rooms, spaces, and sites provided by 707 establishments. Ninety percent of these establishments were vacation rental homes. There were also 21 hotels/motels offering 849 rooms,

6 bed and breakfasts offering 33 rooms, and 6 cottages offering 80 rooms. Four campsites offered 1,143 spaces. The rental of these places to tourists not only generates revenue for the owners but also generates revenue for the town in the form of food and lodging excise taxes.

Tax Revenues

The Town of Chincoteague levies taxes on many of the tourist-related business to help pay for the provision of many public goods. In particular, taxes are levied on real estate, business licenses, occupancy, and meals.

Real estate is assessed by the Accomack County Assessor. Real estate within the town of Chincoteague is taxed by both the Town and Accomack County, with each having different rates. Real estate taxes for the Town are billed in early November of each year and are due on or before December 5 of the same year. The current Town real estate tax rate is $0.06 per $100 of assessed value.[1]

Personal property taxes are assessed by the Accomack County Commissioner of Revenue on such items as automobiles, motorcycles, travel trailers, boats, and mobile homes. Personal property is also taxed by the Town and Accomack County with different rates. Personal property bills are mailed the same time as real estate and have the same due date. The current Town personal property tax rate is $0.85 per $100 of assessed value. However, mobile homes are billed at the real estate rate.

The Town of Chincoteague levies an annual business license tax on all persons conducting business within the town. The tax is due on April 30 of each year. For most business categories, the current rate for this tax is $0.13 per $100 of gross receipts of the previous year, with a minimum tax of $50 and a maximum tax of $500 per year.

Transient occupancy tax is charged by providers of lodging for less than 30 days. The current town transient occupancy tax rate is 3 percent. Meals tax is charged on all prepared meals including beverages within the town. The current meals tax rate is 5 percent. Over the 10-year period from 2000 to 2010, hotels and motels accounted for 60.5 percent of the average annual gross receipts from the transient occupancy lodging tax, tourist homes 31.3 percent, campgrounds 4.7 percent, and bed and breakfasts 3.5 percent. Annual receipts averaged $17.6 million over the 10-year period. Chincoteague also contributed roughly 55 percent of Accomack County's lodging tax receipts between 2005 and 2010.

Both food and lodging excise tax receipts increased from 2004 to 2010. Food tax receipts for the town have increased 12.5 percent, while lodging tax receipts increased 84 percent, leading to an overall 43.1 percent in revenue increase from excise taxes.

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[1] The Town offers tax relief on real estate for certain elderly or handicapped individuals. The relief may be 50 percent or 100 percent. There are eligibility criteria, such as: income and amount of real estate owned. The contact is the Accomack County Commissioner of Revenue. The Commissioner of Revenue will notify the Town of those eligible for this relief.

Non-Tourism Sectors

In addition to tourist revenue, Chincoteague also harvests finfish and shellfish from the waters surrounding the refuge and benefits from its adjacency to NASA and associated facilities.

In 2010, the value of the harvest was over $3.3 million, more than half of which came from private shellfish farms that began forming recently. Blue crab and quahog represent the most valuable harvest. Data from the Virginia Marine Resources Commission show that the annual total amount of the finfish harvest is declining over the years, while the amount of the shellfish harvest has been increasing. In 1993, Accomack County waters produced nearly 400,000 pounds of finfish and 400,000 pounds of shellfish. By 2010, shellfish harvests increased to nearly 1.8 million pounds, while finfish harvests declined to less than 100,000 pounds.

The NASA Wallops Flight Facility and Mid-Atlantic Regional Spaceport also provide economic activity for the town and county. It has been estimated that of the $188.3 million it brings to the region from its operations and the spending of the employees and tourists it attracts, $77.8 million ends up in Accomack County while $110.5 million go to the Lower Eastern Shore. The facility and spaceport are also responsible for 2,347 jobs, of which 1,206 are in Accomack County.

3.5.3 Refuge Recreation Visits and Economics

The refuge attracts visitors to the region for a number of reasons. Visitors come for the beach, the wildlife and Chincoteague ponies, surf fishing, off-road vehicle use, and waterfowl and big game hunting. In 2010, the refuge had almost 1.4 million visits, with over half of those visits occurring in the peak summer months.[2] The beach parking lot closed five times that year due to over capacity.

Visitors stimulate the economy through direct payments for food, lodging, transportation, equipment, and supplies. In turn, local merchants use a portion of the money spent to buy other local goods, resulting in a multiplier effect. While refuge specific expenditures are not available, estimates can be derived from averages taken from the 2007 National Survey of Fishing, Hunting, and Wildlife-Associated Recreation. The percentages of expenditures estimated are then apportioned among Accomack County, Worcester County, and outside the area. The expenditure percentages are assumed to be 45 percent for Accomack County, 45 percent for Worcester County, and 10 percent for outside the area, based on a study of expenditures resulting from the WFF.

Total visitor recreation expenditures and associated economic output for Accomack and Worcester Counties in 2010 are summarized in Table 3-8. Based on the percentages noted above and the assumption, supported by the Springsted report, *Review of Revenues Received by the Accomack County from the Town* (2010), that Chincoteague brings in 85 percent of tourism revenue for Accomack County, total refuge-related expenditures by visitors was $42.4 million, supporting roughly 593 jobs in the lodging, food (including groceries), and retail sectors.

In addition to the revenue coming from visitors, the refuge itself spends $3.4 million in operations and maintenance each year, three-quarters of which goes to employees who live in the area,

[2] A "visitor" is one person visiting the refuge for all or part of one day.

supporting roughly 44 jobs.[3] In addition, refuge revenue sharing agreements resulted in $99,300 to Accomack County, $2,900 to Chincoteague, and $587 to Worcester County, Maryland in fiscal year 2008.

Table 3-8. 2010 Visitor Recreation Expenditures and Associated Economic Output for Accomack and Worcester Counties (in millions)

Economic Category	Residents	Non-Residents	Total
Retail Expenditures	$2.9	$110.9	$113.8
Economic Output	$3.8	$146.5	$150.3
Job Income	$1.2	$47.4	$48.6
Tax Revenue	$0.6	$10.0	$10.6
Total	$8.50	$314.80	$323.30
Jobs	45	1,749	1,794
Source: Estimates compiled by the Division of Economics, USFWS.			

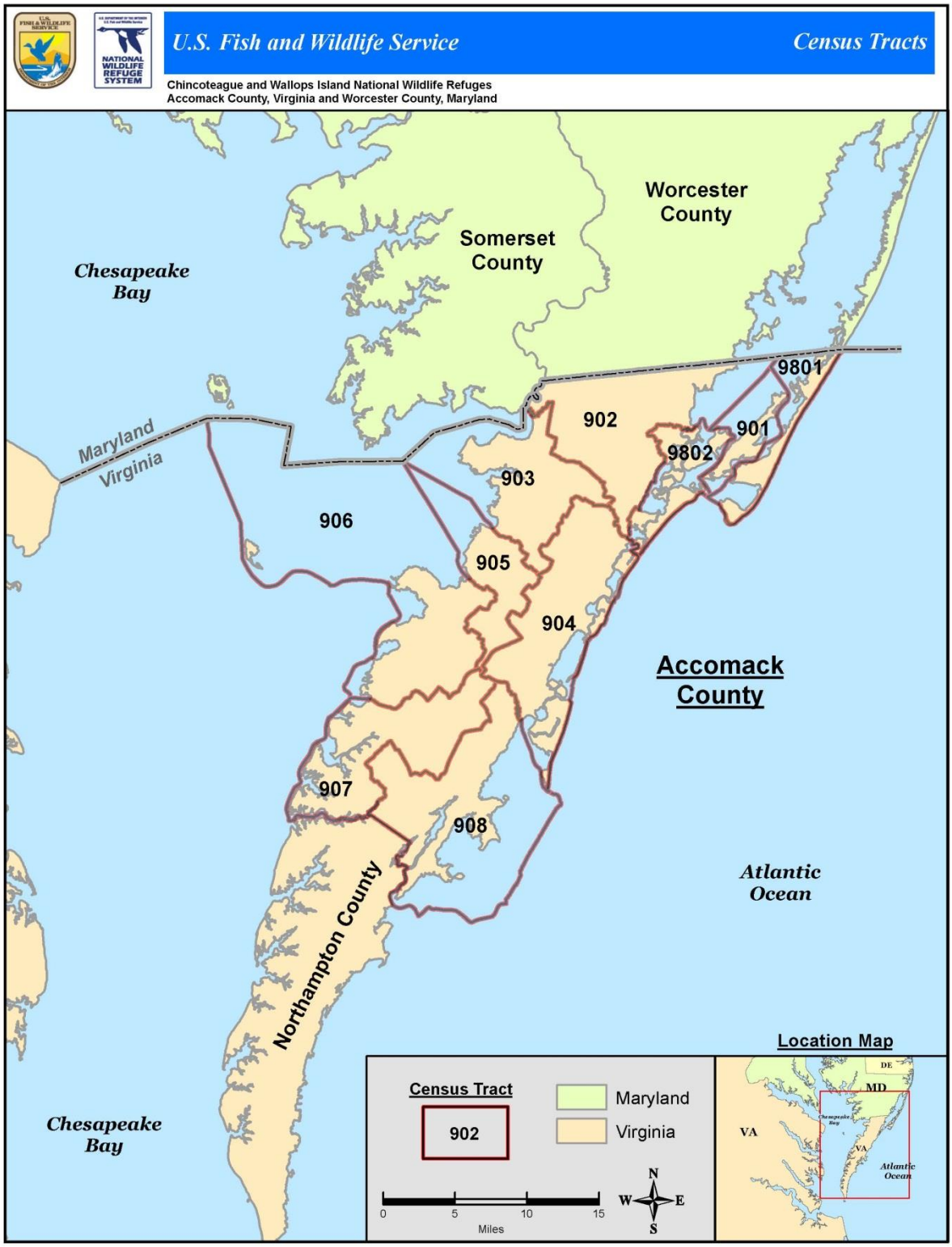
3.5.4 Environmental Justice

Executive Order 12898, General Actions to Address Environmental Justice in Minority Populations and Low-Income Populations (1994), requires all Federal agencies to incorporate environmental justice into their missions by identifying and addressing the disproportionately high and/or adverse human health or environmental effects of their programs and policies on minorities and low-income populations and communities. As defined by the EPA on their Web site, environmental justice is the "fair treatment and meaningful involvement of all people, regardless of race, color, national origin or income, with respect to the development, implementation, and enforcement of environmental laws, regulations, and policies." Fair treatment means that no group of people, including a racial, ethnic, or socioeconomic group, should bear a disproportionate share of the negative environmental consequences resulting from industrial, municipal, and commercial operations or the execution of Federal, State, local, and Tribal programs and policies.

This section identifies the location of environmental justice populations in the study area, including minorities and those with incomes at or below the federal poverty level. For the purposes of this assessment, the study area is defined as Accomack County, consistent with the definition used in the socioeconomic analysis. The presence of environmental justice populations in the study area is determined based on U.S. Census tract information. Figure 3-16 shows the U.S. Census tracts located in Accomack County.

[3] The jobs number includes both refuge jobs and jobs supported by its spending.

Figure 3-16. Map of Census Tracts for Accomack County



One difficulty in identifying the location of these populations within the study area is the highly seasonal nature of Chincoteague's population, which fluctuates based on peak season tourist activities and services during the summer months. The U.S. Census Bureau recording date of April 1 is not during the peak season for the town, leading to a petition by the Town and County for an adjustment to the Census population count. Specific details about the town economics and employment are provided in Section 3.5.2.

Minority Population

As shown in Table 3-9, the town of Chincoteague (Census Tract 901) contains a much smaller proportion of minorities (5 percent) than the surrounding county (35 percent) or the Commonwealth of Virginia (33 percent). Four of the eight census tracts in Accomack County have a higher proportion of minority population than the county as a whole, as shown in Table 3-9.

Low-Income Populations

Two Federal agencies, the Economic Development Administration (EDA) and the Housing and Urban Development Administration (HUD), have developed thresholds to identify concentrations of low-income populations that are commonly used in environmental justice analysis. EDA defines its eligibility for assistance as 80 percent of national per-capita income. HUD defines poverty level for a family of four at 60 percent of the median national household income. Neither total population for Accomack County nor for the town of Chincoteague is below either threshold. However, half (four) of individual census tracts within Accomack Country fall below the EDA threshold, as shown in Table 3-9 (see Figure 3-16 for the tracts located in Accomack County).

Table 3-9. Low-Income Thresholds and Minority Population by Census Tract (see Figure 3-16 for location of census tracts) NOTE: Underlined figures signal that a census tract has a lower income level than the national poverty level or is above the percent minority of Accomack County.

Area	Per Capita Income	Median Household Income	Minority Population
United States	$27,334	$51,914	28%
80%/60% of National	$21,867	$31,148	N/A
Virginia	$32,145	$61,406	33%
Accomack County	$22,766	$41,372	35%
Tract 901 (Chincoteague)	$29,752	$33,109	5%
Tract 902	$23,343	$43,212	35%
Tract 903	$17,595	$35,368	26%
Tract 904	$17,542	$40,412	50%
Tract 905	$20,496	$41,042	38%
Tract 906	$31,658	$50,278	21%
Tract 907	$22,548	$43,629	39%

Tract 908	$20,033	$35,329	47%

3.6 Land Use Setting and Transportation

The refuge has a history of prior land use, as well as several adjacent land uses. Access to the refuge relies primarily on the personal motor vehicle, but there are a range of adjacent transportation systems, some of which connect to the refuge.

3.6.1 Land Use

This section describes use of land adjacent to the refuge, which includes other federally owned lands, the town of Chincoteague, and Accomack County.

Other Federal Lands

Adjacent Federal lands consist of the NPS Assateague Island National Seashore and the NASA Goddard Space Flight Center's WFF, which has U.S. Navy and Commonwealth of Virginia tenants. The Flight Facility is a center for aeronautic research, and it has a visitor center that is adjacent to the Wallops Island NWR. It has launched approximately 16,000 rockets and expects an increase in commercial launch activity in the near future (Orbital 2008). The Virginia Commercial Space Flight Authority leases space for the Mid-Atlantic Regional Spaceport, which offers launch facilities for government, commercial, and academic/scientific uses and is expected to see an increase in commercial space flight activity (Orbital 2008). In addition, the U.S. Navy's Surface Combat Systems Center is co-located with NASA and the NOAA Command and Data Acquisition Station has leased land for its adjacent facility from NASA since 1965 (Town of Chincoteague 2010a).

Chincoteague Island

Figure 3-17 shows land use as of 2005 within the town of Chincoteague as presented in the *Comprehensive Plan* (2010). The two primary commercial areas are located on South Main Street, in the historic downtown area, and along Maddox Boulevard. The remaining land uses are predominantly residential or vacant, with businesses, tourist facilities, and public facilities scattered throughout the Town. Public facilities include schools, the Chincoteague Center, public service and safety facilities, and municipal offices.

According to the *Comprehensive Plan* (2010), Chincoteague's growth is constrained by land, capacity of the drinking water system, and the lack of a centralized sewage treatment system. Although there is vacant land, only a limited amount is available or feasible for commercial or residential development. For drinking water, Chincoteague is entirely dependent upon 5 miles of pipeline that carry water from underground wells on the mainland to the island; withdrawal of water from these wells is regulated by the Virginia Department of Health. There is currently no central sewage collection and treatment system serving the Island. Instead, wastewater is primarily disposed of by discharge directly into seepage pits, cesspools, or by the use of holding tanks or septic tanks and drain fields. Some residents have recently installed "package" sewage treatment systems.

Accomack County

The Accomack County Comprehensive Plan (2008) includes a thorough description of existing land use. The county's landscape consists mostly of farms, forests, and marshlands, interspersed with towns, villages and hamlets. The distribution of these land uses are shown in the County's zoning

map (see Figure 3-18). The plan reports that 1996 satellite land use imagery shows that less than 2 percent of the county is developed, 35 percent is crop and field, 39 percent is wooded, and 24 percent wetlands. The plan also notes the extensive conservation ownership within the county,

Figure 3-17. Town of Chincoteague: Existing Land Use (2005) (Town of Chincoteague 2010a)

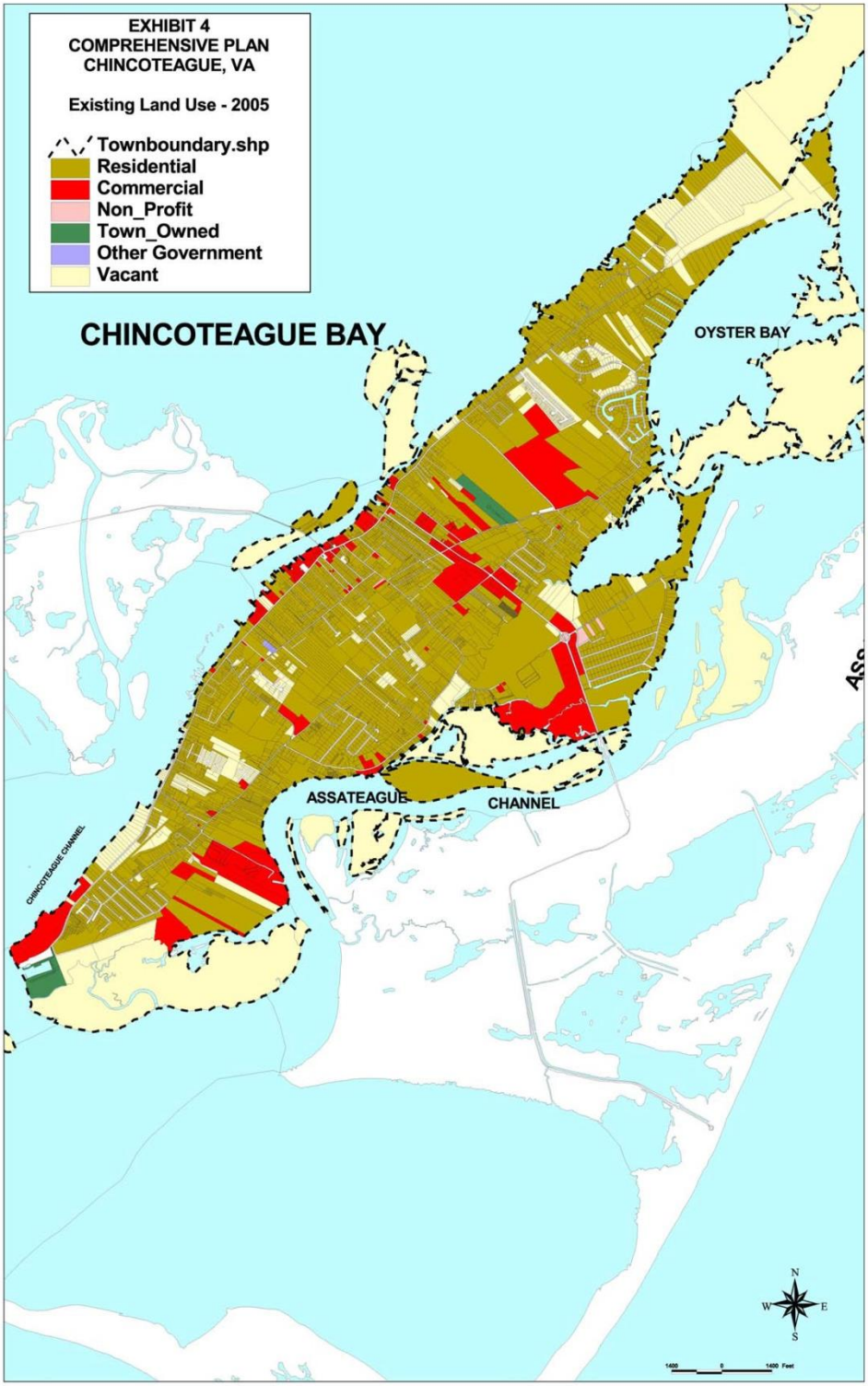
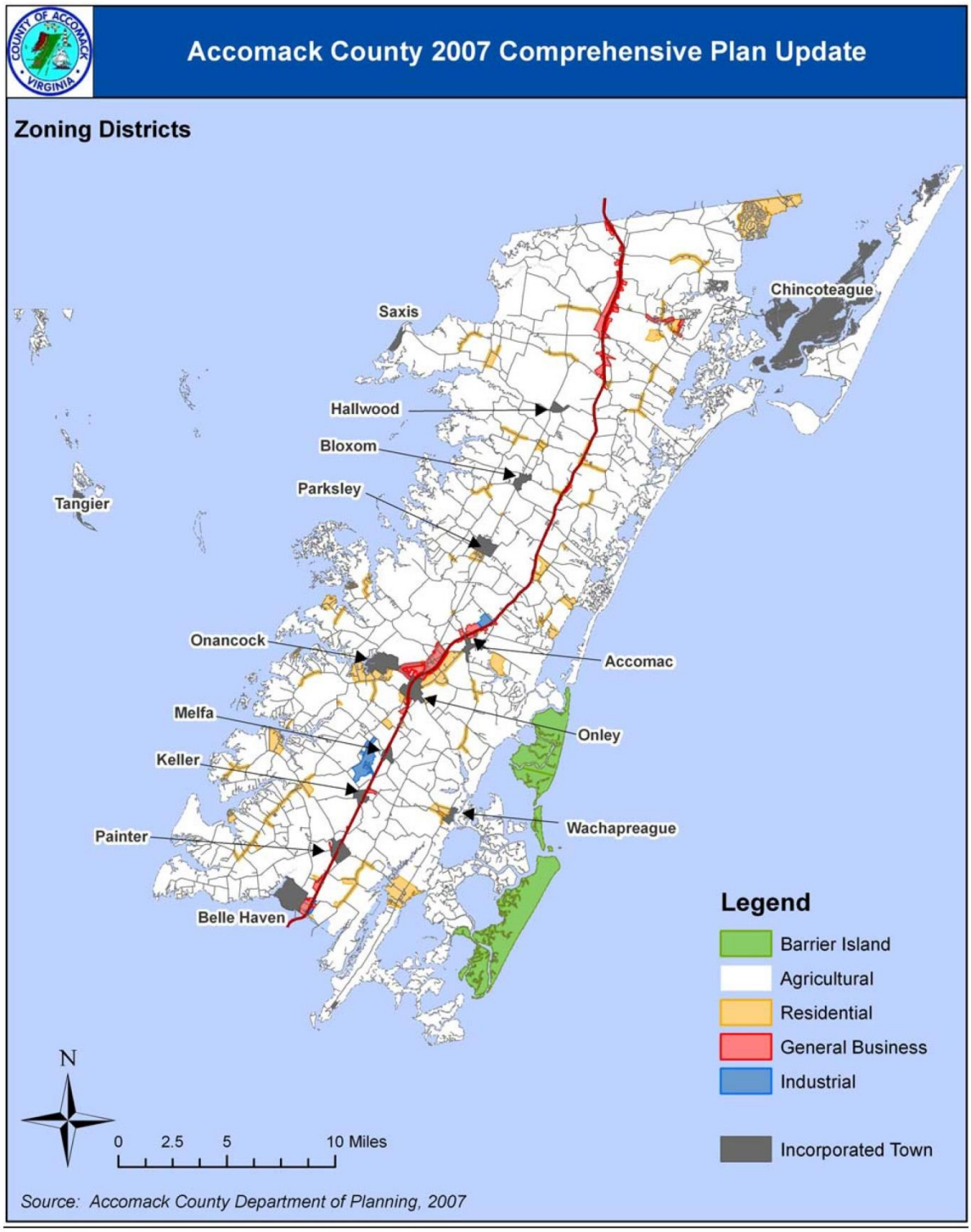


Figure 3-18. Accomack County Zoning Districts (Refuge Lands Excluded) (Accomack County 2008)



including lands owned and managed by the by the NPS, USFWS, VDGIF, the VDCR, TNC, and The Chesapeake Bay Foundation (see Figure 3 19).

Special Designations

In addition to NWR status, the lands within individual refuges may be recognized by additional designations, either legislatively or administratively. Special designation may also occur through the actions of other agencies or organizations. The influence that special designations may have on the management of refuge lands and waters may vary considerably.

Authority for designation of some special management area types (e.g., Research Natural Areas) on refuges lies solely with the USFWS. Wilderness Areas, on the other hand, must be legislatively designated by the U.S. Congress. For most special management area types, responsibility is held by or shared with others.

Refuges may also be included within much larger special management areas designated by other agencies or organizations, such as Western Hemisphere Shorebird Reserves, National Marine Sanctuaries, Estuarine Sanctuaries and Biosphere Reserves. Such designation may result in changes in management strategies, pursuant to this additional designation.

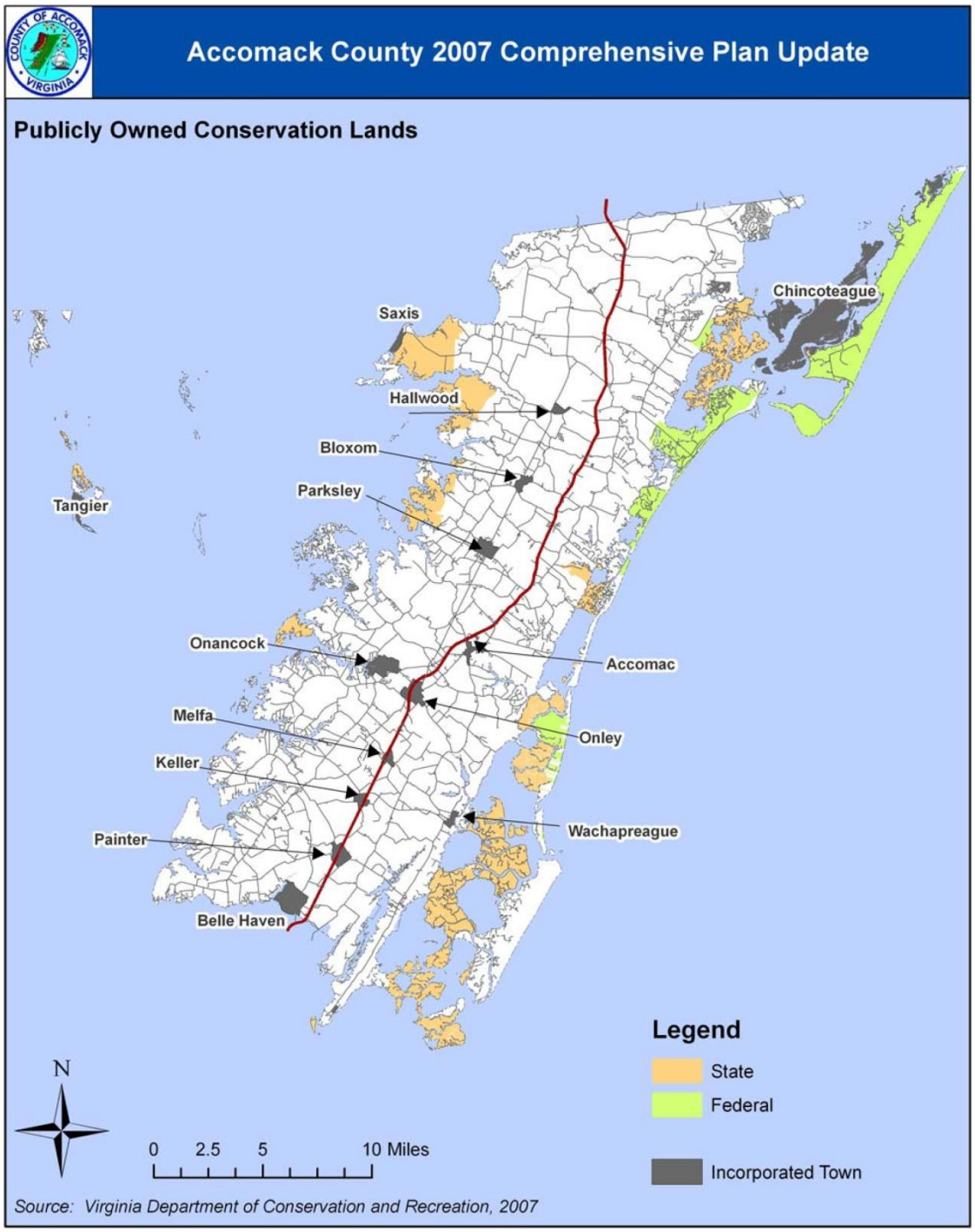
The following specially designated areas exist within the refuge:

Research Natural Areas

Chincoteague NWR contains approximately 150 acres of loblolly pine-shortleaf pine designated as a research natural area. We administratively designate research natural areas on refuges; currently there are 210 such areas on refuges totaling almost 2 million acres. Research natural areas are part of a national network of reserved areas under various ownerships and are intended to represent the full array of North American ecosystems with their biological communities, habitats, natural phenomena, and geological and hydrological formations. In research natural areas, as in designated wilderness, natural processes are allowed to predominate without human intervention. Under certain circumstances, deliberate manipulation may be used to maintain the unique features for which the research natural area was established.

Activities such as hiking, bird watching, hunting, fishing, wildlife observation, and photography are permissible, but not mandated, in research natural areas. Research natural areas may be closed to all public use if such use is determined to be incompatible with primary refuge purposes.

Figure 3-19. Accomack County Conservation Areas (Accomack County 2008)



Western Hemisphere Shorebird Reserves

The Maryland/Virginia Barrier Islands International Reserve, extending along the Atlantic coast of Maryland and Virginia, includes the Chincoteague NWR, Eastern Shore of Virginia NWR, and the Assateague National Seashore. These Barrier Islands are extremely important to migratory shorebirds during both spring and fall migrations. Results obtained from the International Shorebird Surveys (Schulte and Chan 1985 with recent 2008 update) show that of all 600 sites surveyed to the east of the Rocky Mountains, Chincoteague NWR ranks second in species diversity during both spring and fall migrations, and is among the top 10 for sites with greatest maximum counts. Further investigation may likely reveal that the Barrier Islands host numbers of shorebirds well exceeding 500,000 annually. Additional information regarding the Maryland/Virginia Barrier Islands International Reserve can be found at *http://www.whsrn.org/index.html*.

Assateague Island National Seashore

Assateague Island National Seashore was authorized by Congress in PL 89-195, on September 21, 1965, for the purpose of protecting Assateague Island and ". . . for public outdoor recreation and enjoyment . . ." The National Seashore includes approximately 48,000 acres of land, marsh wetlands and water, featuring the 37 miles of Assateague Island's beautiful sandy coastline. Chincoteague NWR (approximately 14,000 acres) and Assateague State Park (approximately 800 acres) are located within the boundaries of the National Seashore. The Seashore exists to preserve the unique mid-Atlantic coastal resources and natural ecosystem conditions and processes upon which they depend while providing high quality resource-compatible recreational opportunities.

Globally Important Bird Area (IBA) – Audubon

The Virginia Barrier Island Lagoon System, which extends from the Maryland-Virginia border south along the eastern coast of the lower Delmarva Peninsula, meets the criteria for, and has been designated as, an IBA by the Audubon Society. The area provides breeding habitat for 100 percent of Virginia's piping plover population, as well as a majority percentage of many other bird populations, and also provides wintering and migration locations for species at risk, such as the red knot.

Coastal Bays Program – National Estuary Program

Established in 1987 under the Clean Water Act, the National Estuary Program was developed to protect economically and environmentally sensitive estuaries across the United States by engaging all user groups. As part of the National Estuary Program, the Coastal Bays Program is a partnership among the towns of Ocean City and Berlin, NPS, Worcester County, EPA, and the Maryland DNR, Agriculture, Environment, and Planning, to manage and protects the land and waters of Assawoman, Isle of Wight, Sinepuxent, Newport, and Chincoteague bays.

UNESCO and DOI

The coastal barrier island/lagoon system of Chincoteague NWR has also been designated a World Biosphere Reserve by the United Nations Educational, Scientific, and Cultural Organization (UNESCO) in recognition of its great ecological value. Moreover, the DOI designated the area a National Natural Landmark in recognition of its outstanding natural values.

Wilderness Areas

Chincoteague and Wallops Island NWRs have been reviewed for their suitability in meeting the criteria for Wilderness Areas, as defined by the Wilderness Act of 1964. In 1974, the USFWS recommended that 1,740 acres on Assateague Island be established as part of the NWPS. Of this,

1,300 are located in Chincoteague NWR (882 acres in Virginia and 418 acres in Maryland) and 440 acres are within the boundaries of Assateague Island National Seashore in Maryland. In addition, 4,760 acres, mostly located in Maryland, were recommended as potential wilderness, to become part of the wilderness when nonconforming uses and structures were eliminated (USDOI 1974). However, at the present time, no action has been taken in regard to this recommendation and there exist no "congressionally designated wilderness lands" within the refuge.

Atlantic Coastal Bays Critical Area

The Chesapeake Bay Critical Area Protection Act was enacted in 1984 by the Maryland General Assembly to help reverse the deterioration of the Chesapeake Bay's (and later the Atlantic Coastal Bay's) environments. The Law and Criteria were designed to foster more sensitive land use and development activity along the shoreline of the Chesapeake Bay, Atlantic Coastal Bays, their tributaries, and tidal wetlands and to ensure the implementation of appropriate long-term conservation measures to protect important habitats. The Atlantic Coastal Bays, including Assawoman Bay, Isle of Wight Bay, and the St. Martin River, Sinepuxent Bay, Newport Bay, and Chincoteague Bay (totaling approximately 30,000 acres), were added to the Critical Area Program in 2002. The three goals of the Critical Area Program are: the protection of water quality; the conservation of fish, wildlife, and plant habitat; and, the accommodation of future growth and development without adverse environmental impacts. The law requires the establishment and maintenance of a minimum 100-foot naturally vegetated buffer adjacent to all tidal waters, tidal wetlands, and tributary streams.

3.6.2 Transportation and Access

Automobile Traffic and Circulation

Private automobile travel is the primary mode of transportation to the refuge from the mainland (see Figure 3-20). U.S. Route 13 is the principal north-south corridor linking the Eastern Shore of Virginia (Accomack and Northampton Counties) with the mainland of Virginia to the south and the State of Maryland to the northeast. On the Eastern Shore, U.S. Route 13 is a four-lane arterial with a variable-width median separating northbound and southbound traffic throughout most of the corridor.

U.S. Route 13 provides a direct connection to Route 175, the only access road to Chincoteague Island and the Virginia section of Assateague Island. Route 175 runs east across the Delmarva Peninsula from Route 13 to the town of Chincoteague, crossing over the Wire Narrows and Black Narrows Salt Marshes. From Route 13, Route 175 is a two-lane road with no shoulders until its intersection with Route 679, where the road broadens to include paved shoulders until it reaches the shore. The John Whealton Memorial Causeway ("Route 175 Causeway"), built in 1922, is a 2.5-mile stretch of two-lane road with no shoulders and a limited number of pull-off zones. The Causeway connects to Chincoteague Island via the Chincoteague Channel Route 175 Bridge, which leads to Maddox Boulevard. There is one parking area off of the Causeway, at Queen Sound Landing, for fishing and boat launching.

The road network in the town of Chincoteague consists of two-lane commercial and residential streets with varying levels of traffic and service. Circulation on local roadways features local and non-local traffic accessing residential, commercial, and recreational destinations.

Once on the refuge, visitors can access the various refuge sites, including the recreational beach, via the two-lane Beach Road. Refuge roads and parking are discussed further in Section 3.9.

Figure 3-20. Transportation Access to the Refuge

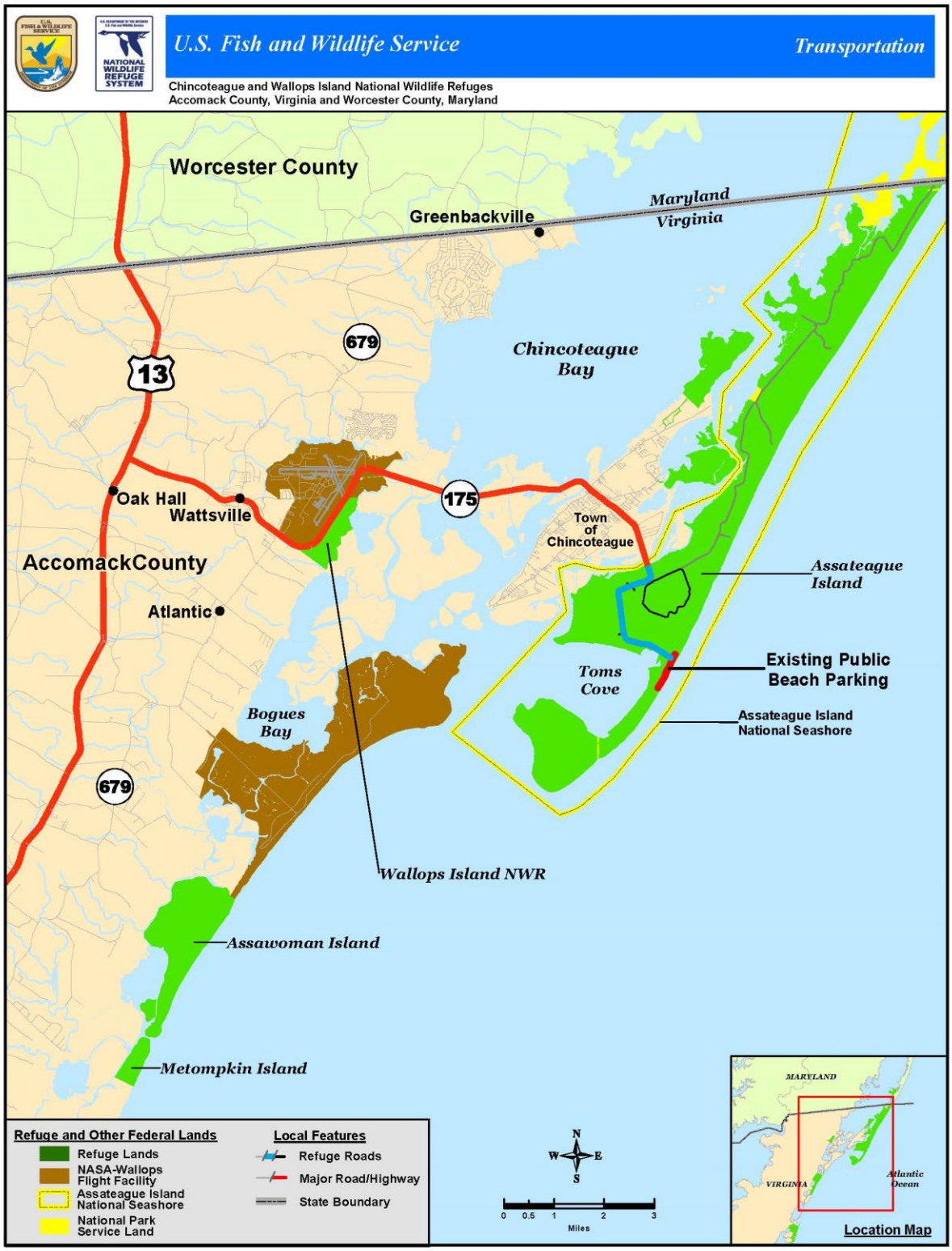
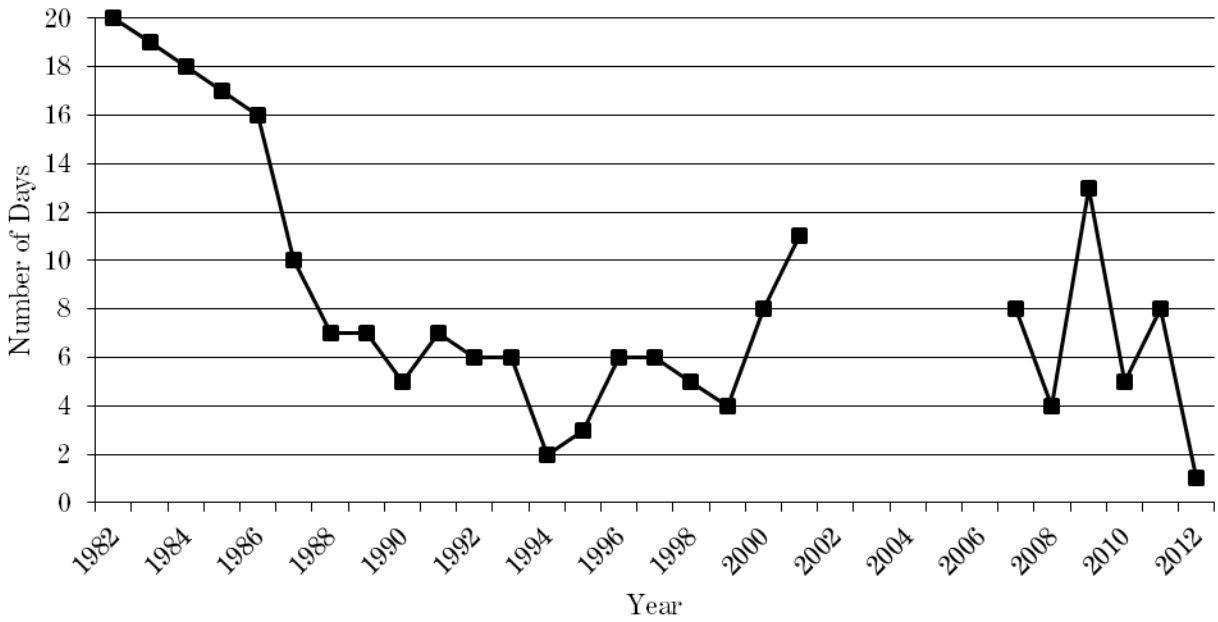


Figure 3-21. Chincoteague NWR Beach Parking Lot (Volpe Center July 2009)

The recreational beach parking consists of four unpaved parking areas at the terminus of Beach Road at the recreational beach (see Figure 3 21). The Chincoteague NWR Master Plan (1993a) references 961 existing spaces on the beach, but the spaces are not marked so the actual maximum capacity is reported as higher by refuge staff, dependent on people's parking and the size of vehicles. Parking capacity at the beach lots is sufficient for most days of the year but occasionally the lots reach capacity resulting in temporary closures. In addition, storm events can temporarily close the lots due to overwash and subsequent restoration efforts. From 1982 to 2001, the refuge and Seashore kept records of the frequency and dates for when the beach parking lots reached capacity; the refuge began recording frequency again in 2007 (see Figure 3-22). A review of data from 2000 and 2001 indicates that closures last from 30 minutes to 4 hours and were always initiated between 11:00 a.m. and 2:00 p.m. There are no similar records for a more recent year, but refuge staff anecdotally reported that there are typically 4 to 6 closures a year, also occurring between the peak hours noted above, and lasting approximately 30 minutes to 2 hours. These closures are highly weather-dependent but usually occur on the 4th of July if it is a 3-day weekend, and on the first two Saturdays and Sundays in August. The capacity closure data do not include closures due to damage to the parking from storm events.

In terms of parking occupancy for non-summer months, the refuge conducted hourly manual parking counts (approximately 9 a.m. through 4 p.m.) for the weekends of April and May 2010 and September 2010 through February 2011. The data indicates that total parked vehicles did not surpass 200 between November and April, and did not surpass 480 from October through May except for Memorial Day weekend.

Figure 3-22. Chincoteague NWR Entrance Closures Due to Full Beach Parking Lots (Seashore and refuge staff)



Intelligent Transportation and Traveler Information Systems

The refuge has been expanding its intelligent transportation and traveler information systems on the refuge using funding from a grant from the Paul S. Sarbanes Transit in Parks and technical assistance from Eastern Federal Lands, a division of the Federal Highway Administration's (FHWA) Office of Federal Lands Highway. The refuge purchased a solar-powered, portable variable message sign (VMS) in October 2009 to inform visitors of refuge and beach conditions, in particular during storm events and parking lot closures. In 2012, the refuge successfully re-activated an AM radio station, installed a traffic counter for the beach parking area, and explored options to sell passes and provide information via off-site kiosks. At the regional level, although VDOT manages a traffic and traveler information website to provide road condition information, it does not yet cover the Eastern Shore.

Public Transportation

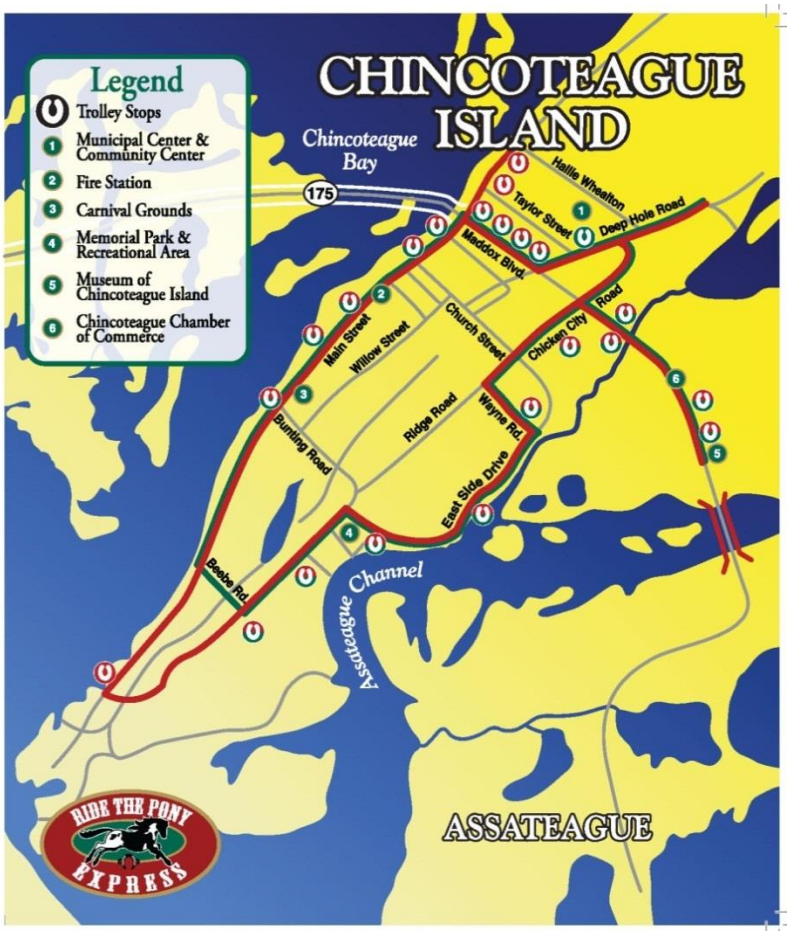
There are two public transportation systems that serve the town of Chincoteague. The town has a public transit system, the Pony Express, which is owned and operated by the Town of Chincoteague and that is also used for a historic tour of the town. Accomack and Northampton counties also have a public transit system, Shore Transit and Rideshare (STAR) Transit, which currently provides limited service to the town of Chincoteague. The refuge's friends group, the CNHA, provides an interpretive tour and has partnered in the past with the refuge to offer transportation to the beach when the parking lots were temporarily destroyed by Hurricane Irene. The town of Chincoteague and CNHA also provide special event public transportation during the Annual Pony Penning in July. The town of Chincoteague is not served by intercity bus transportation.

Pony Express

The Pony Express was initiated in 2004. It is a seasonal trolley that serves primary community and tourist sites throughout the Town but does not currently serve the refuge. The service has two routes (see Figure 3-23) and only operates in the evening from approximately 5 p.m. to 10:30 p.m. every day from the first weekend in June through the end of August. Extended service is provided after 10:30 p.m. on specific dates in May, July, and October and daytime service is provided the week of the Pony Swim and Auction (see below). The service also operates on the weekends in May, September, and October. Frequency varies by route and stop but is either every 30 or 60 minutes. The Town owns three trolleys. Fares are $0.25 per ride.

The Pony Express trolleys are also used by the History Tour Volunteers for an historical tour of the Town that is offered on Tuesday and Thursday afternoons from mid-June through Labor Day. Adult fares are $3 and reduced fares ($2) are available for riders aged 2 to 12. Children under 2 years of age ride free.

Figure 3-23. Pony Express Routes



STAR Transit

STAR Transit began in 1996 and currently runs four fixed-route bus services on weekdays, one of which served the town of Chincoteague from 1996 to 2010, and a demand-response service. STAR Transit offers a deviated route service (1.5 miles) on all its routes for those with an approved ADA

application and its buses are all equipped with external bicycle racks. For 2012, STAR Transit received Federal Transit Administration (FTA) Section 5317 (New Freedom) funds to begin deviated fixed-route service on weekdays to Chincoteague to provide service for the elderly, disabled, and unemployed community from Chincoteague to Route 13, where it will connect to one of STAR Transit's existing fixed route services (KFH Group 2011).

CNHA Services

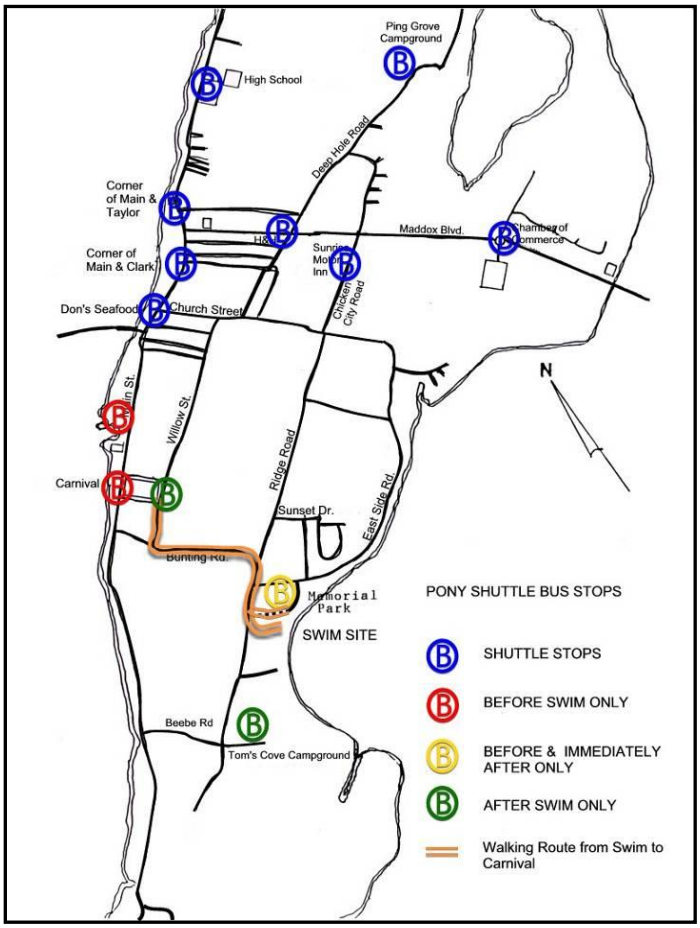
The CNHA provides a seasonal, interpretive bus tour service within the Chincoteague NWR under a cooperative agreement. The service began in 2004 to provide opportunities for the public to develop an understanding and appreciation for wildlife. As a nonprofit enterprise, CNHA uses proceeds collected from the tour to support its interpretation services. The tour operates from April through November and takes visitors to a part of the island that is not publically accessible by vehicles, including one of the best locations to see the Chincoteague ponies. The tour departs from the Visitor Center parking lot and travels to the end of the Service Road and back, a distance of approximately 15 miles round trip. The tour lasts 1.5 hours and is accompanied by an interpreter/guide who provides information about wildlife and ecology. The cost in 2012 is $12 for adults, $8 for CNHA members (except July and August), and $6 for children ages 2 to 12. The CNHA operates a used, 32-seat bus equipped with air conditioning and a wheelchair lift. CNHA contracts with a small company, Eastern Shore Action, to provide drivers.

In 2011, after Hurricane Irene damaged the parking lots and recreational beach (see section 3.9.1), the public beach was temporarily moved to an alternate site outfitted with lifeguard stands and portable toilets. This location was about 1.5 miles away from the closest refuge parking lots. CNHA partnered with the refuge to provide temporary bus transportation every 30 minutes from 10 a.m. to 5 p.m. from the parking for the Herbert H. Bateman Educational and Administrative Center and Wildlife Loop to Swan Cove Trail, from where visitors could walk one-half mile to the beach (USFWS "CNHA Offers Shuttle Service," 2011)). The fare per person was $1. The service ran for 5 days and served 3,286 beach visitors, according to refuge staff.

Pony Swim and Auction Special Event Transportation

During the Annual Pony Swim and Auction each July, several special event transportation services are offered. During the round-up of the northern pony herd, CNHA provides bus services from the Herbert H. Bateman Educational and Administrative Center to the beach on the morning of the Beach Walk, when the ponies from the northern herd are brought to the southern pony corral in preparation for the swim. On the day of the Pony Swim, the Town offers a free shuttle service from Chincoteague High School, which is used for parking, to Memorial Park, near the site of the Pony Swim, where the ponies come ashore from Assateague Island, and then back to the High School or site of the Carnival (see Figure 3-24). The shuttle consists of Accomack County school buses and a rented handicapped-accessible vehicle (note that the Pony Express trolleys maintain their scheduled service). Buses begin operation at 5 a.m. from the High School and operate until approximately 2 p.m., one hour after the ponies reach the Carnival. Volunteer guides are present on each bus.

Figure 3-24. Pony Swim Shuttle Route



Non-motorized Transportation

The refuge has several facilities and opportunities for walking, bicycling, and non-motorized boating. This section focuses on bicycling for transportation; other activities will be covered under section 3.8 Visitor Services and 3.9 Refuge Administration.

Cycling in the town of Chincoteague and within the refuge is a popular recreational activity as well as a mode of transportation for visitors and residents. The bicycle connection between the refuge and the Town is very important because many bicyclists travel from the Town, where they are staying or where they rent bicycles, into the refuge. Rental options within the Town include a variety of two-wheel bicycles (e.g., recumbent, tandem, side-by-side tandem) as well as four-wheel bicycle surreys. Many bicyclists also drive into the refuge with their bicycles to park at the Wildlife Loop or one of the other parking areas to bike recreationally. Limited data exists on the number of cyclists and bicycle trips to and within the refuge, but annual estimates range from 65,000 (Chincoteague Recreation and Community Enhancement Committee, May 19, 2009) to 75,000 (FHWA 2008) bicycle trips between the Town and refuge, with up to 300,000 bicycle trips within the refuge.

Within the refuge, bicycle use enables visitors to observe wildlife. Construction of bicycle trails began in the 1970s and 1980s and currently consists of several trails throughout the refuge (see

Figure 1-4 in chapter 1). An alternating paved and gravel bicycle trail runs from Chincoteague across the bridges between Assateague and Chincoteague (see Figure 3-25) to the Woodland Trail parking lot. It begins at the bridge between Chincoteague and Assateague islands as a paved trail that runs to the Wildlife Loop parking area and shortly beyond, where it then joins the road as a gravel path. The Wildlife Loop itself offers a 3-mile paved loop for exclusive use by bicyclists, runners, and walkers each day before 3 p.m., after which vehicular traffic is permitted. From the Wildlife Loop, bicyclists can access Beach Road via the paved Black Duck Trail or access the beach via the paved Swan Cove Trail. The Swan Cove Trail formerly ran south along the beach to the lifeguarded beach but the refuge stopped maintaining it after it was repeatedly washed away by wave and sand action. In response to the lost connection to the lifeguarded beach, the refuge provided bicycle parking and an emergency cellular phone booth where the Swan Cove Trail met the beach. However, such services were badly damaged by the 2009 nor'easter and have not been replaced. The current plan for the future is to develop a bicycle trail along Beach Road to replace the Swan Cove Trail connection.

Figure 3-25. Bicycle Trail over the Bridge (Volpe Center July 2009)

In 2008, the refuge received a implementation project grant for $600,000 from the FTA's Paul S. Sarbanes Transit in Parks Program to extend the existing pedestrian/bicycle path a quarter-mile (0.25) from the Assateague Channel Bridge to the Maddox Boulevard traffic circle (see Figure 3-26). After design and environmental compliance work, in 2012 a bicycle lane was added along Maddox Boulevard from the traffic circle to the end of private development, and an elevated boardwalk trail was constructed along the remaining road section before the bridge.

Figure 3-26. Section of Maddox Boulevard Bicycle/Pedestrian Trail Extension Before/After Trail Installation (USFWS refuge staff 2008 and Volpe Center March 2012)

Alternative Vehicles

There are a number of rental options for small motorized vehicles for visitors and some electric vehicle use, primarily modified golf carts, by residents. Visitors to Chincoteague have the opportunity to rent several small motorized vehicles including: mopeds, scooters, and the Scoot Coupe, a three-wheeled, two-passenger scooter. The Scoot Coupe meets all Federal safety standards for motorcycles and are "street legal" in all 50 states. Depending on the model, the Scoot Coup is classified as either a moped/scooter or motorcycle and operates at a top speed of 30 or 55 miles per hour (MPH), respectively.

3.7 Visitor Services

Chincoteague NWR provides a range of recreational opportunities, including the six wildlife-dependent activities as well as beach recreation and other uses, while Wallops Island NWR is limited to public access for hunting only. For all activities and facilities, the refuge maintains some mobility-impaired access, such as paved trails, designated mobility-impaired parking spaces, ramp access to boardwalk at the NPS Visitor Center, two beach wheelchairs, and one designated accessible hunting zone. The USFWS and NPS visitor centers are also accessible.

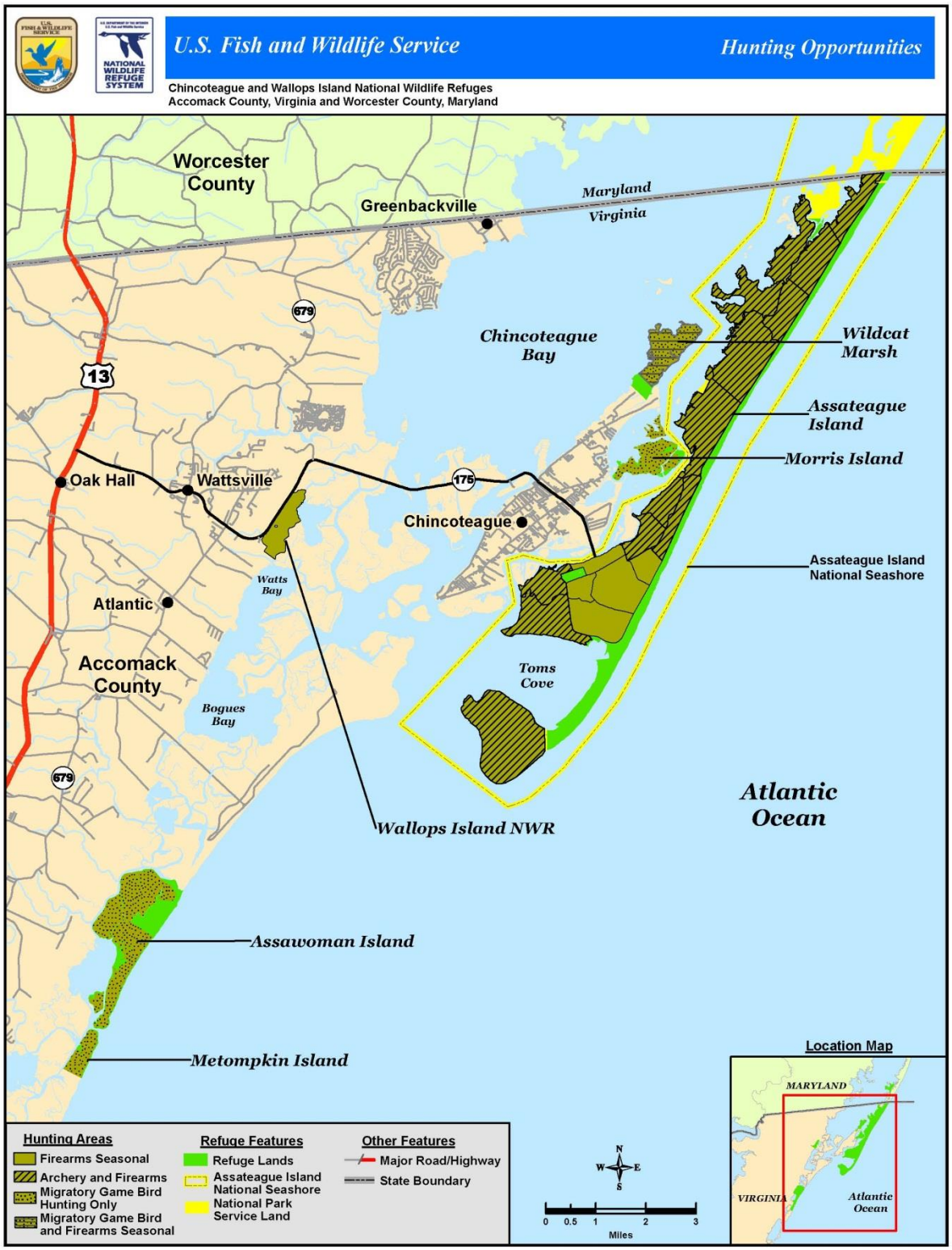
3.7.1 Hunting

Big game hunting and migratory game bird hunting opportunities are provided in designated areas throughout the refuge. Figure 3-27 provides an overview of where each opportunity is allowed. Brochures with specific regulations and maps are available on the refuge Web site: *http://www.fws.gov/northeast/chinco/hunting.html*. All hunting is conducted within the regulatory framework established annually by the Commonwealth of Virginia.

Big Game Hunting

The current big game hunting program for Chincoteague NWR consists of sika (Oriental Elk) and white-tailed deer with archery or firearms. The opportunity for big game hunting is controlled through a lottery process. Once selected by the lottery system, firearm hunters must attend a firearms orientation session prior to hunting on the refuge. The refuge is divided into 11 primary hunting zones, with a few of those zones that are located closer to developed portions of the refuge subdivided for smaller force firearms for safety considerations to the public. A user fee helps defray the annual administrative costs of the program. In 2011, big game hunting saw 1,230 visits.

Figure 3-27. Hunting Opportunities



Each year the deer herds are evaluated, after which species hunted, season lengths, and bag limits are determined for the Annual Hunt Program. Approximately 150 to 200 sika are taken each year, from an estimated populated of 600 to 800.

Wallops Island NWR only allows hunting of white-tailed deer, per the same conditions as described above, including the lottery. Each fall, 25 hunters participate in the big game hunt, either with firearms or archery. A user fee helps defray the annual administrative costs of the program. In 2011, 60 visits were recorded for hunting. All big game lottery applications, which have a $5 application fee, and permits for hunting ($20) are administered online.

Migratory Game Bird Hunting

Hunters must obtain a Migratory Game Bird Hunting permit in order to hunt on the refuge. Hunters must also possess valid hunting license, stamp(s), and/or permits as required by the Commonwealth of Virginia and Federal statutes/regulations. Migratory game bird hunting occurs in the fall on Thursdays, Fridays, and Saturdays and is only provided via water access for four hunt units, Wildcat Marsh, Morris Island, Assawoman, and Metompkin. Hunters may harvest ducks, geese, swans, coots, and rails. In 2011, only 99 visits occurred on the refuge for migratory bird hunting, possibly because the hunt areas are only accessible by boat.

Other Programs

The refuge is currently working with the Wounded Warriors Project, a non-profit dedicated to fostering successful, well-adjusted wounded service members through programs for the mind and body, to develop an opportunity for hunters with disabilities.

3.7.2 Fishing

Surf fishing, crabbing, and clamming are among the most popular wildlife-dependent recreational activities conducted on the refuge. For all activities, Virginia Marine Resources Commission regulations must be observed, including licenses and catch and size limits. Anglers age 16 and older must possess a valid Virginia Saltwater Fishing or Potomac River Fisheries Sport Fishing license. Anglers who are exempt from licensing and holders of out of state reciprocal licenses must register with the Virginia Fisherman Identification Program (FIP). Visitors may fish after refuge operating hours ("overnight") by procuring an overnight fishing permit from NPS. The refuge does not host any fishing tournaments.

Assateague Island

Crabbing and Clamming

Crabbing and clamming on Chincoteague NWR are allowed as recreational activities in accordance with Virginia Marine Resources Commission regulations.[4] Crabbing is allowed in designated areas in Swan Cove Pool (F Pool) and along Beach Road. Clamming is also allowed in the bayside areas for Toms Cove, also accessible via the Bi-Valve Trail. The refuge incorporates crabbing and fishing into its various youth and visitor programs.

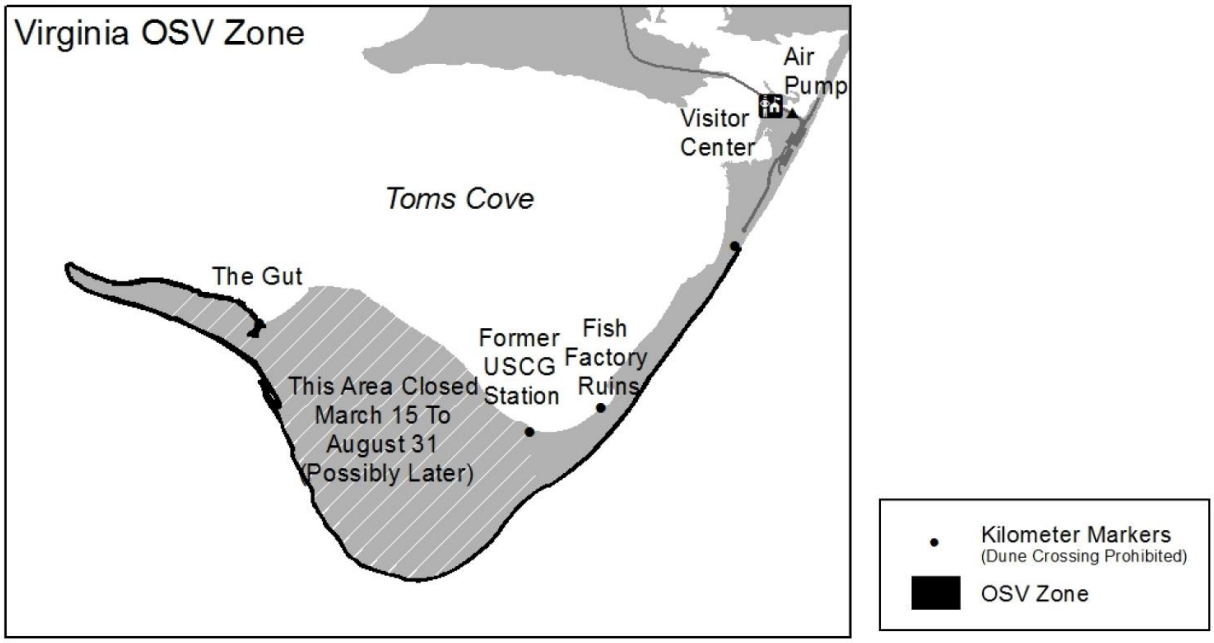
[4] http://www.mrc.virginia.gov/regulations/recfish&crabrules.shtm

Surf Fishing

Some of the fish common to the waters around the refuge are bluefish, striped bass, summer flounder, Atlantic croaker, spot, and red drum. Clearnose skate, bullfish, and southern stingrays may be caught, as well as smooth or spiny dogfish sharks. Surf fishing is allowed anywhere along the Atlantic Ocean on Assateague Island outside of the life-guarded areas and areas closed for coastal nesting birds. NPS and USFWS provide joint programs that include surf fishing demonstrations.

The surf fishing areas south of the current parking lots (overwash and Toms Cove Hook) are also accessible via OSV use, which is administered by NPS and the refuge. Such access is limited to certain times and areas to provide maximum protection to prime nesting habitat for coastal nesting birds. OSV use is limited to the OSV zone, located between the recreational beach and the end of Toms Cove Hook (see Figure 3-28). The Hook portion of the zone is closed to OSV use from March 15 through August 31 or until the last shorebird fledges; the Overwash portion is closed intermittingly during the same period based on nesting behavior. Access can be further restricted based on wildlife management practices. OSV use requires a permit and specific equipment, both of which are set by NPS, and is restricted to 48 vehicles at any one time when the entire zone is open and to 18 vehicles when the Hook portion is closed. More information on OSV use regulations can be found at the NPS webpage: http://www.nps.gov/asis/planyourvisit/osv.htm.

Figure 3-28: Virginia OSV Zone (Source: NPS)



Southern Barrier Islands

Fishing is allowed on Assawoman Island but requires a refuge permit to land a boat to fish the area. However, parts of the island may be closed based on nesting behavior.

3.7.3 Environmental Education and Interpretation

The refuge works with local kindergarten through grade-12 schools, communities, and educational organizations to provide classroom and hands-on programs both on and off the refuge for youth.

Partner agencies include the NPS, local school districts, Eastern Shore Environmental Education Council (sponsored by the Eastern Shore Soil and Water Council), SPARK, CBFS, formerly the Marine Science Consortium (MSC), and CNHA. Activities are conducted throughout the region but on the refuge are concentrated on several trails as well as the Herbert H. Bateman Educational and Administrative Center, a green facility that opened in 2003, offering 5,000 square feet for interpretive natural history exhibits, educational programming, a 125 seat auditorium, and a classroom/wet lab.

The refuge currently provides environmental education opportunities for approximately 7,500 participants annually, primarily through classroom and onsite programs with students as well as programs in collaboration with other groups. The refuge serves students by working with NPS, CBFS, Accomack and Northampton County school districts, Girl Scouts, Boy Scouts, and Home School students, among others. Student programs occur in the classroom of the Herbert H. Bateman Educational and Administrative Center and in the environmental education pavilion (e.g. Habitat Hunting, Forest Ecology, Nature and ME, Critters and Gadgets). The refuge also offers teacher workshops and Teacher Guided Learning Opportunities when staff guided programs are not available. NPS offers several programs from Toms Cove Visitor Center (e.g. Aquarium Talk, Beach Walk, Marine Explorers, and Salt Marsh Adventure). The refuge is also participating in collaboration with NASA, CBFS, TNC, and the Eastern Shore Community College called "Science on the Shore" to "provide the Eastern Shore community with an understanding of how local science-based research and preservation techniques are used to solve challenges that impact the nation."

The refuge currently provides interpretive opportunities to approximately 68,000 participants annually, primarily through self-guided interpretation but also through some guided programs. Refuge staff give presentations at the Herbert H. Bateman Educational and Administrative Center and also lead popular bird walks, crabbing and surf fishing demonstrations, marsh walks, and photography hikes, and assist with NPS beach campfires. Interpretative hubs are located on several trails, with one trail and pavilion designated for environmental education. The refuge maintains exhibits and videos at the Herbert H. Bateman Educational and Administrative Center. The refuge also maintains an outdoor information kiosk at the Virginia New Church Welcome Center on Route 13. The refuge offers multiple week-long day camps, the Children in the Woods Day Camp, for children ages 8 to 11 with activities such as crabbing, clamming, archery, surf fishing, bicycling, and kayaking. The Camp is sponsored by CNHA. NPS also offers interpretive exhibits at the visitor center and activities, such as kayaking programs from Toms Cove. Finally, the refuge holds eight major special events: Great Backyard Bird Count (February), Junior Duck Stamp Contest (April), International Migratory Bird Day Celebration (May), Sunrise Pony Walk during Pony Penning (July), Annual Beach Clean-up (September), National Public Lands Day (September), National Wildlife Refuge Week (October), and Waterfowl Weekend (November).

3.7.4 Wildlife Observation and Photography

Chincoteague NWR provides outstanding wildlife viewing opportunities throughout the year, including migrating birds, resident sika and white-tailed deer, Chincoteague ponies, and others. Birding in particular is a popular wildlife observation activity, with popular sites at Swan Cove Pool (F pool), Toms Cove, Woodland Trail, and Snow Goose Pool (B-South Pool) in the Wildlife Loop. The Wildlife Loop, Marsh Trail, and Woodland Trail, as well as water access, various pull-offs along Beach Road, and the natural beach itself, provide wildlife viewing and opportunities for

amateur and professional photographers. In partnership with the CNHA, the refuge hosts lectures on wildlife and conservation topics throughout the year.

3.7.5 Recreational Beach Use

The beaches of Assateague Island offer a unique experience in the mid-Atlantic area as they exist primarily in an undeveloped setting unlike other nearby beaches, such as Virginia Beach, Virginia or Ocean City, Maryland that are heavily developed. This natural setting draws many families seeking activities such as sunbathing, swimming, shell collection, and campfires.

At the southern end of Assateague Island within the Chincoteague NWR, the NPS manages an "assigned area" that currently includes the 1-mile recreational beach and corresponding adjacent 961 parking spaces, provided via a crushed shell surface. The NPS maintains a visitor contact station, restrooms, and pedestrian trails, as well as seasonal bathhouses, showers, and lifeguard-protected swimming beach. Beyond this recreational area, only wildlife-oriented recreational activities are allowed.

After the establishment of the refuge in 1943, the only public recreation that occurred on Chincoteague before the bridge was constructed in 1962 was beach use, primarily surf fishing. Visitors would drive down the beach from the Maryland end of Assateague Island. On June 17, 1957, Congress passed Public Law 85-57, Chincoteague National Wildlife Refuge, Virginia - Bridge and Road. This law authorized the Secretary of the Interior to permit the construction of a bridge and road across Chincoteague NWR. The objective of this law was "to permit the controlled development of a portion of the seashore of the Chincoteague National Wildlife Refuge, Virginia for recreational purposes, ..." This law also authorized the Secretary to enter into agreements for the construction, maintenance, and operation "of a public beach, concession, parking areas, and other related public conveniences..."

On April 1, 1959, the Bureau of Sport Fisheries and Wildlife (precursor to USFWS) entered into an agreement with the Chincoteague-Assateague Bridge and Beach Authority whereby a public access easement to the Atlantic Ocean beach was established (Mackintosh 1982). The deed of easement provided for the construction of a bridge and access road to the Toms Cove Hook and assigned to the Authority the south 4 miles of the island for 40 years, renewable for two 15-year periods. These rights were subject to "such terms and conditions as the Secretary of the Interior deems appropriate for the adequate protection of the wildlife refuge." The 1959 public access easement has not been in effect since 1966, when it was acquired by the Federal government as directed by the Assateague Island National Seashore enabling legislation (Public Law 89-195), which states: "Notwithstanding any other provision of this Act [16 USCS §§ 459f et seq.], land and waters in the Chincoteague National Wildlife Refuge, which are a part of the seashore, shall be administered for refuge purposes under laws and regulations applicable to national wildlife refuges, including administration for public recreation uses in accordance with the provisions of the Act of September 28, 1962 (Public Law 87-714; 76 Stat. 653) [16 USCS §§ 460k et seq.]."

In 1965, the Assateague Island National Seashore was established. Under a memorandum of Understanding (MOU) completed in the summer of 1979 between the USFWS and NPS, NPS would provide and manage visitor contact and interpretive facilities and programs on a day-use basis for public recreation and interpretation including, but not limited to, swimming and associated beach uses. Also under that agreement, we would retain the primary responsibility for managing the wildlife resources within the "Assigned Area," with the understanding by both agencies that recreational use programs will be planned and carried out to minimize impacts on

wildlife resources. In 1990, an Interagency Agreement replaced the MOU, with the new agreement allowing for the same uses as the MOU. The Agreement was renewed and revised prior to release of the draft CCP/EIS in 2012.

Since the opening of a public beach in the early 1960s, visitation steadily rose during the 1960s, 1970s, and most of 1980s. In 1987 visitation peaked at over 1.5 million visits, with over 800,000 occurring during the summer season, June through August. Since then, the number of annual visits to the refuge has leveled off to between 1.2 and 1.4 million visits. From 2007 to 2011, 58 percent of the visits occurred during the months of June, July, and August. Recreational beach use tapers off quickly after early September and returns at the end of May.

Although not all summer visitation is associated with beach use, the parking patterns and anecdotal reports indicate that beach use is the primary use. The town of Chincoteague developed and distributed a "Beach Access Questionnaire" online and throughout the community in summer of 2010 that resulted in almost 3,000 responses. In the survey, 82 percent of respondents indicated that they primarily came to Chincoteague to go to the beach (Town of Chincoteague 2010b).

3.7.6 Other Recreational Uses

Other recreational uses on Chincoteague NWR include walking, bicycling, horseback riding, OSV use, boating, and commercial uses. All of these uses are limited to specific areas of land and/or times based on wildlife management and some have permits and fees, as described below. There are no campsites on Chincoteague NWR. Visitors are not allowed to feed wildlife and are not allowed to bring alcohol or pets onto the refuge, including in vehicles. Other restricted activities include use of skateboards, roller or in-line skates, or segways and the collection of plants, animals, or artifacts, except for 1 gallon per person per day of unoccupied shells. Motorized vehicles are not allowed on trails and mopeds are not allowed on Wildlife Loop.

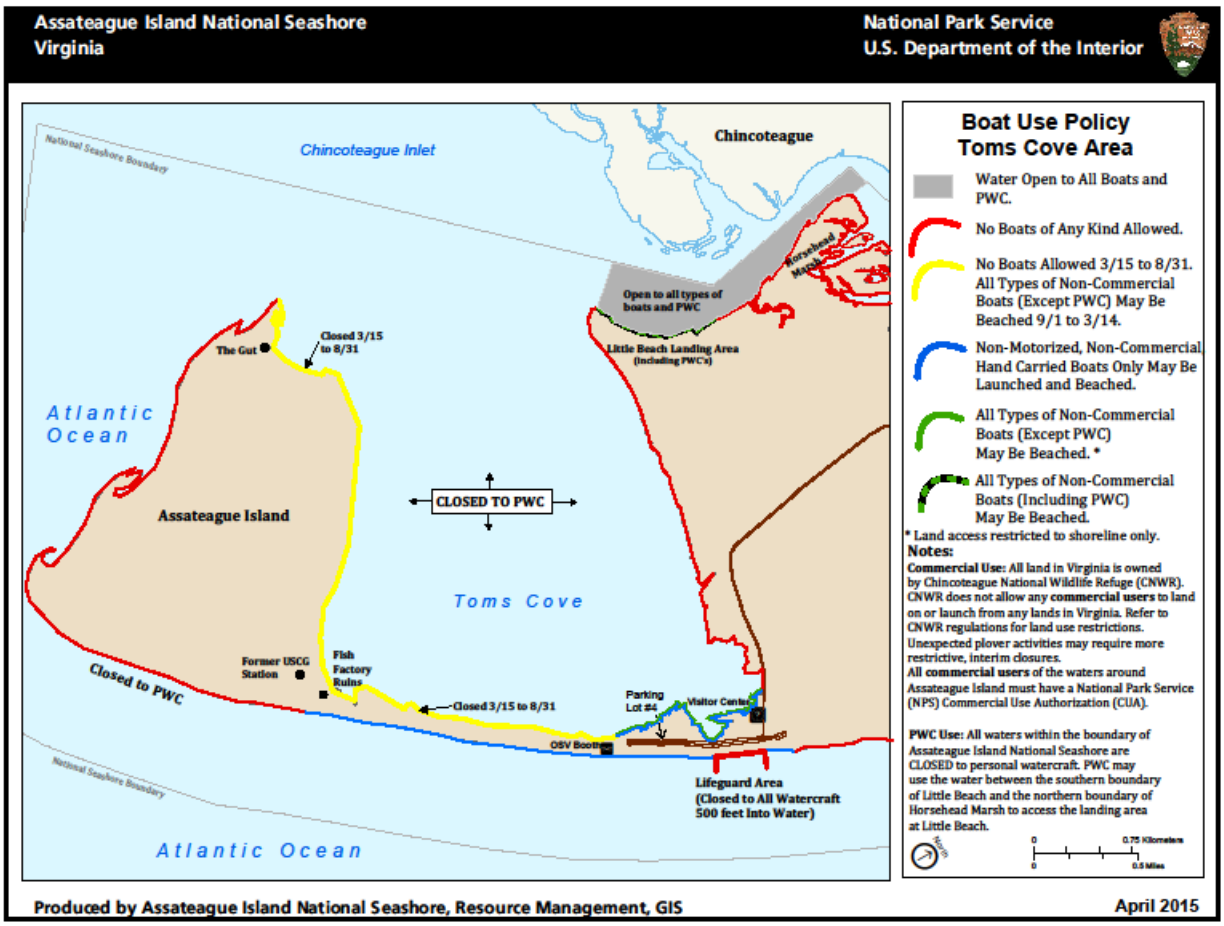
As described previously, bicycling is accommodated through a paved and gravel trail system beginning on Chincoteague Island and running along Beach Road and via the Wildlife Loop and Swan Cove Trail to the beach and to the Woodland Trail parking lot as well as the Woodland Trail itself. Bicycling is not allowed on the Service Road although walking is. Walking visitors make use of the bicycle trails as well as Lighthouse and Marsh Trails.

Horseback riding is limited to within the OSV zone from March 15 through August 31 or until the last shorebird fledges. Access can be further restricted based on wildlife management practices.

Motorized and non-motorized boats are allowed to beach at Toms Cove Hook between September 1 and March 14 but there are no boat ramps or docks available for public use at Chincoteague NWR. Boats and flotation devices are not permitted in the impoundments. Non-motorized, human-powered, hand-carried boats are allowed to access the water from the recreational beach in designated areas.

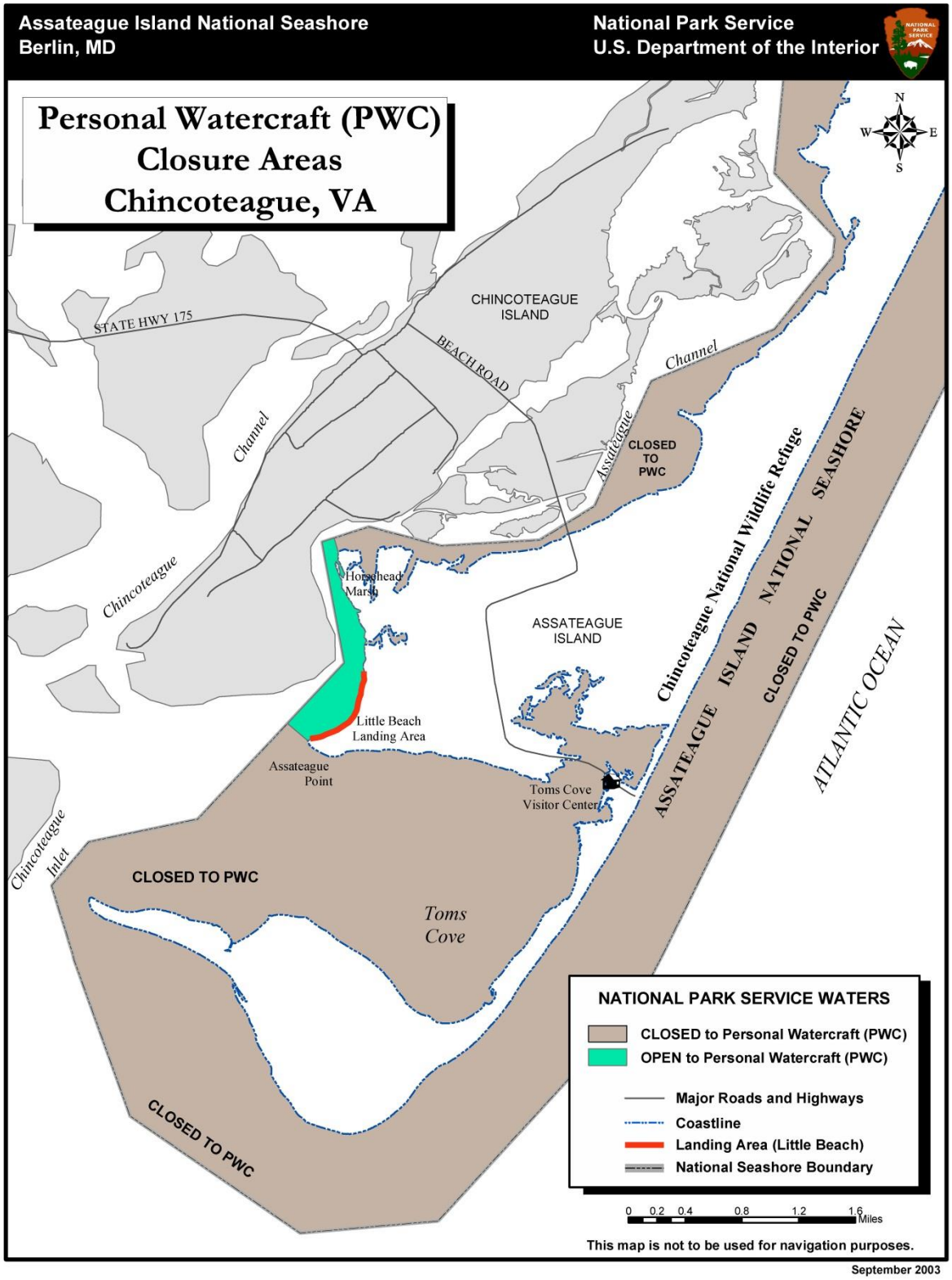
Figure 3-29 provides a summary of the boat policies, as developed by NPS. All waters within the boundary of Assateague National Seashore are closed to personal water crafts (PWCs)[5] except the water between the southern boundary of Little Beach and the northern boundary of Horsehead Marsh, as indicated in Figure 3-30. Visitors with kayaks or canoes may follow part of the 70-mile long Seaside Water Trail, which was developed by the Accomack-Northampton Planning District Commission in cooperation with Accomack County, Northampton County, the Town of Chincoteague, the Town of Wachapreague, and the Virginia Coastal Zone Management Program.

Figure 3-29. Boat Use Policy (NPS Seashore)



[5] PWCs are high performance vessels designed for speed and maneuverability and are often used to perform stunt-like maneuvers. PWC includes vessels commonly referred to as jet ski, waverunner, wavejammer, wetjet, sea-doo, wet bike and surf jet (NPS 2000).

Figure 3-30. Personal Watercraft Closure Areas (NPS Seashore)



3.8 Cultural Resources

This section provides chronological contexts for human settlement in the vicinity of Chincoteague and Wallops Island NWRs during the pre-Contact and post-Contact time periods. Consideration is given to the types of known and possible archaeological resources that may be found within the refuges.

Although a number of broader historical studies were produced around the time the Assateague Island National Seashore was established, and several of more limited scale have also been performed for individual projects on the refuge, a 1989 overview study of the refuge (Fehr et al. 1989) and a subsequent maritime-focused overview of the Seashore (Langley 2002) provide the most comprehensive summaries of current knowledge regarding cultural resources on Assateague Island. An overview study (URS Group, Inc. 2003) was later performed for the Wallops Island NASA facility, but did not cover the nearby refuge lands, and a study of shore erosion identified threatened and eroding sites on some of the other islands, but none are on current refuge lands (Lowery 2000, 2003).

3.8.1 Pre-Contact Period

The present refuge islands began forming around 8,000 years ago as landforms roughly similar in appearance to today, exhibiting beach and dune lines on the eastern face that protect a thin strip of grass and scrub, then a band of maritime forest on the larger islands, and much more extensive salt marsh to the west. However, the size and shape of individual islands undoubtedly differed from their current perimeters. There may also have been additional islands that vanished prior to the earliest mapping of the area.

The majority of local Native American settlements were concentrated at mainland river estuaries, but the islands were probably seasonally occupied from at least around 1,000 years ago to obtain a variety of maritime resources. The diet of those first occupants relied heavily on “the three sisters” (maize, beans, and squash) supplemented by various wild plants, shellfish, finfish, small game, deer, and a wide variety of waterfowl. In 1524, the explorer Giovanni da Verrazano reported that watercraft consisted of log canoes. Abundant marsh reeds were used for arrow shafts, but their points were usually made of bone due to local scarcity of suitable stone materials. Clothing appears to have been woven from Spanish moss and hemp, and mussel and clam shells were valued for manufacture of wampum beads (Wroten 1972).

During the early period of European contact, this area was occupied by several tribes whose names are still reflected in inlet, bay, and island nomenclature today: Metompkin, Kegotank, Chincoteague, and Assateague. They, in turn, were part of the larger Occohannock Confederation, with apparent linguistic and cultural ties to the Pokomoke tribe in Maryland. Serious disruption of Occohannock culture and rights to ancestral land began in 1620 with European settlement of the Eastern Shore, and accelerated very rapidly thereafter. The Metompkins, Kegotanks, and Chincoteagues appear to have merged with the Assateagues after a major smallpox epidemic decimated the Eastern Shore tribes in 1667. By 1686, most or all of the Assateagues had joined the Pokomokes on reservations in Maryland (Langley 2002 20).

At this time, the only confirmed evidence of Native American presence on either refuge is a single stone flake from an otherwise apparently historic period shell midden (Fehr 1989). The lack of additional evidence may partly be due to the fact that only one large-scale archaeological survey has been performed on Chincoteague NWR and no such studies have been done on the much smaller Wallops Island NWR; however, a more significant reason may be the dynamic nature of

island geomorphology. Coastal and wind erosion may be contributing to unobserved loss or burial of unrecorded sites, and sea level rise has also doubtlessly had an effect. Although it is possible that some islands have changed less in the last two centuries, the most obvious limit to pre-Contact site presence on Assateague is illustrated by the fact that all of that island south of Morris Island did not exist prior to 1693. Study of historic coastal maps shows that in 1820 Morris Island included the current area of the Farm Fields Impoundments. It and the Lighthouse Ridge area, then called "Piney Island" (not to be confused with today's island of that name) were the primary barrier islands that protected Chincoteague Island. By 1832, charts show the channels between those islands blocked, making the island continuous all the way down to the present Woodland Trail area. It seems likely that a hurricane driven tidal wave in 1821 was the primary cause of that dramatic change. Fishing Point, the beginnings of Tom's Hook, did not begin to grow until sometime between 1873 and 1882. As is the case with the majority of barrier islands, this growth and reshaping due to sand migration, coastal storms and rising sea levels continues today.

3.8.2 Historic Period Settlements

Local European settlement appears to have begun with a 1664 patent to John Wallop for land on the island that bears his name. Captain Daniel Jennifer obtained a patent to Chincoteague in 1671 and one to the Virginia portion of Assateague in 1687. He used both islands for seasonal livestock pasturing, employing 30 herdsmen to that purpose (Fehr 1989). Assawoman Island was also used for seasonal pasturing around this time, as were probably many others. It is likely that these activities mark the initial establishment of the famous "pony penning" tradition, which was also accompanied by a sheep round-up until the third decade of the 20th century. The herdsmen, and possibly their families, may have lived in huts rather than permanent dwellings.

Year-round settlement on Assateague appears to have begun in 1689 under the auspices of Maximilian Gore, whose 1696 will and testament reference dwellings occupied by tenants Thomas Milman and Alexander Gould, and also gives his son in law Thomas Smith the right to build a "40-foot tobacco house" on the island. By the early 18th century, several Gore and Smith family members appear to have lived near Ragged Neck, Smith Bay, and Smith Hammocks, along with some tenants and at least a few enslaved African Americans (Fehr 1989).

In 1764, there were still only 25 residents on Assateague, but population grew rapidly to 20 families by 1776, 70 by 1835, and 150 by 1860 (Fehr et al. 1989).

Although a substantial part of early islander income and diet was probably from fishing, shell-fishing, and water-fowling, farming appears to have also played a major role despite the extremely poor quality of soils on the island uplands. Place names such as Calf Pen Bay, Peach Creek, Cherry Tree Hill Bay, Farm Fields, Old Fields, and Sow Pond reflect a variety of agricultural activities. The name Wear Bay on an 1840 property map reflects the presence of a dike and weir near the current location of the Old Fields Impoundment. As in many similar areas along the coast, that weir was presumably installed to manipulate water level for production of salt meadow hay in what was then called Great Neck Marsh. Similar weirs for that purpose probably existed elsewhere on both Assateague (perhaps at Farm Fields, for example) and on other refuge islands. Besides the various farming structures, a tidal-powered mill was built by Daniel Gore sometime prior to 1750 and ran for at least two more decades, and John Lewis began a salt works in 1811 that operated until at least 1855 (Fehr 1989).

Maps from 1832 onward document the presence of the Assateague Lighthouse which was commissioned to be built in 1832. The lighthouse was constructed to a height of 45 feet and was

built on a 22-foot high sand dune. The lighthouse was put into service in 1833. However, from the very beginning this light was proved to be inadequate (Cherrix 2011).

Both the American Revolution and War of 1812 largely bypassed this area, and due to strongly loyalist sentiment and early occupation by U.S. forces, the Civil War was not nearly as disruptive and destructive as in the rest of Virginia. The only substantial local military engagement was the burning of the newly outfitted Confederate privateer schooner Venus by the crew of the U.S.S. Louisiana, off Wallops Island in the autumn of 1861 (Langley 2002).

In 1870 the focus of settlement on Assateague abruptly shifted southward to what became known as Assateague Village, shortening water travel to the even more rapidly growing village on Chincoteague. By this time a new much higher (142 feet) Assateague Lighthouse had been constructed on the site of the first lighthouse. The new first-order Fresnel lens provided a beacon for mariners much further out into the Atlantic Ocean.

Assateague Village boasted a population of 225 by 1920, and included two stores, lighthouse, a school, a church, and a cemetery. The population continued to raise livestock, though on a scale smaller than in the 18th century. Fishing, shell-fishing, and fowling continued to be major sources of food and had by now supplanted farming as major sources of income. Beginning in 1881, some residents worked in a series of short-lived fish oil processing factories on the ever-growing spit of land that later became Toms Cove Hook. The last of those plants closed in 1929 (Langley 2002). That year, most of the area south of the Light Station was purchased by an absentee landowner (Samuel B. Fields) whose caretaker (Cooper H. Oliphant) prevented all local residents from trespassing, thereby restricting access to fish in Toms Cove. The resulting hardship soon led to wholesale abandonment of the village. Most of its buildings were moved on rafts to Chincoteague, while the remaining buildings were left to deteriorate. In 1943, the Fields family sold their property to the U.S. Government for use as a national wildlife refuge, and the last village resident, William T. Scott, moved off the island in 1945 (Langley 2002). Today the village site is marked only by some building foundations and the cemetery, which contains only a few marked graves. However, recent ground penetrating radar surveys have identified several additional unmarked graves within the Assateague cemetery, and a new previously unknown family cemetery has been identified within the village confines. Considerable efforts have been made by a group of volunteers loosely associated with the Town of Chincoteague Cemetery Committee and the Chincoteague Natural History Association to clear undergrowth of the cemeteries and restore and maintain the grave markers.

A few small hunting and fishing camps were built on remote portions of Assateague and some smaller islands in the 1930s, but their periods of use appear to have been short. Aside from Coast Guard personnel at the light station and lifesaving stations, there were no longer any year-round residents on Assateague Island between the year of Bill Scott's departure in 1945 and the arrival of the first resident USFWS and NPS staff (Langley 2002).

Although precise sites of most 18th to early 19th century historic settlements on Assateague are unclear, they are probably fairly safe from looting due to their location within a large potential search area within a closed part of the refuge. As they are also probably closer to the marsh-protected bay side than the open ocean, immediate risk of erosion damage appears minimal. However, in light of the high potential of this unique group of sites to provide important information on the life-ways of early islanders, it would be advisable to locate and identify them as

the focus of a targeted follow-up to the 1989 cultural resource overview, then solicit a program of academic research on identified sites before sea level rise becomes a threat (Fehr 1989).

In contrast to those earlier historic sites, the location of Assateague Village is in an area more accessible to the public, has always been very well known to local inhabitants, and retains considerable surface evidence. Despite that visibility, there is little obvious evidence of recent looting. Erosion also does not appear to be an immediate risk. The research potential of the village is improved by the possibility of linking archaeological evidence to its rich local historic record, but for the immediate future it would be better to use that record for purposes of interpretation than to undertake a program of archaeology at such a complex site.

The sites of 20th century sportsmen's camps appear low in priority for research and are too remote and difficult to access for interpretation. The sites of the several fish oil plants on Toms Cove Hook appear to have all now eroded into the cove (Fehr 1989; Langley 2002), and with the westerly migration of Assateague Island the single remaining concrete pillar that was once part of the support structure for a factory will move forever into the Atlantic Ocean.

3.8.3 Wallops Island

The historical context of Wallops Island is best captured in the *Historic Resources Survey and Eligibility Report for Wallops Flight Facility – Accomack County, Virginia* completed by URS Group, Inc. and EG&G Technical Services, Inc., in 2004 for NASA. This document provides important historical context over the time period between 1607 and 2004 and identifies several historical items of interest within the 373-acre Wallops Island NWR. A family cemetery with three marked graves is located near the maintenance facilities. Efforts have been made by a group of local volunteers, NPS and USFWS employees, and the Chincoteague Natural History Association to clear undergrowth of the cemeteries and restore and maintain the grave markers. NPS and USDA currently both have a use agreement with USFWS for maintenance and storage activities on Wallops Island NWR. Two former Navy waste disposal sites are of interest to the Department of Defense and are currently being monitored and studied by the USACE.

Geographically Wallops Island is the next barrier south of Assateague Island. The known historic resources are a small cemetery dating from the late 1800s and the Wallop's Island Life-Saving Station (commissioned in 1884). The uses of the land were similar to that of other barrier islands. In 1947, the U.S. Navy began using the upper two-thirds of the island on a lease-rental basis for aviation ordinance testing. The National Advisory Committee for Aeronautics, fore-runner of the NASA, leased the lower 1,000 acres for rocket launching facilities. NASA eventually purchased the land and leased the fields for agricultural use. In addition, a small section of the property was designated as a dump and sanitary landfill area.

3.8.4 Shipwrecks

Shipwrecks form a significant part of the history and lore of these refuge islands. The first reliable account of a wreck on Assateague is the merchant ship Princess Anne, which broke up somewhere on the beach in 1698 (Langley 2002). Although there seem to be few additional vessel losses on refuge islands during the following century, that scarcity of record may reflect the sparseness of population and rarity of identifiable landmarks more than the actual number of wrecks.

The most famous vessel loss of the 18th century is the La Galga, a Spanish frigate that ran ashore near the Maryland line in 1750 with a loss of only three to five men. Although her survivors

remained unmolested, the dismasted frigate was quickly looted of its cargo of mahogany planks (Langley 2002). The ship was then partially cut up by local residents from both Virginia and Maryland, and then broke apart in another storm soon afterward (Langley 2002). Despite that documentary record, La Galga has been the object of several search and salvage attempts during the last half century, the most recent involving a lengthy case that resulted in a 2001 U.S. Supreme Court ruling awarding title of the vessel to the Spanish government (Langley 2002). Comparable to the situation of any U.S. Navy vessel that sank with loss of life while on duty, the government of Spain asserts legal title to La Galga and considers her a naval grave site. Therefore, under the Sunken Military Craft Act, prior Spanish permission would be required for any further search or salvage attempt.

Many other vessels have been lost offshore or wrecked on island beaches from that first report in 1698 to the present day. They vary considerably in size, design, cargo, and means of propulsion depending on the time period of their construction and use. As one might expect, most were British flagged prior to the American Revolution and most have been in U.S. ownership thereafter. Almost all were fishing or merchant craft rather than naval vessels; one notable exception is the loss in 1891 of the steamer U.S.S. Despatch, which briefly served as the first presidential yacht (Langley 2002).

A number of wrecks and parts of wrecks have been discovered in the intertidal sands of Assateague over the years. Some may be worthy of study as examples of type and time period, though both their changeable visibility and the difficulty of working in the surf zone make such studies very challenging. One relatively intact and exposed wreck of a late 18th to early 19th century sloop or schooner was proposed for detailed measurement by an East Carolina University graduate student some years ago, but when fieldwork was due to begin it was suddenly discovered that the wreck was once again covered by a layer of sand (Langley 2002).

A proposal has been made to establish a partnered interagency monitoring program that would record wreck fragments on the refuge beaches (with a view to discovering the location, type, age, and condition of wrecks), as well as to develop a team of maritime archaeologists and trained volunteers that could perform emergency recording of any relatively intact historic vessels that might appear.

3.8.5 Lighthouse

A lighthouse was first built near the southern tip of the island in 1833 at an elevation of only 43 feet, and a taller structure (142 feet) replaced it in 1867. That light station, listed on the National Register of Historic Places and still an active aid to navigation, is now under USFWS jurisdiction. Its tower and oil house are undergoing a major restoration that is now nearing completion. Only bricks of the foundation remain of the original light keepers' dwelling. However, the 1910 assistant keepers' dwelling which served as the refuge managers living quarters and is now used as a seasonal quarters for refuge employees still exist. That building appears to be eligible for National Register of Historic Places listing as an element of the light station. Over the years, the lighthouse has had a number of different lights. The first-order Fresnel lens that was at the Assateague lighthouse from 1867 to 1963 has been restored and is housed at the Museum of Chincoteague Island.

3.8.6 Lifesaving Stations

The increasingly recognized need for a system to rescue mariners and passengers of wrecked vessels resulted in establishment of the U.S. Lifesaving Service in 1848, but it was not until the early 1870s that a national system of fully manned and equipped stations began to be established. Dedicated surfmen lived with their families near the stations and patrolled the beaches regularly to signal warnings if ships came too close. They also rescued crews and protected ships and cargoes if disaster struck. The Life-Saving Service was abolished in 1915, when the U.S. Coast Guard took over responsibilities.

The earliest lifesaving station on these refuge islands was the Assateague Beach station, erected in 1875 on the north side of Toms Cove Hook, near the current Woodland Trail parking lot. The station site is overgrown and its surface remains are confusing and appear somewhat disturbed, probably by demolition of ruins after it burned during the 1940s. Its archaeological study would be a low priority when compared to earlier and more intact settlements on the island (Fehr 1989).

Another station was built in 1878 on the exposed beach near Pope's Island Inlet on Assateague Island near the Maryland-Virginia border. It closed in 1953 and was destroyed by arson in 1970. Slightly later stations also existed at Wallops Island and Metompkin Inlet; neither of those sites nor the location of the Pope's Island station are on current refuge land (Langley 2002).

3.8.7 U.S. Coast Guard Station

Although the sand spit on the southeast side of Assateague initially provided good shelter for launching surfboats, by 1920 the curving growth of that same spit into Toms Cove Hook forced the boats of Assateague Beach station to take an increasingly roundabout journey to the rescue of shipwreck survivors (Fehr et al. 1989). A new U.S. Coast Guard station was therefore constructed on the spit itself, near its end at that time. Closed in 1967, that station was later determined eligible for inclusion in the National Register of Historic Places and acquired by the NPS as a visitor facility (Langley 2002). In the 1980s the road down the length of Toms Cove Hook began to be washed out with increasing frequency, so a new visitor facility location was established at the north end of the hook. The old "Pony Restaurant" building was transformed into the NPS Toms Cove Visitor Center and has been moved twice since it was originally built, which is another testament to the ephemeral character of human presence on the barrier islands.

3.9 Refuge Administration

3.9.1 Facilities and Maintenance

Refuge facilities consist of buildings and transportation infrastructure, including roads, marine facilities, trails, intelligent transportation and traveler information systems, and parking areas. In addition to the refuge facilities, NPS maintains a visitor center, lifeguard-protected swimming beach, restrooms, bathhouses, parking areas, and boardwalk trail, and coordinates the OSV area, as detailed in a memorandum of understanding. NPS and USDA both have a use agreement with USFWS for shared facilities, mainly for storage, on Wallops Island NWR.

Buildings

Within Chincoteague NWR, buildings consist of a visitor center, staff offices, staff housing, maintenance facilities, and an environmental education pavilion, as well as the Assateague Lighthouse and light keeper's house. The Herbert H. Bateman Educational and Administrative Center, a green facility that opened in 2003, consists of two buildings, one for the visitor center

and one for administrative offices. The visitor center offers 5,000 square feet for interpretive natural history exhibits, educational programming, a 125-seat auditorium, and a classroom/wet lab.

Marine Facilities

The Assateague Lighthouse Landing is on the north side of refuge, on the Assateague Channel, and consists of a boat ramp, a fixed dock and a floating dock connected by a ramp. These facilities are not open to the public.

Roads

As mentioned previously in Section 3.6.2: Transportation and Access, Chincoteague NWR is accessed by a two-lane road, Beach Road, which extends from Maddox Boulevard across the bridge to the beach parking areas. The only other paved road open to the public is Wildlife Loop, which is approximately 3 miles in length and is open to vehicles after 3 p.m. each day. There are also two unpaved service roads that are not open to the public. One service road is approximately one-quarter mile long and leads from Beach Road to Assateague Lighthouse Landing, which has marine facilities on the Assateague Channel. The other service road extends north from the Wildlife Loop 7.5 miles, providing access to one of the areas where the Chincoteague ponies are kept. The entire length of that service road is open to private vehicles only during part of Waterfowl Week at the end of November, but the CNHA bus tour is allowed to use this same section throughout its season of operation.

Trails

Chincoteague NWR has the following paved trails, with round-trip distance:

- Main bicycle trail (0.5 miles from Maddox Boulevard traffic circle to bridge; 1.3 miles from bridge to end of trail; 1.9 miles along Beach Road to beach)
- Woodland Trail (1.6 miles)
- Black Duck Trail (1.0 miles)
- Swan Cove Trail (0.5 miles)

In addition, there is the Marsh Trail (0.6 miles boardwalk, 0.3 miles on Wildlife Loop road) and unpaved Lighthouse trail (0.3 miles) and Bivalve Trail (0.25 miles), which is only accessible from the Woodland Trail. All trails are shown in Figure 1-4 in chapter 1.

Parking

Chincoteague NWR has a number of parking facilities, as documented in Table 3-10. All of these, except for the parking at the recreational beach and NPS visitor center, are maintained by the refuge and require routine maintenance.

Table 3-10. Parking Facilities on Refuge

Location	*Paved, Marked Spaces*	*Handicapped Spaces (paved and marked)*	*Other spaces*	*Bus/Oversize Parking Spaces*
Recreational Beach	-	-	961 (unpaved, unmarked except for handicapped)	-
Herbert H. Bateman Educational and Administrative Center	52	4	23 regular; 6 for Government (unpaved, car stops)	Gravel area for oversized vehicles and bus parking
Wildlife Loop (Main lot)	38	1	5 (paved but unmarked)	3 paved
Woodland Trail	26	1	-	-
Lighthouse Trail	17	-	6 (paved, unmarked)	2 (paved, unmarked)
Wildlife Loop (Near boardwalk)	7	1	None	-
Boat ramp, west side	-	-	12 (paved, unmarked)	-
Light Keepers House	-	-	15 spaces (unpaved) – for handicapped	-
NPS Toms Cove Visitor Center	-	2 (unpaved but marked)	Approximately 50, both sides of road (unmarked, unpaved)	-
TOTAL	**140**	**9**	**1,078**	**Approximately 5**

NPS is the principal Federal agency charged with the restoration and rehabilitation of the recreational beach parking lots located at the Chincoteague NWR. NPS uses Assateague Island National Seashore base funding and supplemental Emergency Relief for Federally Owned Roads (ERFO) funds to perform emergency storm damage repairs and routine parking lot maintenance. Through an intra-governmental agreement between the NPS and USFWS, the refuge transfers $200,000 from its entrance fees to the Seashore for maintenance of the recreational beach, parking lots, visitor safety services (lifeguards), and law enforcement support.

Routine maintenance consists of raking the lot's surface and filling in ruts from ocean over-wash, hard rains, and vehicular traffic with crushed-shell. Maintenance generally occurs twice weekly April through November and weekly December through March. The estimated annual cost for this work is $7,200 in labor (assuming 4 hours per day at $20/hour), but there are also additional costs for the fuel and for the purchase and maintenance of a ¾-ton pick-up with drag attachment.

Repair of the beach parking from storm events varies based on the level of damage. The length of time needed for storm repairs varies from 2 weeks to 3 months and can consist of additional routine maintenance tasks or more significant replacement of sand and crushed shell and moving the parking areas westward (see Figure 3-31). There have been five storm events in the past 10 years that resulted in impacts to the beach parking that meet the definition of "totally destroyed." "Totally destroyed" refers to major portions of the Toms Cove recreational beach parking and visitor use infrastructure that were damaged so as to be unusable or inaccessible by the public. These storms were the following: Hurricane Isabel in 2003, Hurricane Ernesto and Nor'easter in

Figure 3-31. Damage and Clean-up of Parking Areas 2-4 (Patrick J. Hendrickson, Highcamera.com (9-30-08), provided to USFWS refuge staff)

Figure 3-32. Turn Circle at Chincoteague NWR Beach and Beach Road during Nor'easter Ida. November 2009 (USFWS refuge staff; James Fair, November 2009)

2006, Nor'easter Ida in 2009 (see Figure 3 32), Hurricane Irene in 2011, and Hurricane Sandy in 2012.

Table 3-11provides a summary of the expenses for the recreation beach parking for 2007 through 2011; at the time of publication of this document, USFWS was still working with NPS and the FHWA on final costs for repair of the beaching parking lots, Beach Road, and Service Road from damage sustained during Hurricane Sandy. In 2008, NPS received funding from the FHWA to rehab the asphalt parking lot leading to the beach parking lot. The other funding sources reflect storm-specific funding requests. In addition to those four storm events listed, there may have been some high-tide or overwash events that destroyed the parking lots, but USFWS and NPS do not have verifiable data on the dates, cost to repair, or extent of damage from those events.

To provide one example, for the Hurricane Irene repairs, approximately $151,300 (21 percent) of the total estimated repair cost of $724,112 was accomplished with existing NPS staff and equipment during normal working hours. All of the personnel, material, supply, and equipment

costs for repairing the roads and parking lots were funded through the ERFO Roads program. While the use of existing NPS staff to conduct storm damage repairs is cost effective, the additional workload detracts from the park's ability to conduct normal operational activities such as preventative maintenance and repairs to other visitor use facilities. Similarly, the use of NPS-owned equipment contributes to accelerated wear and tear that is not accounted for in normal replacement cycles.

Table 3-11. Record of Maintenance and Repair Costs for Recreational Beach Parking

Fiscal Year in which Funding Received	Storm (Year)	Routine Repairs and Storm Damage		Storm Damage		Total
		NPS Base Funding and FWS Reimbursable	Federal Highway Project - non emergency	Emergency Relief for Federally Owned Roads	NPS	
2007	Hurricane Ernesto (2006)			$746,213		$746,213
2008		$218,521	$39,226			$257,747
2009	Hurricane Hanna (2008)	$133,820			$196,931	$330,751
2010	Nor'easter Ida (2009)	$160,826		$343,771		$504,597
2011	Hurricane Irene (2011)	$275,036		$724,112		$999,148
2012	Hurricane Sandy					TBD
Total		$788,203	$39,226	$1,814,096	$196,931	$2,838,456

When a storm occurs, the following steps are taken:

- Secure funding. One main funding source has been the ERFO, which provides assistance to Federal agencies when their Federal roads that have sustained damaged from natural disasters.
- Define the wetland boundary. Each time a strong coastal storm hits Assateague Island, the island literally rolls over on itself, moving the island in a westward direction. This is a normal barrier island response to coastal storms and sea level rise. When this happens, the bayside wetlands immediately adjacent to the island are covered with sand that has washed across the island; this provides a new upland site on which to rebuild the parking lots. However, a new wetland/upland boundary has to be determined so the new parking lot is aligned with the new upland.
- Recover materials. In order to recycle and reuse as much of the old parking lot material as possible to reduce costs, the NPS reclaims old shell and clay material from the old parking lot, which requires heavy equipment such as bulldozers, graders, large high-flotation material hauling dump trucks, etc. The reclaimed materials are stockpiled on-site for reuse at a later time.
- Design the new parking areas. The new parking lots are laid out on the ground using a design best fitted to the new wetlands delineation provided by the regulatory agencies. To date, the NPS has always been able to fit 961 parking spaces for cars on the newly created uplands.
- Construct the parking areas. During the winter months, when visitation is low, the construction work can be accomplished in phases, which allows the NPS to complete one

parking lot and open it to the public in a safe manner. If the lots are lost during the summer months, i.e., the peak visitation period, the demand for any parking spaces will quickly exceed the capacity the NPS can provide and will thus create an unsafe environment for the public and equipment operators. Therefore, the parking lots are totally closed to public access until they are fully restored. When at all possible, the NPS will provide parking at the beach. For example, the total time needed to completely repair storm damages similar that those caused by Hurricane Irene is approximately three months.

- Reinstall infrastructure. The last stage of recovery is the replacement of shower stalls, pump houses, restroom facilities, lifeguard stands, displays, and informational and traffic signs, etc.

Refuge Revenues

Under the authority of the Federal Lands Recreation Enhancement Act (FLREA), which expires in December 2014 unless re-authorized, Chincoteague NWR charges an entrance fee per vehicle; Table 3-12 lists the 2012 fee amounts. The refuge introduced a daily fee in 2008 along with an increase to the weekly entrance fee and the addition of an expanded amenity fee for beach parking for the refuge annual pass and the Federal Duck Stamp program. Entrance fees are collected year-round 7 days a week, but the hours of operation for the entrance fee booth (Figure 3 33) vary throughout the year. Credit card machines were added to the fee booths in 2007. When the fee booths are unstaffed, the honor system is used. Visitors who need to pay the daily fee are expected to use the iron ranger, a self-serve pay station located outside the Herbert H. Bateman Educational and Administrative Center, by taking an envelope, inserting $8, and dropping the envelope into the vaulted iron ranger. The refuge is working on plans to install off-site pass purchase machines.

Total annual revenue from entrance fee dollars averages $750,000 to $850,000. Twenty percent of the total revenues collected are provided to the USFWS Region 5 (Northeast Region) Office to be used in a competitive grant program for field stations that provide visitor services, or maintenance projects that have a direct tie to the visitor. Additionally, each year, we transfer approximately $200,000 to the NPS for maintenance of the recreational beach parking lots, visitor safety services (lifeguards), and law enforcement support. The refuge retains approximately $400,000 to $450,000 annually. In compliance with FLREA, we allocate these funds for:

- Visitor services, visitor information, visitor needs assessments, interpretation and signs;
- Habitat restoration directly related to wildlife-dependent recreation limited to hunting, fishing, wildlife observation, or photography;
- Law enforcement related to public use and recreation;
- Repair, maintenance, and facility enhancement directly related to visitor enjoyment, visitor access, and health and safety. This includes annual or routine maintenance, deferred maintenance, and capital improvements. and
- Costs of collection – operating and capital.

Table 3-12. Chincoteague NWR Entrance Fees (as of 2012)

Type of Fee*	Description	New Fee Total
Daily Fee		$8
Weekly Pass		$15
Refuge Annual Pass		$30
Federal Duck Stamp	Annual pass to NWRs valid from July 1 to June 30 of the following year. Hunters over the age of 16 must purchase a Federal Duck Stamp each year if they want to hunt migratory waterfowl. Revenue from the Federal Duck Stamps goes directly to the Migratory Bird Conservation Fund, which uses $0.98 out of every dollar to purchase or lease wetland habitat for protection in the National Wildlife Refuge System.	$15 or $30**
America The Beautiful - The National Parks and Federal Recreational Lands Pass		$80
Senior Pass	Lifetime pass for U.S. citizens or permanent residents age 62 and over. Admits the pass holder and passengers in a non-commercial vehicle at per vehicle fee areas and pass holder +3 adults at per person fee areas	$10
Access Pass	Lifetime pass for U.S. citizens or permanent residents with permanent disabilities (documentation required). Admits the pass holder and passengers in a non-commercial vehicle at per vehicle fee areas and pass holder +3 adults at per person fee areas.	Free
Commercial Buses – 20 or fewer passengers		$40
Commercial Buses – 21 or more passengers		$100

* Entrance fees are per vehicle. Fee required for anyone over the age of 16.

** $15 Expanded Amenity Fee added in 2008 for beach parking maintenance. Visitors with Federal Duck Stamp pass must pay if such visitors want to park in the beach parking lots.

Figure 3-33. Chincoteague NWR Entrance Booths (USFWS refuge Web site)

3.9.2 Staffing

Chincoteague NWR shares its refuge manager with both Wallops Island NWR and the Eastern Shore of Virginia and Fisherman Island NWRs, which have their own designated staffing and CCP process. Since its creation in 1971, Wallops Island NWR has been otherwise unstaffed, with little to no monitoring or management, except by A&N Electric Cooperative, a utility company with a power line ROW that removes tall growing trees, primarily the non-native autumn olive, and some brush species.

Chincoteague NWR has 23 full-time positions and 10 to 20 part-time, student, or contractor positions in the areas of visitor services, law enforcement, biology, administration, fee collection, management, and maintenance (see Appendix K for current staff plan). Fee collection employees primarily work from May to September, although some work from March to November. In addition to refuge staff, NPS provides 6 permanent and 21 seasonal employees to provide lifeguard, law enforcement, maintenance, and interpretive services at Toms Cove and the recreation beach. The staffing breakdown is as follows: 1 permanent and 2 seasonal law enforcement staff, 1 permanent and 6 seasonal interpretation staff, 1 permanent visitor use assistant, 2 permanent and 7 seasonal maintenance staff, and 1 permanent and 6 seasonal lifeguards.

3.9.3 Volunteer Programs

Refuge staff is supplemented by year-round volunteers as well as from local and national youth and adult groups such as Service Road Scholar and the Student Conservation Association (SCA). These individuals and groups provide assistance with wildlife and habitat management programs, wildlife and habitat surveys, invasive species removal, trash pick-up, interpretive education, and other projects.

Chincoteague NWR also receives significant support from the CNHA, a non-profit association established in partnership with the USFWS. The purpose of the CNHA is to promote a better understanding and appreciation of the refuge, the Eastern Shore of Virginia NWR, and the natural history and environment of Virginia's Eastern Shore in general. The CNHA produces and

provides interpretive and educational material for refuge visitors and for local teachers, funds student interns, and enables both refuges to receive matching grants for workshops and programs. Proceeds from memberships and items sold at the retail store at the Herbert H. Bateman Educational and Administrative Center are used to support and enhance the interpretive programs, projects, and activities at both of the refuges. Under a cooperative agreement with USFWS since 2004, the CHNA owns and operates a small seasonal interpretive bus tour service, which they use to provide interpretive tours of Chincoteague NWR from April through November. CHNA also manages the visitation of the Assateague Lighthouse, and seeks grants for its restoration.

3.9.4 Management Units

Chincoteague NWR is a wildlife refuge comprised of over 14,000 acres administered by the USFWS with land spanning over five islands in Accomack County, Virginia. Within the refuge is a vast array of natural habitats that make up a barrier island ecosystem: Beach-Dune, Shrub-Early Successional, Forested Uplands, Wetlands, and Salt Marsh. All of these are described in greater detail in Section 3.3 Vegetation. For management purposes and to facilitate understanding of the descriptions of these habitats and biological resources, Chincoteague NWR is divided into two management units: the Assateague Island Unit and the Southern Islands Unit. The Assateague Island Unit consists primarily of the Virginia section of Assateague Island as well as adjacent Morris Island and Wildcat March and is comprised of beach, dune, salt marsh, freshwater impoundments, maritime forest, and shrub habitats. The Southern Islands Unit includes Assawoman, Metompkin, and Cedar Islands, and is made up mostly of beach-dune and salt marsh habitats.

3.9.5 Landscape Conservation Cooperatives

The refuge is located in the North Atlantic Landscape Conservation Cooperative (LCC), of which USFWS is an active participant. LCCs are public-private partnerships composed of states, tribes, Federal agencies, NGOs, universities, and others that were established by DOI Secretarial Order Number 3289, signed on September 14, 2009. The cooperatives are intended to address landscape-scale stressors, including climate change, and to work interactively with DOI Climate Science Centers to help coordinate regional adaptation efforts. There are 22 LCCs, covering all states and territories of the United States and adjacent areas of Canada, Mexico, and the Caribbean, and transcending political and jurisdictional boundaries to create a networked approach to conservation (see Figure 3-34). The geographic areas were developed by a team of USFWS and USGS scientists and experts by aggregating BCRs. Other frameworks, such as the Freshwater Ecoregions of the World, were also referenced. The LCC effort is coordinated with other partnerships, such as the National Fish Habitat Action Plan, Migratory Bird Joint Ventures and the State and Tribal Wildlife Grants Program.

LCCs were developed with the recognition by the DOI and others that in order to ensure landscapes that are resilient and can sustain natural resources and cultural heritage into the future, conservation agencies and partners need to work together at landscape scales to address increasing land use pressures and widespread resource threats and uncertainties amplified by multiple effects of a rapidly changing climate including sea level rise and increased frequency and intensity of coastal storms.

There are three components to the LCC initiative: the LCC network, individual LCCs, and LCC partners. The LCC network provides a national forum for conservation planning and is intended

to integrate the efforts of 22 LCCs organized, governed and operated in a consistent manner that promotes landscape conservation. LCCs are self-directed, regional, science-management partnerships directed by a steering committee, supported by technical teams and facilitated by a small staff. The LCCs improve data sharing, communication and coordination across and within agencies; provide and leverage funding, staff and resources; develop common goals, tools, and strategies; link science to management; and facilitate information exchange (USFWS 2012f).

USFWS Region 5 is a member of the North Atlantic LCC steering committee and has the lead role for staffing and facilitating the partnership. The LCC has a science strategic plan, operations and development plan, and a number of collaborative active projects that are focused on providing science and information to guide conservation planning and actions in the face of change. These projects include regional habitat and species climate change vulnerability assessments, a project to forecast effects of accelerating sea level rise on the habitat of Atlantic Coast piping plovers (with an initial focus on Assateague); the Designing Sustainable Landscapes project that is assessing landscape changes including climate change and urban growth on species, habitats and systems in the LCC, and a research and decision support framework to evaluate sea level rise impacts in the northeastern United States.

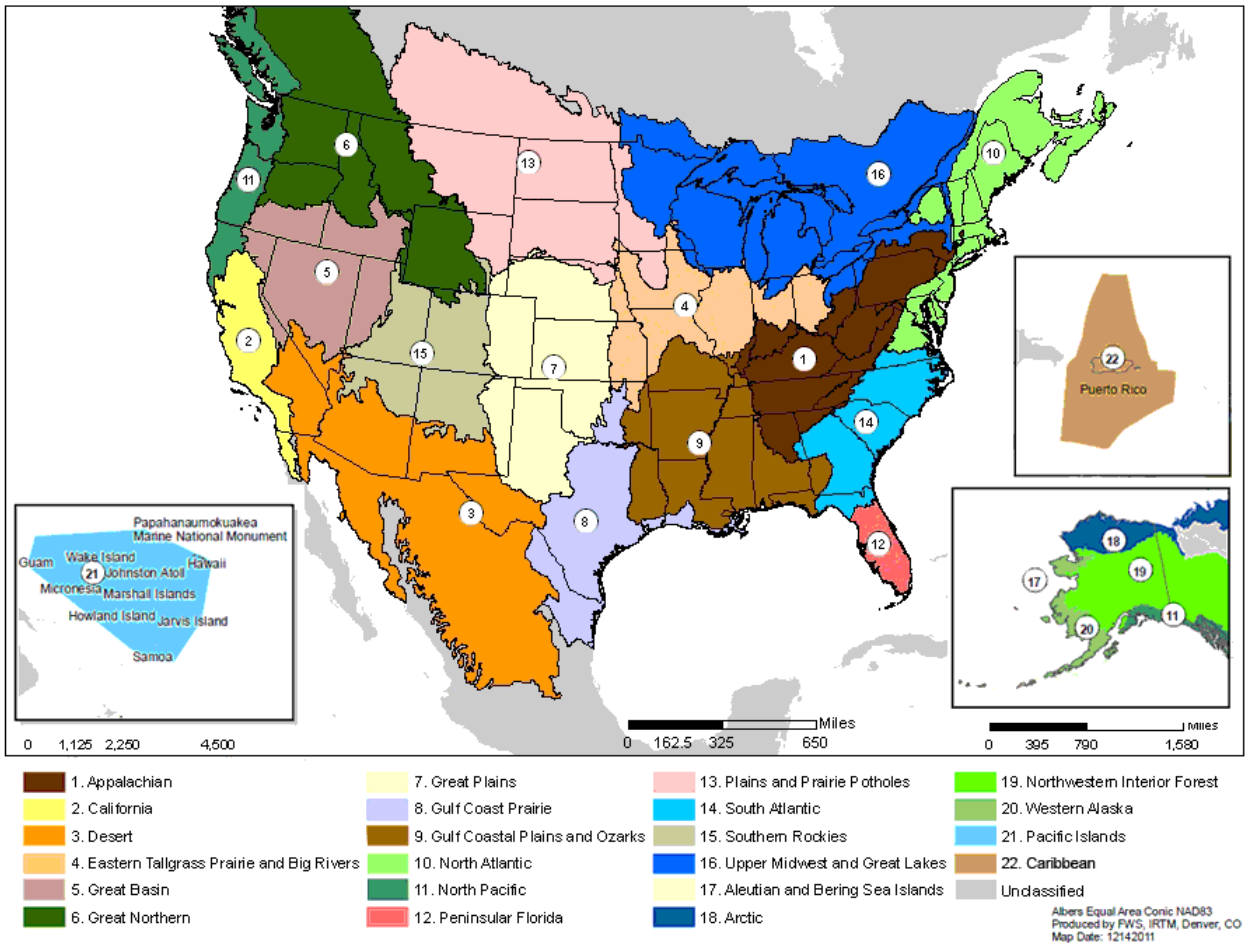



Figure 3-34. Map of Landscape Conservation Cooperatives (USFWS 2012f)