United States Department of the Interior

FISH AND WILDLIFE SERVICE
Ecological Services
6669 Short Lane
Gloucester, Virginia 23061

MAY 10 2010

Mr. Josh Bundick
NASA Wallops Flight Facility
Code 250.W
Wallops Island, Virginia 23337

Re: Biological Opinion for Expansion of Wallops Flight Facility and Ongoing Operations, Accomack County, Virginia, Project # 2010-F-0105

Dear Mr. Bundick:

This document transmits the U.S. Fish and Wildlife Service's (Service) biological opinion based on our review of the National Aeronautics and Space Administration's (NASA) referenced proposed and ongoing launch operations at the Wallops Flight Facility (WFF), including new operations at the Mid-Atlantic Regional Spaceport (MARS) launch pad 0-A and the ongoing operations of launch pad 0-B, in Accomack County, Virginia and the effects on the federally listed endangered green sea turtle (*Chelonia mydas*) and leatherback sea turtle (*Dermochelys coriacea*) and the threatened piping plover (*Charadrius melodus*), loggerhead turtle (*Caretta caretta*), and seabeach amaranth (*Amaranthus pumilius*) in accordance with section 7 of the Endangered Species Act (16 U.S.C. 1531-1544, 87 Stat. 884), as amended (ESA). On March 16, 2010 a proposed rule was published in the Federal Register to reclassify the loggerhead sea turtle through determination of the appropriate listing status for each of nine distinct populations of loggerhead sea turtle worldwide. Based on this proposed rule, the population affected by the proposed action is the north Atlantic population, and it is proposed for listing as endangered (72 FR 12598). Your request for formal consultation was received on September 21, 2009.

The candidate species red knot (*Calidris canutus rufa*) was included in NASA's August 29, 2009 biological assessment (BA). This species has not yet been proposed for listing and therefore will not be addressed further in this document; however, we appreciate NASA's consideration of this species and any conservation measures implemented to minimize or avoid threats to this species will contribute to its conservation. The Service would like to work with NASA to develop a candidate conservation agreement for the red knot.

This biological opinion is based on information provided in the BA, an April 2009 draft environmental assessment (EA) for the expansion of WFF (2009 EA [NASA 2009]), the January 2005 final site-wide EA (2005 EA [NASA 2005]), telephone conversations, field investigations, and other sources of information. A complete administrative record of this consultation is on file in this office.

NASA has determined in its BA that the proposed actions "may affect, and are likely to adversely affect" piping plover, green sea turtle, leatherback sea turtle, and loggerhead sea turtle. Effects of the proposed action on those species will be discussed in this biological opinion. NASA has determined in its BA that the proposed actions "may affect, but are not likely to adversely affect" red knot and seabeach amaranth. The Service does not concur with the "not likely to adversely affect" determination on seabeach amaranth as presented in the BA, and the effects of the proposed action on this species are included in this document. NASA did not provide a determination for the federally listed endangered Delmarva fox squirrel (*Sciurus niger cinereus*), which may occasionally occur in the vicinity of the proposed project. Based on absence of routine Delmarva fox squirrel use of habitat proximal to the action area and lack of good habitat, the effects of the proposed action are insignificant and discountable, and the proposed action may affect, but is not likely to adversely affect this species.

CONSULTATION HISTORY

April 2009	Service received a copy of the EA for the WFF Launch Range Expansion project.
June to July 2009	Several telephone calls between the Service and NASA to discuss the proposed project and gather additional information about the proposed project.
08-05-2009	At a meeting with NASA, the Service recommended consultation on all other NASA ongoing activities in conjunction with the Expansion project.
08-21-2009	NASA provided a BA on the proposed launch range expansion and ongoing activities.
09-21-2009	NASA submitted a letter requesting formal consultation on the Expansion of WFF Launch Range and ongoing operations as described in the August 21, 2009 BA.
01-07-2010	The Service issued a letter indicating that formal consultation was initiated on September 21, 2009.
01-21-2010	The Service met with NASA personnel to discuss the proposed draft threatened / endangered species monitoring plan, and conducted a site visit with NASA personnel.
01-22-2010	NASA provided a draft Wallops Island Protected Species Monitoring Plan.
05-06-2010	NASA provided an updated Wallops Island Protected Species Monitoring Plan, dated April 2010.

BIOLOGICAL OPINION

DESCRIPTION OF PROPOSED ACTION

Two actions are proposed in the BA. In the first action, NASA and MARS will continue transporting, processing, and launching up to twelve orbital-class expendable launch vehicles (ELVs) from existing Pad 0-B as described in the 2005 EA. In the second action, NASA will construct new infrastructure on Wallops Island as described in the 2009 EA to support transportation, processing, and launching of up to six additional medium-class ELVs and spacecraft from Pad 0-A on Wallops Island.

Orbital and suborbital rockets are launched from Launch Complex 0 at the south end of Wallops Island, between the southernmost extent of the sea wall and the unmanned aerial vehicle (UAV) runway. Pad 0-B is topped with a permanent gantry that is illuminated with metal halide uplighting for two days preceding a launch. An exhaust port on the gantry directs rocket motor exhaust to the east, across a narrow strip of steep sandy beach and out over the Atlantic Ocean. Many classes of rockets could be launched from this site, the largest of which would be an equivalent to the LMLV-3(8). Rockets launched from Pad 0-B use solid fuel systems based on an ammonium perchlorate/aluminum (AP/AL) or nitrocellulose/nitroglycerine (NC/NG) combination. Launches from Pad 0-B may occur at any time of day, on any day of the year, as dictated by weather conditions and program needs.

Sounding rockets are launched from a series of three launch pads to the northeast of Launch Complex 0, between Beach Road and the sea wall. These launch pads are topped with mobile shroud sheds rather than gantries, and temporary rail launchers are used to orient the rockets for launch. Sounding rockets do not have a long loiter time on the launch pad after ignition, therefore these launch pads are not equipped with exhaust ports. Many classes of sounding rockets are used at these sites, the largest of which is the Black Brant XII burning 3,350 kilograms (kg) of solid propellant. Propellants used are based on an AP/AL or NC/NG combination. Sounding rockets do not deliver spacecraft into orbit, and therefore do not carry hypergolic propellants. As many as 60 sounding rockets are launched from Wallops Island per year, at any time of day, on any day of the year, as dictated by weather conditions and mission needs.

Drone targets are launched from WFF or air launched from military aircraft in support of U.S. Navy missile training exercises. These targets use a variety of fuels, including liquids such as JP-5 jet fuel or hydrazine derivatives, or solid fuels such as AP/AL or NC/NG. Drones travel on preprogrammed flight paths and are engaged by shipboard interceptor systems over the military's Virginia Capes Operating Area (VACAPES OPAREA), with all debris from the intercept falling within the VACAPES OPAREA boundary. Noise from drone launches adds to the ambient noise level at WFF. As many as 30 drone flights are launched from WFF each year. Drone flights may occur at any time of day, on any day of the year, as dictated by training needs.

Defective or waste rocket motors are ignited at the open burn area south of the UAV runway on Wallops Island. Those motors that cannot be returned to the manufacturer or repurposed for other projects are placed on a concrete pad or bolted to a subunit and ignited to burn off any stored propellant. Multiple motors can be consolidated into a single burn. Ash remaining after a burn is either reburned or shipped off site for disposal. The remaining motor casings are steam cleaned and disposed of as scrap metal. The water used for steam cleaning is captured and tested for toxins before disposal under a Virginia Department of Environmental Quality permit. The maximum amount of propellant to be disposed of per year at the open burn area is 68 metric tons. Burns are infrequent and have not approached the disposal permit limit. Noise produced is variable and can approach the level of a rocket launch.

Combustion products from solid fuels used by sounding rockets and drone targets include hydrogen chloride, aluminum oxide, carbon monoxide, carbon dioxide, nitrogen, nitrogen oxides, and water. During launches, exhaust from sounding rockets typically dissipates fairly quickly into the atmosphere. Aluminum oxide particles are known to scavenge hydrogen chloride and water vapor from the atmosphere to form acidic droplets, and this occurs in the immediate vicinity of the launch pad. However, pH levels in the surrounding ocean and wetlands do not measurably change after a rocket launch. The pH level of surrounding wetlands decreases by roughly 0.1 with a standard deviation of 0.4 in the hours after a large disposal burn, and then is quickly returned to background levels by the buffering capacity of the water.

Scientific balloons are launched in support of several projects at WFF. Balloons launched from WFF may be latex balloons of 600 grams to 3,000 grams in mass, or a much larger polyethylene balloon up to 1,132,673 cubic meters (m) in volume. The latex balloons carry scientific instrument payloads of up to 4.5 kg inside styrofoam carriers to altitudes of 30.5 to 38 kilometers (km). These balloons will expand with decreasing atmospheric pressure at altitude and eventually burst, dropping the scientific payload into the Atlantic Ocean. Payloads are not typically recovered. The polyethylene balloon can carry payloads of up to 3,628 kg. Missions involving these balloons are terminated by remotely detonating a small charge to puncture the balloon and separate the payload from the balloon. The collapsed balloon and payload fall into the Atlantic Ocean and are recovered by the U.S. Coast Guard.

Piloted aircraft use the runways on WFF Main Base. Flights totaled 4,281 during the January 2004 through August 2004 period (NASA 2005). These included civilian, NASA, and military flights, with the U.S. Navy accounting for most flights. Aircraft using the runways range from small single propeller designs up to the Boeing 747, and include such military designs as the F-16 and F-18. Peak noise levels generated by aircraft at WFF range from 67 dB for a single-engine propeller airplane landing on Wallops Main Base to 155 dB for an F-18 conducting a touch and go maneuver at Wallops Main Base. The 2005 EA proposed that piloted operations would expand by no more than 25 percent over the January 2004 through August 2004 level. Air traffic from Wallops Main Base flies over Wallops Island.

UAVs are used frequently at WFF in support of scientific missions. These may use the UAV runway on the south end of Wallops Island, between Pad 0-B and the open burn area, as well as the runways on the Main Base. WFF flies a maximum of 75 UAV missions per week. The 2005 EA anticipated the largest UAV that may be used at WFF would have engines and fuel capacity one-fifth those of a Boeing 757, though most are considerably smaller.

A sea wall composed of large rock is located along Atlantic side of Wallops Island, and protects WFF from damage due to storms and large waves. The wall limits sand migration along the shoreline, and little to no sandy beach exists on the seaward side of the wall. The lack of suitable beach habitat on the seaward side of the wall renders this area unsuitable for piping plover nesting, sea turtle nesting, or seabeach amaranth establishment. Maintenance of the sea wall and facilities adjacent to the beach and sea wall may include operation of heavy equipment and placing dirt and/or rock in previously disturbed areas behind the sea wall to maintain and augment the protection resulting from these features.

Navy and NASA facilities on Wallops Island are equipped with exterior lights at ground level, along catwalks, and at Federal Aviation Administration mandated heights for aircraft orienteering.

Pad 0-A is being reconstructed to include an access ramp, deluge system, and liquid fueling facility. Similar to Pad 0-B, rockets staged on Pad 0-A will be uplit with metal halide lighting for two days preceding launch, and the exhaust from Pad 0-A will be directed through a trench toward the ocean. During non-critical operations, the launch pad area will be illuminated by a combination of amber light emitting diode (LED) and low pressure sodium (LPS) fixtures. The Orbital Sciences Corporation Taurus II rocket is the largest vehicle proposed for launch from this site. Rockets launched from this location will use liquid fuel systems with kerosene or liquid methane and liquid oxygen as propellants, thus requiring liquid nitrogen prior to launch for cooling the propellants, and gaseous helium and nitrogen as pressurants and purge gases. Launches from Pad 0-A may occur at any time of day, on any day of the year, as dictated by weather conditions and program needs.

In support of the orbital launch program at WFF, as many as two static test firings of rocket engines may occur at Pad 0-A each year. In a static test firing, the ELV is held stationary on the launch Pad while the engine is ignited so that functionality of the engine design can be tested in a non-flight situation. Exhaust from static test firings would be directed through a trench and over the Atlantic Ocean. The deluge system used for orbital launches from Pad 0-A will also be used to cool the launch pad and dampen vibration during static firing tests.

Three buildings will be constructed to support existing and expanded launch operations. A dedicated Payload Processing Facility (PPF) will be built on the north end of Wallops Island. Payload spacecraft will be assembled, cleaned, and tested in the PPF. A dedicated Payload Fueling Facility (PFF) will be built on the north end of Wallops Island. Spacecraft delivered to orbit by rockets launched from WFF use hypergolic propellants such as anhydrous hydrazine for position adjustment while in orbit. Spacecraft will be loaded with hypergolic fuels and oxidizers in the PFF. A Horizontal Integration Facility (HIF) will be built at the intersection of Causeway Road and North Seawall Road in the middle of Wallops Island. Final assembly of launch vehicles and integration of spacecraft into launch vehicles will be performed in the HIF. All exterior building lighting on Wallops Island will be provided by amber LEDs.

The boat dock at the north end of Wallops Island will be modified to receive equipment such as rocket components that cannot be delivered to the island by truck. Modifications will be limited to the addition of sheet pile, fendering, and armor stone around the existing dock structure. The existing access channel and boat basin will be maintained via dredging to a depth of four feet at low tide to accommodate deliveries at any time of day.

Security of facilities on Wallops Island is maintained by a private contractor. Individuals on foot or in vehicles tour the perimeter of Wallops Island, including the beach areas on the north and south end of the island. These patrols may be performed as often as deemed necessary to maintain base security. Security will transition from the current system of frequent roving patrols to a closed circuit television system. Upon completion of the closed circuit surveillance system, security officer beach access will be reduced to the minimum required to augment the cameras in providing facility security.

The activities included in the Wallops Island Protected Species Monitoring Plan (April 2010) are included as part of the proposed actions. This includes the surveys, monitoring, and management for sea turtle nesting activity, piping plover nesting red knots, and seabeach amaranth.

The proposed action is expected to continue for the foreseeable future. Therefore, this biological opinion remains in effect until such time as a change occurs as described in the "Reinitiation Notice" at the end of this document. At that time the Service should be contacted to determine if additional consultation is necessary.

Additional details and descriptions of each element of the proposed action can be found in the 2005 EA, the 2009 EA, and the Protected Species Monitoring Plan.

Action Area

The action area is defined as all areas to be affected directly or indirectly by the federal action and not merely the immediate area involved in the action. In their BA, NASA determined that the action area was delineated by the noise effects, and selected a noise threshold of 108 dB. This level of noise was reported as a threshold under which effects to shorebirds were not significant (Burger 1981). The area expected to be exposed to at least 108 decibels (dB) during the launch of rockets from Wallops Island Launch Complex 0 is represented by a circle with a radius of 12.6 km originating at Pad 0-B. All other activities supporting orbital launch operations at WFF will occur within the 108 dB radius.

The 108 dB range of sound intensity is similar to a lawnmower or power tools in close proximity, loud music and thunder (McKinley Health Center 2007). In the natural environment, sounds of this intensity may not routinely be expected to have significant, direct, or adverse effects, but intensity in this range is routinely reported as having some effect on some bird species (Manci et al. 1988). Sound intensity is only one factor associated with the proposed action that affects listed species. Sound in conjunction with visual stimuli may result in additional behavioral responses, and the frequency and intensity of background or ambient noises at a location may contribute to whether effects occur because of developed tolerance for noise.

Because of the number of factors that must be considered in evaluating the effects of noise on a species, including the intensity and duration of noise generated, distance from noise, frequency of the noise, atmospheric conditions, ambient noise levels, and others, it is difficult to determine the full extent of effects. Based on the available information, we have determined that the action area for this consultation encompasses all of the barrier islands from Metompkin Island on the south through the northern end of the Public Beach on Chincoteague National Wildlife Refuge (CNWR). Under some circumstances, the sound and effects may extend beyond these distances, but both the sound and visual effects are expected to be comparable to ambient levels, taking into account other ongoing activities such as recreational boating and fishing, military activities, non-military aviation, and recreational use.

STATUS OF THE SPECIES AND CRITICAL HABITAT RANGEWIDE

PIPING PLOVER

On January 10, 1986, the piping plover was listed as endangered or threatened in various parts of its range pursuant to the ESA. Three separate breeding populations have been identified, each with its own recovery criteria: Atlantic Coast (threatened), Great Lakes (endangered), and Northern Great Plains (threatened). The Atlantic Coast population is the focus of this biological opinion. No critical habitat has been proposed or designated for piping plovers in the Atlantic Coast breeding area.

The recovery plan for the Atlantic Coast population of the piping plover (Service 1996a) delineates four recovery units or geographic subpopulations within the population: Atlantic Canada, New England, New York-New Jersey, and Southern (Delaware, Maryland, Virginia, and North Carolina). Recovery criteria established within the recovery plan defined population and productivity goals for each recovery unit, as well as for the population as a whole. Attainment of these goals for each recovery unit is an integral part of a piping plover recovery strategy that seeks to reduce the probability of extinction for the entire population by: (1) contributing to the population total, (2) reducing vulnerability to environmental variation (including catastrophes, such as hurricanes, oil spills, or disease), (3) increasing likelihood of genetic interchange among subpopulations, and (4) promoting recolonization of any sites that experience declines or local extirpations due to low productivity or temporary habitat succession.

Species Description - Piping plovers are small, sand-colored shorebirds, approximately 17 centimeters (cm) (7 inches) long with a wingspread of about 38 cm (15 inches) (Palmer 1967). The Atlantic Coast population breeds on sandy, coastal beaches from Newfoundland to North

Carolina, and winters along the Atlantic Coast from North Carolina south, along the Gulf Coast to Texas, and in the Caribbean (Service 1996a). Additional detailed information on the piping plover, its life history, and the population dynamics of the Atlantic population are provided in the species' recovery plan (Service 1996a).

Life History - Piping plovers generally begin returning to their Atlantic Coast nesting beaches in mid-March (Coutu et al. 1990, Cross 1990, Goldin 1990, MacIvor 1990, Hake 1993). Males establish and defend territories and court females (Cairns 1982). Piping plovers are monogamous, but usually shift mates between years (Wilcox 1959, Haig and Oring 1988, MacIvor 1990), and less frequently between nesting attempts in a given year (Haig and Oring 1988, MacIvor 1990, Strauss 1990). Plovers are known to begin breeding as early as one year of age (MacIvor 1990, Haig 1992); however, the percentage of birds that breed in their first adult year is unknown.

Piping plovers nest on the ground above the high tide line on coastal beaches, on sand flats at the ends of sand spits and barrier islands, on gently sloping foredunes, in blowout areas behind primary dunes, and in washover areas cut into or between dunes. In the central portions of their Atlantic Coast range, the birds may also nest on areas where suitable dredge material has been deposited. Nest sites are shallow, scraped depressions in substrates ranging from fine-grained sand to mixtures of sand and pebbles, shells or cobble (Bent 1929, Burger 1987, Cairns 1982, Patterson 1988, Flemming et al. 1988, MacIvor 1990, Strauss 1990). Nests are usually found in areas with little or no vegetation although, on occasion, piping plovers will nest under stands of American beachgrass or other vegetation (Patterson 1988, MacIvor 1990). Plover nests may be very difficult to detect, especially during the six to seven day egg-laying phase when the birds generally do not incubate the eggs within the nest cup (Goldin 1994).

Eggs may be present on the beach from early April through late July. Clutch size for an initial nest attempt is usually four eggs, one laid every other day. Eggs are pyriform in shape, and variable buff to greenish brown in color, marked with black or brown spots. The incubation period usually lasts 27-28 days. Full-time incubation usually begins with the completion of the clutch and is shared equally by both sexes (Wilcox 1959, Cairns 1977, MacIvor 1990). Eggs in a clutch usually hatch within four to eight hours of each other, although the hatching period of one or more eggs may be delayed by up to 48 hours (Cairns 1977, Wolcott and Wolcott 1999).

Piping plovers generally fledge only a single brood per season, but may renest several times if eggs are lost. Chicks are precocial, meaning they immediately can run from the nest cup upon hatching (Wilcox 1959, Cairns 1982). They may move with their parents hundreds of meters from the nest site during their first week of life (Service 1996a), and chicks may increase their foraging range up to 1,000 m before they fledge (are able to fly) (Loegering 1992). At CNWR, Daisey (2006) found that brood movements averaged 60.1 $\pm$ 28.0 m/day in 2004 and 68.8 m/day in 2005 (range = 5.4 – 120.8 m/day; 28.9 – 122.2 m/day, respectively). Chicks remain together with one or both parents until they fledge at 25 to 35 days of age. Depending on their date of hatching, flightless chicks may be present from mid-May until late August, although most fledge by the end of July (Patterson 1988, Goldin 1990, MacIvor 1990, Howard et al. 1993).

Cryptic coloration is a primary defense mechanism for this species; eggs, adults, and chicks all blend in with their typical beach surroundings. Chicks sometimes respond to vehicles and/or pedestrians by crouching and remaining motionless (Cairns 1977, Tull 1984, Goldin 1993, Hoopes 1993). Adult piping plovers respond to intruders (avian and mammalian) in their territories by displaying a variety of distraction behaviors, including squatting, false brooding, running, and injury feigning, in an effort to lure the predators away from the nest or chicks. Distraction displays may occur at any time during the breeding season but are most frequent and intense around the time of hatching (Cairns 1977).

Plovers feed on invertebrates such as marine worms, fly larvae, beetles, crustaceans, and mollusks (Bent 1929, Cairns 1977, Nicholls 1989). Important feeding areas include intertidal portions of ocean beaches, washover areas, mudflats, sand flats, wrack lines, sparse vegetation, and shorelines of coastal ponds, lagoons, or salt marshes (Gibbs 1986, Coutu et al. 1990, Hoopes et al. 1992, Loegering 1992, Goldin 1993, Elias-Gerken 1994). The relative importance of various feeding habitat types may vary by site (Gibbs 1986, Coutu, et al. 1990, McConnaughey et al. 1990, Loegering 1992, Goldin 1993, Hoopes 1993, Elias-Gerken 1994) and by stage in the breeding cycle (Cross 1990). Adults and chicks on a given site may use different feeding habitats in varying proportion (Goldin 1990). Feeding activities of chicks are particularly important to their survival. Most time budget studies reveal that chicks spend a high proportion of their time feeding. Cairns (1977) found that chicks typically tripled their weight during the first two weeks post-hatching; chicks that failed to achieve at least 60 percent of this weight gain by the twelfth day post-hatching were unlikely to survive.

During courtship, nesting, and brood rearing, feeding territories are generally contiguous to nesting territories (Cairns 1977), although instances where brood-rearing areas are widely separated from nesting territories are not uncommon. Feeding activities of both adults and chicks may occur during all hours of the day and night (Burger 1993), and at all stages in the tidal cycle (Goldin 1993, Hoopes 1993).

Both spring and fall migration routes of Atlantic Coast breeders are believed to occur primarily within a narrow zone along the Atlantic Coast (Service 1996a). Relatively little is known about migration behavior or habitat use within the Atlantic Coast breeding range (Service 1996a), but the pattern of both fall and spring counts at migration sites along the southeastern Atlantic Coast demonstrates that many piping plovers make intermediate stopovers lasting from a few days up to one month during migration (National Park Service [NPS] 2003, Noel et al. 2005, Stucker and Cuthbert 2006).

A growing body of information shows that habitats on overwash beaches, accessible bayside flats, unstabilized and recently healed inlets, and moist sparsely vegetated barrier flats are especially important to piping plover productivity and carrying capacity in the New York-New Jersey and Southern recovery units.

In New Jersey, Burger (1994) studied piping plover foraging behavior and habitat use at three sites that offered the birds access to ocean, dune, and backbay habitats. The primary focus of the study was on the effect of human disturbance on habitat selection, and the author found that both habitat selection and foraging behavior correlated inversely with the number of people present. In the absence of people on an unstabilized beach, plovers fed in ocean and bayside habitats in preference to the dunes.

Loegering and Fraser (1995) found that chicks on Assateague Island, Maryland, that were able to reach bayside beaches and the island interior had significantly higher fledgling rates than those that foraged solely on the ocean beach. Higher foraging rates, percentage of time spent foraging, and abundance of terrestrial arthropods on the bay beach and interior island habitats supported their hypothesis that foraging resources in interior and bayside habitats are key to reproductive rates on that site. Their management recommendations stressed the importance of sparsely vegetated cross-island access routes maintained by overwash, and the need to restrict or mitigate human activities that reduce natural disturbance during storms.

Dramatic increases in plover productivity and breeding population on Assateague since the 1991-1992 advent of large overwash events corroborate Loegering and Fraser's (1995) conclusions. Piping plover productivity on Assateague, which had averaged 0.77 chicks per pair during the five years before the overwash events, averaged 1.67 chicks/pair in 1992-96. The nesting population on the northern five miles of the island also grew rapidly, doubling by 1995 and tripling by 1996, when 61 pairs nested there (MacIvor 1990). Habitat use is primarily on the interior and bayside of this island.

In Virginia, Watts et al. (1996) found that piping plovers nesting on 13 barrier islands between 1986 and 1988 were not evenly distributed along the islands. Beach segments used by plovers had wider and more heterogeneous beaches, fewer stable dunes, greater open access to bayside foraging areas, and proximity to mudflats. They note that characteristics of beaches selected by plovers are maintained by frequent storm disturbance.

At Cape Lookout National Seashore in North Carolina, 13 to 45 pairs of plovers have nested on North and South Core Banks each year since 1992 (NPS 2007). While these unstabilized barrier islands total 44 miles long, nesting distribution is patchy, with all nests clustered on the dynamic ends of the barrier islands, recently closed and sparsely vegetated "old inlets," expansive barrier mudflats, or new ocean-to-bay overwashes. During a 1990 study, 96 percent of brood observations were on bay tidal flats, even though broods had access to both bay and ocean beach habitats (McConnaughey et al. 1990).

At Cape Hatteras National Seashore, North Carolina, distribution of nesting piping plovers is also "clumped," with nesting areas characterized by a wide beach, relatively flat intertidal zone, brackish ponds, and temporary pools formed by rainwater and overwash (Coutu et al. 1990).

Notwithstanding the importance of bayside flats, ephemeral pools, and sparsely vegetated barrier flats for piping plover nest site selection and chick foraging, ocean intertidal zones are used by adults and chicks of all ages. A three-year study of piping plover chick foraging activity at six sites on four Virginia barrier islands (Cross and Terwilliger 2000) documented chick use of the ocean intertidal zone at three of six study sites. Intensive observations at CNWR Overwash Zone in 2004, where chicks had unimpeded access to a large undisturbed bayside flat, documented occasional visits to the ocean intertidal zone by six of eleven broods ranging in age from one to 24 days (Hecht 2004 in litt.).

Population Dynamics/Status and Distribution - Historical population trends for the Atlantic Coast piping plover have been reconstructed from scattered, largely qualitative records. Nineteenth-century naturalists, such as Audubon and Wilson, described the piping plover as a common summer resident on Atlantic Coast beaches (Haig and Oring 1985). However, by the beginning of the 20th Century, egg collecting and uncontrolled hunting, primarily for the millinery trade, had greatly reduced the population, and, in some areas along the Atlantic Coast, the piping plover was close to extirpation. Following passage of the Migratory Bird Treaty Act (40 Stat. 775; 16 U.S.C. 703-712) in 1918, and changes in the fashion industry that no longer exploited wild birds for feathers, piping plover numbers recovered to some extent (Haig and Oring 1985).

Available data suggest that the most recent population decline began in the late 1940s or early 1950s (Haig and Oring 1985). Starting in 1972, the National Audubon Society's "Blue List" of birds with deteriorating status included the piping plover (Tate 1981). Johnsgard (1981) described the piping plover as ". . . declining throughout its range and in rather serious trouble." The Canadian Committee on the Status of Endangered Wildlife in Canada designated the piping plover as "Threatened" in 1978 and elevated the species status to "Endangered" in 1985 (Canadian Wildlife Service 1989).

Reports of local or statewide declines between 1950 and 1985 are numerous and many are summarized by Haig and Oring (1985). While Wilcox (1939) estimated more than 500 pairs of piping plovers on Long Island, New York, the 1989 population estimate was 191 pairs (Service 2010). There was little focus on gathering quantitative data on piping plovers in Massachusetts through the late 1960s because the species was commonly observed and presumed to be secure. However, numbers of piping plover breeding pairs declined 50 to 100 percent at seven Massachusetts sites between the early 1970s and 1984 (Griffin and Melvin 1984). Recent experience of biologists surveying piping plovers has shown that counts of these cryptically colored birds sometimes go up with increased census effort, suggesting that some historic counts of piping plover numbers by one or a few observers, who often recorded occurrences of many avian species simultaneously, may have underestimated the piping plover population. Thus, the magnitude of the species' decline may have been more severe than available numbers imply.

Appendix 1 summarizes nesting pair counts for the Atlantic Coast piping plover population since listing in 1986 through 2009. Final range-wide numbers for the 2009 breeding season are not yet available, and 2009 data are considered preliminary at this time. The apparent increase in numbers of plover pairs between 1986 and 1989 is thought, at least partially, to reflect the effects of increased survey efforts following the proposed listing of the species in 1986.

The Atlantic Coast population has increased from 790 pairs since listing to over 1,800 pairs each year since 2007 (Service 2010). Population growth has been greatest in the New England and New York-New Jersey recovery units, with a more modest and recent increase in the Southern unit and a smaller increase in Atlantic Canada.

Productivity - Productivity needed to maintain a stable population for Atlantic Coast piping plovers is estimated at 1.24 fledged chicks per pair (Melvin and Gibbs 1994). Small populations may be highly vulnerable to extirpation due to variability in productivity and survival rates. The average productivity needed for a stable population may be insufficient to assure a high probability of species survival. To compensate for small populations, the recovery plan establishes productivity goals needed to assure a secure 2,000-pair population at 1.5 chicks per pair in each of the four recovery units, based on data from at least 90 percent of each recovery unit's population.

Appendix 1 provides a summary of piping plover productivity from 1987 to 2009. Both regional population trends and productivity rates have been uneven. The 10-year (1997-2009) average productivity for piping plovers on the U.S. Atlantic Coast is below the recovery target of 1.5 chicks per pair. Peak productivity in the U.S. occurred in 1994 when average productivity exceeded the recovery plan goal of 1.5 chicks per pair. In most years, average productivity across the Atlantic population remained below the target. While weather events were contributors to egg and chick losses in some years (Service 1998, 2002a), such periodic natural events are inevitable, and they underscore the need to reduce the species' vulnerability by increasing the breeding population and protecting the species against human caused factors that affect productivity.

Southern Recovery Unit Status and Distribution - The Southern Recovery Unit (a portion of the Atlantic Coast population) includes Delaware, Maryland, Virginia, and North Carolina. Some limited plover nesting has occurred in South Carolina. There were approximately 158 plover pairs in the Southern Recovery Unit in 1986 and approximately 302 pairs in 2009 (Appendix 1). The 2007 total (333) is the highest recorded within the Southern Recovery Unit to date. However, the Southern Recovery Unit, which includes CNWR, continues to fall short of its recovery goal of 400 pairs. During the period of monitoring, the population size has declined in some years, but has consistently rebounded following declines. The numbers have shown an increasing trend over the last 10 years, from 182 pairs in 1999 to 302 pairs in 2009 (Service 2010; Appendix 1).

In the Southern Recovery Unit, productivity has varied substantially over the past 10 years, with a low of 0.67 chicks per pair recorded in 2008 and a high of 1.96 in 2004 (Appendix 1). Overall, plover productivity has generally increased in Virginia and throughout the Southern Recovery Unit since 1999, despite declines in some years. High productivity in Virginia from 2000 to 2005 has contributed to population increases in Virginia and in the Southern Recovery Unit (Service 2010). Continued productivity at or above levels identified in the recovery plan are attainable with ongoing intensive management efforts, and are expected to result in additional increases in plover populations.

Factors Affecting the Species - Intensive management measures to protect piping plovers from disturbance by beach recreationists and their pets have been implemented for the Atlantic population at many nesting sites in recent years. In 2004, about 30 percent of the U.S. Atlantic Coast population of piping plovers nested on federally owned beaches where some protection is afforded under section 7 of the ESA (within the Southern Recovery unit, the majority of plovers occur on public or private conservation lands). The remaining 70 percent of the birds nested on state, town, or privately-owned beaches where plover managers are implementing protections in the face of increasing disturbance from recreation and development. Recreational activities and public use of some federally owned beaches have also increased. Pressure on Atlantic Coast beach habitat from development and human disturbance continues (Service 1996a). Piping plover protection is dependent on the efforts of Federal, State, and local government agencies, conservation organizations, and private landowners.

Recreational activities can be a source of both direct mortality and harassment of piping plovers. Pedestrians may flush incubating plovers from nests (Flemming et al. 1988, Cross 1990, Cross and Terwilliger 1993), exposing eggs to predators or excessive temperatures. Repeated exposure of shorebird eggs on hot days may cause overheating, killing the embryos (Bergstrom 1991); excessive cooling may kill embryos or retard their development, delaying hatching dates (Welty 1982). Pedestrians can also disturb unfledged chicks (Strauss 1990, Burger 1991, Loegering 1992, Hoopes 1993, Goldin 1993), forcing them out of preferred habitats, decreasing available foraging time, and causing expenditure of energy.

Concentrations of pedestrians may deter piping plovers from using otherwise suitable habitat. In Jones Beach Island, New York, Elias-Gerkin (1994) found less pedestrian disturbance in areas selected by nesting piping plovers than areas unoccupied by plovers. Burger (1991, 1994) found that presence of people at several New Jersey sites caused plovers to shift their habitat use away from the ocean front to interior and bayside habitats, and that the time plovers devoted to foraging decreased and the time spent alert increased when more people were present. Burger (1991) also found that when plover chicks and adults were exposed to the same number of people, chicks spent less time foraging and more time crouching, running away from people, and being alert than did adult birds.

Fireworks are highly disturbing to piping plovers (Howard et al. 1993). Plovers are also intolerant of kites, particularly as compared to pedestrians, dogs, and vehicles. This may be because plovers perceive kites as potential avian predators, such as gulls, crows, or raptors (Hoopes 1993).

Motorized vehicle use on beaches is an extreme threat to piping plovers, as well as other shorebirds that nest on beaches and dunes. Vehicles can crush eggs, adults, and chicks (Wilcox 1959, Tull 1984, Burger 1987, Patterson et al. 1991). In Massachusetts and New York, 18 piping plover chicks and 2 adults were killed by off-road vehicles in 14 documented incidents (Melvin et al. 1994). Goldin (1993) compiled records of 34 chick mortalities (30 on the Atlantic Coast and 4 on the Northern Great Plains) due to vehicles. Biologists who monitor and manage piping plovers believe that vehicles kill many more chicks than are found and reported (Melvin et al. 1994).

Beaches used by recreational vehicles during nesting and brood-rearing periods generally have fewer breeding plovers than available nesting and feeding habitat can support. In contrast, plover abundance and productivity has increased on beaches where recreational vehicle restrictions during chick-rearing periods have been combined with protection of nests from predators (Goldin 1993).

Once hatched, piping plover broods are mobile and may not remain near the nesting area. Wire fencing placed around nests to deter predators (Rimmer and Deblinger 1990, Melvin et al. 1992) is ineffective in protecting chicks from vehicles because chicks typically leave the nest within a day after hatching and move extensively along the beach to feed. Typical behaviors of piping plover chicks increase their vulnerability to vehicles. Chicks frequently move between the upper berm or foredune and feeding habitat within the wrack line and intertidal zone. Chick use of the ocean intertidal zone is lower in the Southern recovery unit compared with more northerly portions of the breeding range. Data from Assateague Island Seashore in Maryland and from CNWR demonstrates that many broods make sporadic use of ocean intertidal zone habitat (Hecht 2004 in litt.). These movements along the beach and intertidal zone place chicks in the paths of vehicles. Chicks stand, walk, and run along tire ruts, and sometimes have difficulty crossing deep ruts or climbing out of them (Eddings et al. 1990, MacIvor 1990, Strauss 1990, Hoopes et al. 1992, Goldin 1993, Howard et al. 1993, Hoopes 1994). Chicks sometimes stand motionless or crouch as vehicles pass by or do not move quickly enough to get out of the way (Tull 1984, Hoopes et al. 1992, Goldin 1993).

Vehicles may also significantly degrade piping plover habitat or disrupt normal behavior patterns by crushing wrack into the sand and making it unavailable as cover or foraging substrate (Hoopes et al. 1992, Goldin 1993). Vehicles that are driven too close to the toe of the dune may destroy vegetation that may provide piping plover cover habitat (Elias-Gerken 1994).

Substantial evidence shows that human activities exacerbate natural predation on piping plovers, their eggs, and chicks (Service 1996a). Where Wilcox (1959) had observed 92 percent hatching success of nests observed between 1939-1958 on Long Island, New York, and loss of only 2 percent of nests to crows (*Corvus* sp.), Elias-Gerken (1994) documented loss of 21 percent of nests in her study area to crows in 1992-1993 as a result of increased human activity. Other important predators of plover eggs and chicks in the recovery unit include foxes (*Vulpes vulpes*), raccoons (*Procyon lotor*), Norway rats (*Rattus norvegicus*), herring gulls (*Larus argentatus*), great black-backed gulls (*Larus marinus*), domestic and feral dogs (*Canis familiaris*) and cats (*Felis catus*), and ghost crabs (*Ocypode quadrata*) (Riepe 1989, Jenkins and Nichols 1994, Jenkins et al. 1999, Canale 1997, Service 1996a).

Predators can be a major source of loss of eggs and juvenile plovers. For example, predators accounted for over half of all piping plover nest losses in New Jersey from 1995-1998 (Jenkins et al. 1999). A variety of techniques have been employed to reduce predation on plovers. Most notably, the use of predator exclosures (fences around nests) has demonstrated success to reduce predation on piping plover eggs (Melvin et al. 1992, Rimmer and Deblinger 1990) and has been credited with an important role in population increases in some parts of their range (Jenkins and Nichols 1994, Jenkins et al. 1999). However, these same devices have also been associated with serious problems including entanglements of birds in the exclosure netting, and attraction of "smart" predators that have learned there is potential prey inside. The downside risks may include not only predation or nest abandonment, sometimes at rates exceeding those that might occur without exclosures, but also induced mortality of adult birds. Exclosures provide no protection for mobile plover chicks, which generally leave the exclosure within a day of hatching and move extensively along the beach to feed.

Although exclosures are contributing to improved productivity and population increases in some portions of the Atlantic Coast range, problems have been noted in some localities. Loegering (1992) reported loss of six nests in exclosures without tops in Maryland in 1988, but nest loss stopped after string tops were added. Cross (1991) found that exclosed nests hatched significantly more often than unexclosed nests over three years on three sites at CNWR, but hatch rates were not significantly improved at all sites or in all years; furthermore, two instances of foxes depredating adult plovers occurred in the vicinity of exclosures. Due to the magnitude of predation threats to plovers and limitations associated with all currently available solutions, the piping plover recovery plan strongly recommends that on-site managers employ an integrated approach to predator management that considers a full range of management techniques (Service 1996a).

As effectiveness of exclosures has declined, managers have increased selective predator removal activities at many sites throughout the Atlantic Coast range (e.g., U.S. Department of Agriculture [USDA] 2006, NPS 2007, Cohen et al. 2009). Most predator removal efforts have focused on mammalian predators, but gulls and crows have been targeted at some sites (e.g., Brady and Inglefinger 2008, USDA 2008). Boettcher et al. (2007) state that predator management is "one of the most important and expensive avian conservation measures being implemented on Virginia's barrier islands." Cohen et al. (2009) found that the number of chicks fledged per pair at Westhampton, New York increased with the annual number of cats and foxes trapped. Mean productivity at Maine sites where predator management was conducted was approximately double the productivity at sites without predator management in both 2007 and 2008 (USDA 2008). Productivity of piping plovers at Plymouth Beach, Massachusetts, averaged 1.67 fledged chicks per pair during three years when foxes were removed, compared with 0.86 chicks per pair during the preceding seven years (Service 2009a). Following selective crow removal at Crane Beach in Ipswich, Massachusetts, in 2008, piping plover productivity was the highest since 1999 and exceeded 1.25 fledglings per pair for first time since 2002 (Brady and Inglefinger 2008).

A detailed discussion of threats to Atlantic Coast piping plovers including contaminants, wind turbines, effects of climate change and sea level rise, and the reliability of effort and expenditures for conservation measures is found in the Piping Plover (*Charadrius melodus*) 5-year review: summary and evaluation (Service 2009b).

<u>SEABEACH AMARANTH</u>

In 1993, seabeach amaranth was listed as a threatened species (58 FR 18035). The listing was based upon the elimination of seabeach amaranth from two-thirds of its historic range and continuing threats to the 55 populations that were known at the time (58 FR 18035).

<u>Species Description</u> - Seabeach amaranth is an annual plant and a member of the Amaranth family (*Amaranthaceae*). Upon germination, the plant initially forms a small, unbranched sprig, and soon begins to branch profusely, forming a low-growing mat. Seabeach amaranth's fleshy stems are prostrate at the base, erect or somewhat reclining at the tips, and pink, red, or reddish in color. The leaves are small, rounded, and fleshy, spinach-green in color, with a characteristic notch at the rounded tip. Leaves are approximately 1.3 to 2.5 cm in diameter, and clustered towards the tip of the stem (Weakley and Bucher 1992). The foliage turns deep red in the fall (Snyder 1996). Plants often grow to 30 cm in diameter, consisting of 5 to 20 branches, but occasionally reach 90 cm in diameter, with 100 or more branches. Flowers and fruits are inconspicuous, borne in clusters along the stems. Seeds are 2.5 millimeters (mm) in diameter, dark reddish-brown, and glossy, borne in low-density, fleshy, indehiscent utricles (bladder-like seed capsules or fruits), 4 to 6 mm long (Weakley and Bucher 1992). The seed does not fill the utricle, leaving an air-filled space (Service 1996b).

<u>Habitat</u> – Seabeach amaranth occupies a narrow beach zone that lies at elevations from 0.2 to 1.5 m above mean high tide, the lowest elevations at which vascular plants regularly occur. Seaward, the plant grows only above the high tide line, as it is intolerant of even occasional flooding during the growing season. Landward, seabeach amaranth does not occur more than approximately 1 m above the beach elevation on the foredune, or anywhere behind it, except in overwash areas. The species is, therefore, dependent on a terrestrial, upper beach habitat that is not flooded during the growing season. This zone is generally absent on beaches experiencing high rates of erosion. Seabeach amaranth is not found on beaches where the foredune is scarped by undermining water at high or storm tides (Weakley and Bucher 1992).

The species' primary habitat consists of overwash flats at accreting ends of barrier islands, and lower foredunes and upper strands of non-eroding beaches. This species occasionally establishes small and temporary populations in secondary habitats including sound side beaches, blowouts in foredunes, and sand or shell dredge spoil or beach nourishment material (Weakley and Bucher 1992).

Seabeach amaranth usually occurs on a pure silica sand substrate, occasionally containing shell fragments. The Natural Resources Conservation Service classifies the habitat of seabeach amaranth as either Beach-Foredune Association or Beach (occasionally flooded). Seabeach amaranth habitat occurs within a wetland system classified by Cowardin et al. (1979) as Marine System, Intertidal Subsystem, Unconsolidated Shore Class (Weakley and Bucher 1992).

The habitat of seabeach amaranth is sparsely vegetated with annual herbs and, less commonly, perennial herbs (mostly grasses) and scattered shrubs. The number and type of vegetative associates vary with specific habitat type (i.e., overwash flat, accreting barrier island end, or lower foredune) (Chicone undated). The most constant associates of seabeach amaranth, with which the species almost always co-occurs, are sea rocket (*Cakile edentula*) and seabeach spurge (*Chamaesyce polygonifolia*) (Weakley and Bucher 1992).

Biogeography and Range - Seabeach amaranth is limited by its habitat requirements to a narrow strip of barrier islands and mainland oceanfront beach strands along the Atlantic coast. The original range of this species extended from Cape Cod in Massachusetts to central South Carolina, a stretch of coast approximately 1,600 km (994 miles) long. This stretch correlates with a geographic range of low tidal amplitude. Tidal amplitude and the relative importance of tidal versus wave energy in shaping coastal morphology are thought to limit the geographic range of seabeach amaranth, rather than availability of sandy beach substrates or sea water temperatures. The range of seabeach amaranth is characterized by islands developed by high wave energy, low tidal energy, frequent overwash, and frequent breaching by hurricanes with resulting formation of new inlets (Weakley and Bucher 1992). Some authors have observed that seabeach amaranth tends to occur on south or southeast facing coasts (Weakley and Bucher 1992, Snyder 1996), but a range-wide analysis of beach orientation has not been conducted.

Historic records of seabeach amaranth are known from nine states. Largely due to human activities, the species was eliminated from seven of these states by the 1980s, remaining only in North and South Carolina. Since 1990, the species has been rediscovered in four states from which it had previously been considered extirpated. Seabeach amaranth is still considered extirpated from two states: Massachusetts and Rhode Island. Table 1 gives the dates of rediscovery and the last previously known occurrence of the plant in each state.

Table 1. Rediscovery Dates of Seabeach Amaranth in Four States.

State	Date Rediscovered	Date of Last Previously Known Occurrence
New York	July 2000	1950 (Van Schoik and Antenen 1993)
Delaware	August 2000	1913 (Service 1996b)
Maryland	August 1998	1875 (McAvoy 2000)
Virginia	September 2001	1973 (Service 1996b)

To date, explanations for seabeach amaranth's rediscovery in the northern part of its range remain speculative. Sites in these five states may have been re-colonized by long-distance transport of seeds by wind or currents. At some sites, seeds may have been long buried in sediments used in beach nourishment projects. This hypothesis requires that seeds can remain viable after prolonged off-shore burial, an unknown factor. In Maryland's Assateague Island National Seashore, the NPS has allowed a previously stabilized foredune system to return to more natural conditions. This change in beach management and the possible existence of a persistent seed bank have been cited as factors in the species' return to the area (Ramsey et al. 2000).

The current range of naturally occurring seabeach amaranth is from Water Mill Beach on Long Island, New York, south to Dewees Island in South Carolina; a few reintroduction efforts south of Dewees Island have been unsuccessful (Young 2001; Hamilton 2000a; E. Eudaly, U.S. Fish and Widllife Service, Charleston, South Carolina , personal communication 2008).

Life History - Seabeach amaranth occupies a highly specific and restricted niche as a "fugitive" species in the narrow upper beach zones of newly formed, accreting barrier island ends and non-eroding beach strands. A dynamic, early successional pioneer species, seabeach amaranth is termed a "fugitive" because its populations are constantly shifting to newly disturbed areas. The plant is eliminated from existing habitats by competition and erosion, and colonizes newly formed habitats by dispersal and (probably) long-lived seed banks. A poor competitor, seabeach amaranth is eliminated from sites where perennials have become established, probably because of root competition for scarce water and nutrient supplies (Weakley and Bucher 1992). Seabeach amaranth acts as a capable sand binder (Weakley and Bucher 1992), which is typical of pioneer beach plants. The species is not likely to be a young or recently evolved species, considering its isolation within the genus (it has no apparently close relatives) and its possession of numerous adaptations to the peculiar environment in which it grows (Service 1996b).

Seabeach amaranth habitat exists in dynamic conditions. The same physical forces (e.g., storms, extreme high tides) that create the plant's specific and ephemeral coastal habitat also destroy it. Coastal storms are probably the single most important natural limitation on the abundance of seabeach amaranth. Existing habitat is eroded away, but new habitat is created by island overwash and breaching. Therefore, seabeach amaranth requires extensive areas of barrier island beaches and inlets, functioning in a relatively natural and dynamic manner. Such conditions allow the species to move around in the landscape, occupying suitable habitat as it becomes available (Service 1996b).

Density and Distribution - Density of seabeach amaranth is extremely variable within and between populations. The species generally occurs in a sparse to very sparse distribution pattern, even in the most suitable habitats. A typical density is 100 plants per linear km of beach, though occasionally on accreting beaches, dense populations of 1,000 plants per km can be found. Island-end sand flats generally have higher densities than oceanfront beaches (Weakley and Bucher 1992). Comparing overwash flats, accreting barrier island ends, and lower foredunes, Chicone (undated) found that seabeach amaranth plants growing in foredune habitats tended to be larger, healthier, and have fewer associates. Seabeach amaranth has a strongly clumped distribution (Hancock 1995).

Within its primary habitats, seabeach amaranth tends to be concentrated in the line of wrack material deposited by high tides (Mangels 1991, Weakley and Bucher 1992, Hancock 1995, McAvoy 2000). Observations from New Jersey and Maryland suggest that plants within the wrack line tend to be larger (Service 2002b). Pauley et al. (1999), however, found that plots centered on seabeach amaranth had a lower percent area covered by litter material than random plots, suggesting that litter material may be an advantageous microhabitat for seabeach amaranth only when it contains higher levels of organic material and moisture than bare sand, as in the wrack line.

Life Cycle and Phenology - Individual plants live one season, with a single opportunity to produce seed. The species over-winters entirely as seeds. Germination of seedlings begins in April and continues at least through July. In the northern part of the range, germination occurs slightly later, typically late June through early August. Reproductive maturity is determined by size rather than age, and flowering begins as soon as plants have reached sufficient size. Flowering sometimes begins as early as June in the Carolinas, but more typically commences in July and continues until the death of the plant. Seed production begins in July or August and reaches a peak in most years in September. Seed production likewise continues until the plant dies. Senescence and death occur in late fall or early winter (Service 1996b).

Seabeach amaranth seems capable of essentially indeterminate growth (Weakley and Bucher 1992). However, predation and weather events, including rainfall, hurricanes, and temperature extremes, have significant effects on the length of the species' reproductive season. As a result of one or more of these influences, the flowering and fruiting period can be terminated as early as June or July (58 FR 18035).

Reproduction - As an annual, seabeach amaranth reproduces solely by sexual reproduction by seed, with no vegetative or clonal form of reproduction. The species is monoecious (male and female flowers on the same plant), and, based on morphology of the flower and inflorescence, most likely wind pollinated. Seabeach amaranth is capable of self fertilization, an advantageous adaptation for a pioneer species, allowing the founding of a new colony by a single propagule. Self fertilization likely plays a large, probably dominant, role in seed production (Weakley and Bucher 1992). Once it reaches maturity, seabeach amaranth flowers and fruits continuously until death or senescence. Late season plants may continue flowering and fruiting with few or no leaves, sometimes producing an aberrant, dense, terminal inflorescence (Weakley and Bucher 1992). Even very small plants produce flowers under conditions of a short (12-hour) photoperiod (Jolls and Sellars 2000), likely an opportunistic adaptation to permit small, late germinating plants to reproduce at the end of the growing season.

Nearly all adult seabeach amaranth plants produce seeds, and fertility is assumed to be high (Weakley and Bucher 1992). Fruit production is correlated with plant weight (Hancock 1995), and large plants are estimated to produce several thousand fertile seeds over a fruiting season (Weakley and Bucher 1992). Within the genus *Amaranthus*, this is a low reproductive rate, but seabeach amaranth has apparently evolved a strategy of producing fewer, larger seeds than other members of its genus. Under favorable conditions, seabeach amaranth shows good reproductive success (Weakley and Bucher 1992).

Seed Dispersal - Seabeach amaranth seeds are dispersed by a variety of mechanisms. The fleshy tissues and air pocket of the utricle cause the fruit to have a lower density than the bare seed.

Seeds retained in utricles are easily blown about, deposited in depressions, the lee behind plants, or in the surf. Naked seeds are also commonly encountered in the field, and are also dispersed by wind, but to a much lesser degree than seeds retained in utricles. Naked seeds tend to remain in the lee of the parent plant or get moved to nearby depressions (Weakley and Bucher 1992). Observations from South Carolina indicate that seabeach amaranth seeds are also dispersed in the guts of birds and deposited with their droppings (Hamilton 2000b).

Many utricles remain attached to the parent plant and are never dispersed, leading to *in situ* "planting." This phenomenon has also been observed in sea rocket (*Cakile edentula*), and may be an adaptation to dynamic beach conditions. If conditions remain favorable at the site of the parent plant, the seed source for retention of that site is guaranteed. If conditions become unsuitable, other seeds have been dispersed to colonize new sites (Weakley and Bucher 1992).

<u>Germination</u> - Fresh seabeach amaranth seeds are physiologically dormant (Baskin and Baskin 1994, 1998). The tough seedcoat requires some physical modification before germination can occur. The primary mechanism(s) for breaking seed dormancy in the field is not known, but possible factors include abrasion, cold, imbibing water, and gradual breakdown over time (Weakley and Bucher 1992; Hancock 1995; Baskin and Baskin 1994, 1998; Hamilton 2000c; Jolls and Sellars 2000). Once dormancy is broken, light and high temperatures (25-35°C) are required for germination (Hancock 1995, Baskin and Baskin 1994, 1998). This high temperature requirement causes seabeach amaranth to germinate later in the season than other dune associates, and limits the time in which new seedlings can grow. Rainfall is also significant in promoting germination (Hancock 1995).

Initial studies have found that seabeach amaranth seedlings cannot emerge from a depth of more than 1 (Hancock 1995) or 2 cm (Service 2002b). Results of these studies, combined with the finding that light is required for germination, are strong evidence that deep burial may completely prevent germination and seedling emergence (Jolls et al. 2001). Seabeach amaranth may have less opportunity to emerge and become established compared to other dune species such as sea rocket, as mean emergence of seedlings (growth rate of the newly sprouted seed) is less than predicted for the species' seed mass (Hancock 1995).

<u>Natural Limiting Factors</u> - Except where suitable habitat has persisted long enough for perennials to become established, the primary limiting factors of seabeach amaranth under natural conditions are abiotic. Abiotic limiting factors are expected for a fugitive species that occupies dynamic, early successional habitats. Weather is an important limiting factor, given the relatively narrow temperature and rainfall requirements for germination and seedling establishment. Flooding, drought, or unseasonable temperatures may impair survival and reproduction. Weather also limits abundance through wind, which may cause burial of seeds and plants by sand. In addition to decreasing germination and seedling establishment, burial may also impact reproduction by covering adult plants prior to seed set. This effect was observed in South Carolina (Hamilton 2000b) and may have occurred in Maryland (Service 2002b).

Under natural conditions interspecific competition for water and nutrients, especially with perennials, may be a significant biotic limiting factor of seabeach amaranth. Weakley and Bucher (1992) cite intraspecific competition as a possible factor in the mortality of young plants, but Hancock (1995) found no evidence of intraspecific density effects. If intraspecific competition limits seabeach amaranth abundance its effects are likely small compared to the effects of competition with perennial species, which possess superior abilities to extract water and nutrients from porous sand. Predators and disease are discussed below under threats.

Population Dynamics - Although the longevity of seabeach amaranth seeds is unknown, several lines of evidence suggest that seed banks may be an important factor in this species' life history (Weakley and Bucher 1992, Baskin and Baskin 1998). The relative roles of fresh and banked seeds are unknown (Service 1996b). In experimental plots in Maryland, a few late-season seedlings emerged from the current year's seed crop (Service 2002b); however the contribution of same-season seed to the current year's population and seed crop is likely small. For a sexually reproducing annual plant, natality is comprised of two components, the seed production rate (or fecundity) and the germination rate.

The viability rates of both fresh and banked seeds are uncertain; more is known about mortality of the plants. Substantial mortality of young plants occurs in some years, prior to reproduction. Hancock (1995) found seven percent survival of seedlings to 40 days of age, with mortality caused primarily by high tide flooding. Flooding resulted in almost 100 percent mortality of propagated plants at three of six experimental transplant sites in South Carolina in 1999. At a fourth site, drifting sand covered most of the transplants, with 10 of 196 plants (about 5 percent) surviving to produce seed (Hamilton 2000b). Burial by blowing sand may have also affected reproduction in New Jersey and Maryland in 2000 (Service 2002b). Unfavorable conditions early in the growing season, including drought, burial, and especially flooding and other storm damage, may reduce seed production by 90 (Weakley and Bucher 1992) to 98 percent (Hancock 1995).

Once past the stage of germination and early growth, mortality rates are generally lower. In the Carolinas, mortality of older plants tends to be caused primarily by webworm predation (Weakley and Bucher 1992). Larger plants may be able to withstand saltwater inundation better than smaller plants; however, prolonged salt water inundation kills almost all plants, regardless of size (Hancock 1995). Storms later in the growing season can effectively and abruptly curtail reproduction for the year (Weakley and Bucher 1992). Plants that have not died from other causes senesce and die in late fall or early winter.

Genetic Variability - Preliminary results from two initial genetic studies of seabeach amaranth suggest that the species' genetic variability is low. A study by Salisbury State University looked for genetic differences in nuclear DNA within and across three groups: propagated plants from Maryland, wild plants from Maryland, and wild plants from Delaware. Overall, genetic variability was low. Wild and propagated Maryland plants were similar, as might be expected, since the propagated plants were produced from wild plants taken from the same area (Service 2002b). Higher levels of genetic variability were found within the sample of plants from

Delaware. A second study by Strand (2002) analyzed non-coding regions of nuclear and chloroplast DNA taken from seed and dry leaf samples from New York, New Jersey, North Carolina, and South Carolina. This study found no observable genetic variation among any of the samples. Although the results of these two studies are consistent, these results must be interpreted with caution. Lack of detection does not prove a lack of genetic variability, which might be present in other regions of the genome, or detectable through other techniques (Jolls and Sellars 2000, Strand 2002, Service 2002b).

Population Status and Distribution - As might be expected for a fugitive annual plant of dynamic barrier beach habitats, populations of seabeach amaranth at any given site are extremely variable (Weakley and Bucher 1992). Population size at a site often fluctuates by several orders of magnitude from year to year. The primary reasons for the natural variability of seabeach amaranth are the dynamic nature of its habitat, and the significant effects of stochastic factors such as weather and storms on mortality and reproductive rates. Although wide fluctuations in species populations tend to increase the risk of extinction, variable population sizes are a natural condition for seabeach amaranth, and the species is well adapted to its ecological niche.

Because variability in population size is so great among years, a single survey is a poor measure of a population's health. Assessing site-specific population trends is difficult even with several years of surveys. Weakley and Bucher (1992) suggest that a 5 to 10 year average is a more meaningful measure for assessing the vigor of a seabeach amaranth population. However long-term, consecutive, annual data are available for only a few sites in New York. Estimates of population sizes for seabeach amaranth across its range are imprecise, given available survey data. Early (pre-1987) survey data are limited. Rangewide surveys were conducted in 1987, 1988, and 1990 (excluding states where the species was considered extirpated at the time). Annual statewide surveys have been conducted subsequently in New York, but no comprehensive surveys in North or South Carolina have been carried out since 1990. Suitable areas in New Jersey, Delaware, and Maryland were thoroughly surveyed in 2000, but these efforts did not necessarily extend state-wide. Approximately 14 locations in Virginia were surveyed in 2000, and no seabeach amaranth was found (Belden 2000). In 2001, seabeach amaranth was found on Assateague Island, Virginia, most likely the result of a restoration program in Assateague Island National Seashore in Maryland (Service 2002b).

Since 2000, the number of plants in each state has fluctuated greatly (Table 2). In Delaware numbers have always been low, with a high count for 2002 of 423 plants. New York has always produced the highest number of plants, with the 2000 numbers also being the highest count for the state (244,608 plants). In 2006, 1,551 plants were counted in Maryland and Virginia. Of these 1,551 plants, all but 13 were found on the Maryland side of Assateague Island. Numbers of plants within CNWR (see Virginia numbers in Table 2) have experienced major fluctuations since the species' rediscovery in 2001.

Factors Affecting the Species

Habitat Loss and Degradation - In the geologic past, seabeach amaranth has persisted through even relatively rapid episodes of sea level rise and barrier island retreat. A natural barrier island landscape, even a retreating one, contains localized accreting areas, especially in the vicinity of inlets (Service 1996b).

Erosion is accelerated in many areas by human-induced factors such as reduced sediment loads reaching coastal areas due to damming of rivers and beach stabilization structures. When the shoreline is "hardened" by artificial structures (e.g., seawalls, bulkheads) overwash and inlet formation is curbed. Erosion may also be increasing due to sea level rise and increased storm activity caused by global climate change (58 FR 18035).

Table 2. Seabeach amaranth numbers by year and state.

Year	New York	Delaware	New Jersey	Maryland	Virginia	North Carolina	South Carolina	Total
1987	0	0	0	0	0	3,395	1,341	4,736
1988	0	0	0	0	0	4,433	1,800	6,233
1989	0	0	0	0	0	0	0	0
1990	331	0	0	0	0	1,127	188	1,646
1991	2,251	0	0	0	0	1,170	0	3,421
1992	422	0	0	0	0	32,160	15	32,597
1993	195	0	0	0	0	22,214	0	22,409
1994	182	0	0	0	0	13,964	560	14,706
1995	599	0	0	0	0	33,514	6	34,119
1996	2,263	0	0	0	0	8,357	0	10,620
1997	11,918	0	0	0	0	1374	2	13,294
1998	10,699	0	0	2	0	11,490	141	22,332
1999	31,196	0	0	1	0	588	196	31,981
2000	244,608	32	1,039	4	0	103	2,312	248,098
2001	205,233	83	5,813	869	9	5037	231	217,275
2002	193,412	423	10,908	801	56	4440	0	210,040
2003	114,535	13	5,084	459	22	11,290	1,381	132,784
2004	30,942	4	6,820	531	2	11,213	2,110	51,622
2005	16,813	6	5,795	489	69	19,976	671	43,819
2006	32,553	40	6,522	1,538	13	3,190	721	44,577
2007	3,914	19	2,189	2176	3	872	60	9233
2008	4,416	40	1,139	1041	7	1,575	11,786	19974

Attempts to halt beach erosion through hard structures (i.e., sea walls, jetties, groins, bulkheads) appear invariably to destroy habitat for seabeach amaranth. In the Carolinas, seabeach amaranth is not found on shorelines where bulkheads, sea walls, or rip rap zones have been constructed. Such armoring generally occurs in the primary habitat of the plant, and water and wind erosion lower the profile of the beach seaward of the armoring. The upper beach habitat required by seabeach amaranth (above inundation by tidal action) ceases to exist as the beach is steadily eroded. Groins have mixed effects on seabeach amaranth. Immediately updrift from a groin, accretion sometimes provides or maintains, at least temporarily, habitat for seabeach amaranth; immediately downdrift, erosion usually destroys seabeach amaranth habitat. In the long term, groins (if they are successful) stabilize updrift beaches, allowing succession to perennials, and rendering even the updrift side only marginally suitable for seabeach amaranth. Widespread construction of sea walls, jetties, and other hard stabilization structures in New Jersey, New York, and other northern states is associated with the extirpation of seabeach amaranth from the northern part of its range (Service 1996b).

Even minor structures and non-structural beach stabilization techniques, such as sand fences and beachgrass planting, are generally detrimental to seabeach amaranth (58 FR 18035). Dune stabilization and vertical sand accretion caused by sand fences appear to be detrimental to seabeach amaranth. The effects of dune stabilization by planting vegetation are similar (Service 1996b). Seabeach amaranth very rarely occurs when sand fences and vegetative stabilization have taken place and, in these situations, is present only as rare, scattered individuals or short-lived populations (Weakley and Bucher 1992).

Beach nourishment can have positive site-specific impacts on seabeach amaranth. Although more study is needed before the long-term impacts can be accurately assessed, seabeach amaranth has colonized several nourished beaches and has thrived in some sites through subsequent re-applications of fill material (58 FR 18035). However, on the landscape level, beach nourishment is similar to other beach stabilization efforts in that it stabilizes the shoreline and curtails the natural geophysical processes of barrier islands. These effects are detrimental to the rangewide persistence of the species. In addition, beach nourishment may cause site-specific adverse effects by crushing or burying seeds or plants, or by altering the beach profile or upper beach micro-habitats in ways not conducive to colonization or survival. Deeply burying seeds during any season can have serious effects on populations; this also applies to the placement of dredge spoil (Service 1996b). Burial of the seed bank may be particularly detrimental to isolated populations, as no nearby seed sources are available to re-colonize the nourished site. Adverse effects of beach nourishment may be compounded if accompanied by artificial dune construction and stabilization with sand fencing and/or beach grass, or if followed by high levels of erosion and scarping of the upper beach.

As a fugitive species dependent on a dynamic landscape and large-scale geophysical processes, seabeach amaranth is vulnerable to habitat fragmentation and isolation of small populations (58 FR 18035). Rendering 50 to 75 percent of a coastline permanently unsuitable may doom seabeach amaranth, because any given area will become unsuitable at some time due to natural forces. If a seed source is no longer available in the vicinity, seabeach amaranth will be unable to reestablish itself when the area once again provides suitable habitat. In this way, the species can be progressively eliminated even from generally favorable stretches of habitat surrounded by permanently unfavorable areas. Fragmentation of habitat in the northern part of the species range contributed to the regional extirpation during the last century. Areas of suitable habitat were separated from one another by distances too great to allow recolonization following natural catastrophes (Weakley and Bucher 1992).

Recreational Impacts - Intensive recreational use of beaches can threaten seabeach amaranth populations, both through direct damage and mortality of plants and by impacting habitat. Light pedestrian traffic, even during the growing season, usually has little effect on seabeach amaranth (58 FR 18035). Substantive impacts generally occur only on narrow beaches or beaches which receive heavy recreational use. In such areas, populations are sometimes eliminated or reduced by repeated trampling. While pedestrian traffic appears to be a minor problem in the Carolinas, the heavier traffic borne by northern beaches near major population centers may have been partially responsible for the past extirpation of seabeach amaranth in those regions (Service 1996b).

Vehicle use on the beach during the growing season can have detrimental effects on the species, as the fleshy stems of this plant are brittle and easily broken. Plants generally do not survive even a single pass by a truck tire (Weakley and Bucher 1992). Sites where vehicles are allowed drive on beaches often show severe population declines. Dormant season vehicle use has shown little evidence of significant detrimental effects, unless it results in massive physical erosion or degradation of the site, such as compacting or rutting of the upper beach. In some cases, winter vehicle traffic may actually provide some benefits for the species by setting back succession of perennial grasses and shrubs with which seabeach amaranth cannot compete successfully. However, extremely heavy vehicle use, even in winter, may have some negative impacts, including pulverization of seeds (Weakley and Bucher 1992).

Beach grooming, more common on northern beaches, may also have contributed to the previous extirpation of seabeach amaranth from that part of its range. Motorized beach rakes, which remove trash and vegetation from bathing beaches, do not allow seabeach amaranth to colonize long stretches of beach (Service 1996b). In New Jersey, plants were found along a nearly continuous length of beach, noticeably interrupted by stretches that are routinely raked.

Herbivory - Predation by webworms (caterpillars of small moths) is a major source of mortality and lowered fecundity in the Carolinas, often defoliating plants by early fall (58 FR 18035). Defoliation at this season appears to result in premature senescence and mortality, reducing seed production, the most basic and critical parameter in the life cycle of an annual plant. Webworm predation may decrease seed production by more than 50 percent (Weakley and Bucher 1992). In the Carolinas, four species of webworm collected from seabeach amaranth have been identified: beet webworm (*Loxostege similialis*), garden webworm (*Achyra rantalis*), southern beet webworm (*Herpetogramma bipunctalis*), and Hawaiian beet webworm (*Spoladea recurvalis*). Webworm herbivory of seabeach amaranth has not been documented in Delaware or

Maryland. Although the four webworms so far identified on seabeach amaranth are native species, their use of barrier islands has probably been altered by changes in the coastal plain landscape (i.e., extensive agricultural use), development of barrier islands, and introduction of weedy plants that can also serve as host plants. All four webworms are probably much more abundant now than in pre-Columbian times. For this reason, the level of predation that seabeach amaranth is experiencing is likely unnaturally high (Service 1996b). Webworm herbivory is probably a contributing, rather than a leading factor in the decline of seabeach amaranth. However, in combination with extensive habitat alteration, severe herbivory could threaten the existence of the species (Weakley and Bucher 1992).

Utilization and Collection - Seabeach amaranth is generally not threatened by over-utilization or collection, as it does not have showy flowers and is not a component of the commercial trade in native plants. However, because the species is easily recognizable and accessible, it is vulnerable to removal, vandalism, and incidental trampling by curiosity seekers. Seabeach amaranth is an attractive and colorful plant, with a prostrate growth habit that could lend itself to planting on beach front lots. The species' effectiveness as a sand binder could make it even more attractive for this purpose. In addition, seabeach amaranth is being investigated by the USDA and several universities and private institutes for its potential use in crop development and improvement. Over-collection and the development of genetically altered, domesticated varieties are potential, but currently unrealized, threats to the species (58 FR 18035).

New Threats - New threats have been documented since the species was listed in 1993. These factors are lesser threats than habitat modification, but may increase the risk of extinction by compounding the effects of other, more severe threats.

Several additional herbivores of seabeach amaranth have been observed including deer (*Odocoileus virginianus*), Sika deer/elk (*Cervus nippon*), eastern cottontail (*Sylvilagus floridanus*), and migratory song birds (Van Schoik and Antenen 1993), as well as feral horses in Maryland (Service 2002b). Hancock (1995) suggests that grasshoppers may feed on seabeach amaranth, but does not indicate whether this was actually observed. There is also strong circumstantial evidence for seabeach amaranth herbivory by grasshoppers (Service 2002b). Minor insect damage was noted on a few New Jersey plants in 2000, and larval insects were observed feeding on seabeach amaranth in 2001; to date, no species have been identified. In addition, a cluster of New Jersey plants appeared to have been damaged by a congregation of loafing gulls (*Larus* spp.), based upon feathers and droppings. As with webworms, the abundance of these newly documented predators on barrier islands is increased by human activities.

Asiatic sand sedge (*Carex kobomugi*) has been suggested as another potential threat. This sedge is strongly rhizomatous and dune-forming (NPS and Maryland Natural Heritage Program 2000). Asiatic sand sedge was introduced to the east coast (New Jersey to Virginia) from East Asia in the 1930s for erosion control and as a sand stabilizer. The species is known to crowd out native dune species (Virginia Department of Conservation and Recreation and Virginia Native Plant Society undated). Asiatic sand sedge may be detrimental to seabeach amaranth by direct competition, and by reducing habitat suitability through sand stabilization and dune building. Control programs have been implemented in managed natural areas where this species occurs.

The first known disease of seabeach amaranth was documented in South Carolina in 2000. During the 2000 growing season, a fungus (*Albugo* sp.) was observed on seabeach amaranth in several South Carolina sites (Strand and Hamilton 2000). This pathogen is a white rust or water mold. Lesions developed on the leaves during flowering, starting in July; leaves later fell off (Service 2002b). Effects on infected individuals were significant, resulting in death of the plants two to four weeks after lesions were first observed. Anecdotal observations suggest that isolated plants tended to avoid infection (Strand and Hamilton 2000).

Rangewide Trends - Total population trends can disguise important regional trends. Recent population increases have occurred almost entirely in the northern part of the species' range (Table 2). Seabeach amaranth has undergone a geographic expansion, reappearing in five states over 11 years, after decades of extirpation from the entire northern portion of its range. New York sites account for virtually all of the recent increases in total population size rangewide, offsetting lower numbers in the south. Although natural population variability and survey effort must be considered, the recent trend in North Carolina appears downward. The low 1999 and 2000 plant totals in that state are especially noteworthy given the relatively high survey effort in these years (approximately 75 percent of known sites visited). In South Carolina, the species experienced a 90 percent reduction in that state following 1988 storms, including Hurricane Hugo. However, survey efforts since 1998 suggest that populations may have recovered in some areas of South Carolina.

Despite the natural variability of seabeach amaranth's population size and distribution and inconsistent survey efforts, some trends can be discerned from the available data. The species has undergone a significant geographic expansion, both in terms of the number and distribution of occupied states and counties. Since the first intensive surveys in 1987, the species' extant range has increased approximately 650 km (404 miles) to the north, but contracted about 50 km (31 miles) to the south. Numerically, the population has seen a dramatic increase. Equally notable is the geographic shift of the species' stronghold (in terms of total numbers) from North Carolina to New York.

Despite the geographic expansion and booming New York populations, seabeach amaranth is still vulnerable to local and regional extirpation. The primary threat to seabeach amaranth, habitat alteration, has not significantly diminished since the species was listed and new threats have been subsequently discovered. Small population sizes in many locations increase the risk that seabeach amaranth will become locally extirpated. Almost 44 percent of sites documented in 2000 contained fewer than 10 plants, including more than 60 percent of sites in North Carolina (Hamilton 2000a; Jolls and Sellars 2000; McAvoy 2000; NPS 2001a, 2001b; U.S. Army Corps of Engineers 2001; Young 2001).

One final trend of note is the propagation of seabeach amaranth in greenhouses and laboratories and the transplanting of propagated individuals or seed back into the wild. Such programs have been undertaken in Delaware, Maryland, North Carolina, and South Carolina (McAvoy 2000, NPS and Maryland Natural Heritage Program 2000, Jolls and Sellars 2000, Hamilton 2000b). These efforts have met with mixed results; thus a long term trend cannot be predicted.

LOGGERHEAD SEA TURTLE, GREEN SEA TURTLE, and LEATHERBACK SEA TURTLE

The loggerhead sea turtle was listed as threatened in the U.S. in 1978 (National Marine Fisheries Service [NMFS] and Service 1991a), the green sea turtle was listed as endangered in 1978 (NMFS and Service 1991b), and the leatherback sea turtle was listed as endangered in 1970 (NMFS and Service 1992). In March 2010, the Service and NMFS published a proposed rule in the Federal Register to recognize nine distinct populations of loggerhead sea turtles worldwide. Under this proposed rule, the loggerhead sea turtle population that would be affected by the proposed actions is the north Atlantic population and it is proposed to be listed as endangered (72 FR 12598). There is designated critical habitat outside of Virginia for the green and leatherback sea turtles, but none has been designated for the loggerhead sea turtle.

This account emphasizes sea turtle nesting and breeding biology, which is the subject of this biological opinion. Additional information about the life history of these sea turtle species and their habitat use, behavior, and survival at sea can be found in other documents, including the recovery plans (NMFS and Service 1991a, 1991b, 1992), five-year statues reviews (NMFS and Service 2007a, 2007b, 2007c), and other sources (National Research Council 1990).

Species Description - The loggerhead is the smallest of the three turtles, with a mean carapace length of 92 cm and a mean mass of 133 kg (NMFS and Service 1991a), compared to 102 cm and 136 kg for the green sea turtle (National Research Council 1990). Green sea turtles nest primarily in the tropics and are rarer nesters at higher latitudes, while loggerheads have significant nesting populations outside the tropics (National Research Council 1990). Leatherback sea turtles are the largest turtle and the largest living reptile in the world. Mature males and females can be as long as 6.5 feet (2 m) and weigh almost 2,000 pounds (900 kg). The leatherback is the only sea turtle that lacks a hard, bony shell. The U.S. Caribbean, primarily Puerto Rico and the U.S. Virgin Islands, and southeast Florida support minor nesting colonies of the leatherback, but represent the most significant nesting activity within the U.S. (James et al. 2005).

Life History and Population Dynamics - Loggerhead females are believed to reach sexual maturity at a minimum age of 30 years (Snover 2002). At the start of the breeding season, they migrate from foraging areas on the continental shelf to mating areas in the waters near their nesting beaches (Schroeder et al. 2003). Reproductive females exhibit the desire to return to their birthplace to lay their eggs (Miller et al. 2003). Females may be inseminated by multiple males (Bollmer et al. 1999). After mating, males return to their foraging areas while females remain in the waters near their natal beaches to emerge onto their nesting beaches to lay eggs. The following account of nesting biology is a synopsis of Miller et al. (2003).

Loggerhead females tend to nest on high wave energy, sandy ocean beaches. Gravid females emerge from the wash zone and crawl toward the dune line until they encounter a suitable nest site, typically on open sand at the seaward base of a dune, but sometimes in vegetation. The female clears away surface debris with the front flippers, creating a "body pit," then excavates a flask-shaped nest cavity with her hind flippers. Loggerheads lay an average of 112 eggs per nest. After laying, the female covers the nest with sand using all four flippers. Once the nest-covering phase is complete, she crawls back into the sea. Individual females may nest 1 to 6 times per nesting season, at intervals of 12-16 days, during the late spring to late summer. Intervals between nesting shorter than 10 days indicate that the previous nest attempt was likely aborted due to disturbance. Mature loggerheads nest every two to three years, on average (Schroeder et al. 2003). Nest incubation period (from laying to hatching) depends on temperature and ranges from 48 to 90 days at the extremes. Emergence of hatchlings from the nest cavity usually occurs within four days of hatch, but may take up to two weeks longer. Hatchling emergence from nests usually occurs at night when temperatures are lower and diurnal predators are inactive. Hatching success typically approaches 80percent; after hatchlings leave the beaches, they typically fall prey to a variety of predators, including birds, fish, and sharks (National Research Council 1990).

Sex ratio of hatchlings depends on temperature during incubation. Below 84° Fahrenheit (29° Celsius), more males are produced than females and above that temperature more females are produced (Carthy et al. 2003). Furthermore, fluctuating incubation temperatures often produce more females than stable temperatures, and temperature, hydration, and gas exchange during incubation can determine hatchling size, early swimming behavior, growth rate, and hatchling robustness (Carthy et al. 2003). Newly emerged hatchlings immediately head for the sea, most likely orienting toward the water by moving toward the brightest horizon and away from dark silhouettes (Lohmann and Lohmann 2003). Sea turtles are most negatively sensitive to blue and green light and loggerheads in particular are averse to yellow light (Witherington and Martin 1996). Once in the sea, hatchling loggerheads swim into the waves and eventually enter the open ocean, where they will spend the first 6.5 to 11.5 years of their lives primarily at the top of the water column, until finally moving to foraging areas on the continental shelf (Bolten 2003).

Green sea turtles nest in two, three, or four year intervals, and may lay as many as nine clutches within a nesting season (NMFS and Service 1991b). Clutch size varies from 75-200 eggs, and incubation ranges from about 45-75 days (NMFS and Service 1991b).

Leatherback sea turtles nest in two to three year intervals, and average five to seven clutches per nesting season (NMFS and Service 1992). Leatherbacks average fewer eggs per clutch, 70-80 eggs, and incubation ranges from 55-75 days (NMFS and Service 1992).

Nesting habitat - Less is known about factors that cue nest site selection than about anthropogenic disturbances that discourage nesting (Miller et al. 2003). Typical nesting areas are sandy, wide, open beaches backed by low dunes, with a flat, sandy approach from the sea (Miller et al. 2003). Nesting is nonrandom along the shoreline, but studies of the physical characteristics associated with nests versus random or non-nesting sites on the beach have produced varying results. Some factors found to determine nest selection are beach slope (3 of 3 studies), temperature (2 of 3 studies), distance to ocean (1 of 3 studies), sand type (2 of 2 studies), and moisture (1 of 3 studies), although the results were occasionally contradictory (Miller et al. 2003). Data indicates that the leatherback sea turtle prefers beaches with proximity to deep water and generally rough seas (NMFS and Service 1992). Other factors examined but not found to be significant were sand compaction, erosion, pH, and salinity. Although the process of nest site selection is not well understood, a successful nest must be laid in a low salinity, high humidity, and well-ventilated substrate that is not prone to flooding or burying due to tides and storms and where temperature is optimal for development (Miller et al. 2003).

Status and Distribution – Approximately 58,000 loggerhead nests were estimated in the U.S. Atlantic in 1983 (NMFS and Service 1991a) and between 53,000 and 92,000 nests from 1989 to 1998 (Turtle Expert Working Group 2000). Within the northern subpopulation (north Florida to Virginia), studies in South Carolina and Georgia have documented a decline in number of nests (Ehrhart et al. 2003). Based on genetic evidence, male loggerheads disperse freely among sites within the U.S. Atlantic population, while females are faithful to their natal sites (Bowen et al. 2005). Because sex ratio is determined by temperature during incubation (Miller et al. 2003), the northern part of the U.S. Atlantic population, which includes Virginia, apparently provides a disproportionate number of males to the larger population (Mrosovsky et al. 1984, Hanson et al. 1998, Hawkes et al. in review).

"Analyses of historic and recent abundance information by the Marine Turtle Specialist Group (MTSG) indicate that extensive population declines for the green sea turtle have occurred in all major ocean basins. The MTSG analyzed population trends at 32 index nesting sites around the world and found a 48-65percent decline in the number of mature females nesting annually over the past 100-150 years. The two largest nesting populations of green turtles are found at Tortuguero, on the Caribbean coast of Costa Rica, and Raine Island, on the Great Barrier Reef in Australia, where an annual average of 22,500 and 18,000 females nest per season, respectively. In the U.S., green turtles nest primarily along the central and southeast coast of Florida; present estimates range from 200 - 1,100 females nesting annually." (NMFS 2008). In the southeast U.S., the majority of green turtle nesting occurs in Florida. The green turtle nesting population of Florida appears to be increasing based on 19 years (1989-2007) of index nesting data from throughout the state (http://research.myfwc.com/features/view_article.asp?id=27537).

"Because adult female leatherbacks frequently nest on different beaches, nesting population estimates and trends are especially difficult to monitor. In the Pacific, the International Union for the Conservation of Nature (IUCN) notes that most leatherback nesting populations have declined more than 80. In other areas of the leatherback's range, observed declines in nesting populations are not as severe, and some population trends are increasing or stable. In the Atlantic, available information indicates that the largest leatherback nesting population occurs in French Guyana, but the trends are unclear. Some Caribbean nesting populations appear to be increasing, but these populations are very small when compared to those that nested in the Pacific less than 10 years ago. Nesting trends on U.S. beaches have been increasing in recent years." (NMFS 2008). Similar to the green turtle, in the southeast U.S., the majority of leatherback nesting occurs in Florida. The leatherback nesting population of Florida appears to be increasing based on 19 years (1989-2007) of index nesting data from throughout the state (http://research.myfwc.com/features/view_article.asp?id=27537).

<u>Factors Affecting the Species</u> – Numerous factors affect sea turtle growth, survival, and behavior while at sea from when they leave natal beaches as hatchlings until they mature and return to beaches to breed. These factors are discussed in detail in the 5-year status reviews for the three turtle species (NMFS and Service 2007a, 2007b, 2007c). The discussion herein is limited to factors affecting turtle nesting. Threats to the loggerhead sea turtles on the nesting grounds are similar to those faced by the green and leatherback sea turtles. The following threats affect all three species, though there may be some differences in susceptibility among the three turtle species.

Weather and Tides - Storm events may erode beaches and destroy nests or cause nest failure due to flooding or piling of eroded sand on the nest site. Beach erosion due to wave action may also decrease the availability of suitable nesting habitat (Steinetz et al. 1998), leading to a decline in nesting rate on a particular beach. Sea level rise, often in combination with human development along beaches, is contributing to erosion, changes in beach characteristics, and more intensive management of many beaches

Predation - Predation of eggs and young by mammals, birds, and ghost crabs may eliminate up to 100 percent of the nests and any hatchlings that emerge on beaches where predation is not managed (National Research Council 1990). This is a natural phenomenon that has always affected sea turtle populations, but due to reduced turtle population sizes, reduced turtle habitat availability, and unnatural population increases of nest predators in some areas, predation is a significant threat to remaining breeding populations and is actively controlled through predator exclusion and predator control on most beaches where turtles nest.

Human Activities - Crowding of nesting beaches by pedestrians can disturb nesting females and prevent laying (NMFS and Service 1991a). Furthermore, the use of flashlights and campfires may interfere with sea-finding behavior by hatchlings. Beach driving, including pedestrian traffic, vehicle use, and beach cleaning pose a risk of injury to females and live stranded turtles, can leave ruts that trap hatchlings attempting to reach the ocean (Hosier et al. 1981, Cox et al. 1994), can disturb adult females and cause them to abort nesting attempts, and can interfere with sea-finding behavior if headlights are used at night (NMFS and Service 1991a). Driving directly over incubating egg clutches can cause sand compaction, which may decrease hatching and emergence success and directly kill pre-emergent hatchlings (NMFS and Service 2007a). Artificial lighting on human structures may affect turtle behavior in a similar manner (Witherington and Martin 1996). Beach cleaning can directly destroy nests. Poaching is a problem in some countries and occurs at a low level in the U.S. (NMFS and Service 2007a). An increased human presence may also lead to an increase in the presence of domestic pets that can depredate nests and an increase in litter that may attract wild predators (National Research Council 1990).

The rate of habitat loss due to erosion and escarpment formation may be increased when humans attempt to stabilize the shoreline, either through renourishment (Dolan et al. 1973) or placement of hard structures such as sea walls or pilings (Bouchard et al. 1998). Vehicle traffic may alter the beach profile leading to steeper foredunes (Anders and Leatherman 1987), which may be unsuitable for nesting. Improperly placed erosion control structures such as drift fencing can act as a barrier to nesting females. Humans may also introduce exotic vegetation in conjunction with beach development, which can overrun nesting habitat, make the substrate unsuitable for digging nest cavities, invade nests and desiccate nests, or trap hatchlings.

Reduced nesting success on constructed/augmented beaches could result due to sand compaction, escarpment formation, and changes in the beach profile. Sand compaction has been shown to negatively impact sea turtles, particularly concerning beach nourishment projects. Research has shown that placement of very fine sand and/or the use of heavy machinery can cause sand compaction on nourished beaches (Nelson et al. 1987, Nelson and Dickerson 1988). Significant reductions in nesting success (i.e., false crawls occurred more frequently) have been documented on severely compacted nourished beaches (Nelson and Dickerson 1987, Nelson et al. 1987), and increased false crawls may result in increased physiological stress to nesting females. Sand compaction may also increase the length of time required to excavate nests and result in increased physiological stress (Nelson and Dickerson 1988).

ENVIRONMENTAL BASELINE

Status of the Piping Plover Within the Action Area - Piping plovers use wide sandy beaches on Metompkin, Assawoman, Wallops, and Assateague Islands for courtship and nesting. Suitable habitat has a variable distribution along the seaward edge of islands within the action area year to year due to the competing effects of erosion and vegetation succession. Annual piping plover production within the action area indicates that all islands possess some nesting habitat, with the greatest areas of suitable beach occurring on Assawoman Island and in the Hook, Overwash, and Public Beach portions of Assateague Island. Metompkin Island supports large numbers of plovers, with larger numbers occurring in the portion owned by The Nature Conservancy (TNC). Little potential habitat is available for plover nesting on the south end of Wallops Island, but the north end of Wallops Island has been rapidly accreting and appears to offer increasing quantities of wide sandy beach on which plovers may seek to nest.

CNWR, Virginia Department of Game and Inland Fisheries (VDGIF), TNC, and USDA Wildlife Services personnel conduct piping plover nest surveys on islands within the action area and observe fledgling production to determine fledgling production per nesting pair. Results of the 2005-2009 piping plover nest surveys within the action area are shown in the Tables 3-7 below. No nesting has been recorded within the Public Beach portion of Assateague Island since 2005.

Table 3. Piping Plover Nesting Trends-Assateague (Overwash), Island (Service 2009c).				
Year	Nesting Pairs	Nest Attempts	Chicks Fledged	Fledglings/Pair
2005	8	12	16	2.00
2006	8	10	4	0.50
2007	6	8	6	1.00
2008	6	6	5	0.84
2009	3	5	3	1.00

Table 4. Piping Plover Nesting Trends-Assateague (Hook), Island (Service 2009c).				
Year	Nesting Pairs	Nest Attempts	Chicks Fledged	Fledglings/Pair
2005	32	39	58	1.81
2006	27	30	37	1.37
2007	22	30	24	1.09
2008	30	36	21	0.70
2009	23	33	12	0.52

Table 5. Piping Plover Nesting Trends-Wallops Island (Service 2009c).				
Year	Nesting Pairs	Nest Attempts	Chicks Fledged	Fledglings/Pair
2005	2	5	0	0.00
2006	1	1	0	0.00
2007	3	3	0	0.00
2008	0	0	0	0.00
2009	4	5	10	2.50

Table 6. Piping Plover Nesting Trends- Metompkin Island (Boettcher 2005, 2007; Wilke and Boettcher 2006; Smith and Boettcher 2008; Smith et al. 2009).				
Year	Nesting Pairs	Nest Attempts	Chicks Fledged	Fledglings/Pair
2005	40	52	91	1.00
2006	49	51	82	1.61
2007	43	57	84	1.47
2008	60	48	59	0.98
2009	42	46	51	1.11

Table 7. Piping Plover Nesting Trends-Assawoman Island (Service 2009c).				
Year	Nesting Pairs	Nest Attempts	Chicks Fledged	Fledglings/Pair
2005	30	37	34	1.14
2006	23	25	28	1.22
2007	23	25	40	1.74
2008	26	35	30	1.15
2009	26	27	31	1.19

In addition to nesting, during migration most of the plovers that nest farther north within the Atlantic population likely pass through the action area. This may involve birds passing through in flight, but many of these birds may stop and roost or feed on the beaches, tidal flats, and overwash areas within the action area. Little is known about the extent of use of the action area by migrating plovers beyond knowledge that they use the area.

Status of Seabeach Amaranth Within the Action Area - Seabeach amaranth surveys have been conducted on Assateague Island 12 times since 1966, with nine of those surveys performed on an annual basis between 2001 and 2009. Assawoman Island and Metompkin Island were surveyed for the first time in 2009 and no plants were found. A single plant was discovered in the Hook portion of Assateague Island in 2004 and no additional occurrences are known within the action area. Seabeach amaranth routinely occurred on the Wild Beach portion of Assateague Island just north of the action area. As a fugitive species favoring loose unconsolidated sand, seabeach amaranth may appear at any location within the action area where newly created bare beach or dune habitat provides conditions suitable for germination. No surveys for this species have been conducted on Wallops Island to date, and the species has not been documented there, despite the presence of suitable habitat.

Status of Sea Turtles Within the Action Area - Loggerhead sea turtles are known to have occasionally nested within the action area. In mid-July 2008, a loggerhead nest was discovered by NASA personnel on north Wallops Island. Following flood inundation from several fall storms, CNWR personnel recovered approximately 170 eggs from the nest in October 2008. None were viable. In addition to this nest occurrence on WFF, a low level of sea turtle nesting has become relatively common on CNWR.

Although green sea turtles and leatherback sea turtles are not known to have nested within the action area, the action area falls within the geographic range in which both species have shown nesting behavior. In 1996, a leatherback was seen displaying nesting behavior in daylight on the Maryland portion of the Assateague Island National Seashore. Although a possible egg cavity was found on the beach, no eggs were discovered (Rabon et al. 2003). In 2006, a leatherback carcass was discovered on the southern tip of Assawoman Island at Gargatha Inlet.

A green sea turtle nest was recorded near Sandbridge, Virginia in 2005 outside of the action area (SeaTurtle.org 2006). However, the species is present within the waters of the action area and there may be potential for nesting within the action area.

Nesting behavior is most often detected by the presence of crawl tracks turtles leave in the sand as they traverse the beach. CNWR staff document evidence of sea turtle nesting within the action area as tracks are discovered and conduct surveys for turtle nesting primarily in conjunction with plover monitoring. The following table presents recorded nesting behavior for sea turtles within the action area (Service 2009d).

Table 8. Sea Turtle Nest Activity 1974-2009 (Service 2009d).				
Location	False Crawls	Nests	Unknown Crawl Type	Total Activity
Metompkin	0	0	0	0
Assawoman	1	0	0	1
Wallops	7	5	0	12
Hook	18	3	0	21
Overwash	6	4	0	10

Factors Affecting the Species Within the Action Area

A suite of existing actions affect listed species on Wallops Island, these involve flight operations and support operations associated with WFF. Of those, some are performed by NASA while others are performed by various military branches, MARS, and private contractors of these organizations. The activities include ongoing rocket launches and related training, testing, and preparation; maintenance of existing buildings and infrastructure, including the existing shoreline stabilization structures; and operation of UAVs and aircraft overhead, primarily launched from Wallops Main Base.

On Service lands and lands owned and managed by TNC, personnel actively manage invasive vegetation within action area. Phragmites (*Phragmites australis*) is found on all islands within the action area, and is controlled with herbicides on Metompkin and Assawoman Islands, and in the Hook and Overwash areas of Assateague Island. The Service, VDGIF, TNC, and other contractors and universities conduct surveys for breeding birds, sea turtle nests, and seabeach amaranth throughout the action area each year. Predator control efforts affect both plover and sea turtle reproduction within the action area. Predator control efforts occur on both Wallops Island and CNWR, and control mammalian and avian predators.

Recreational use of CNWR and the northern portion of Wallops Island (NASA personnel after-hours recreational area) occur seasonally, with most activity occurring in spring and summer months. On CNWR, limited seasonal use of vehicles on the beach occurs. Other recreational use includes wildlife observation, sunbathing, and other typical beach recreation. CNWR staff posts signage and implement closures to aid in protecting sensitive resources and routinely patrol the beach and recreational use areas.

Storms and ocean currents contribute to erosion, accretion, and sand transport along the islands within the action area. NASA reports an erosion rate of 3.3 m/year on southern Wallops Island, and there is no longer any beach remaining seaward of the geotubes and seawall installed to protect sensitive infrastructure. Similar erosion has occurred recently on portions of Assawoman Island. In contrast, the beach on the north end of Wallops Island has been rapidly accreting, and the feature known as Fishing Point, the southernmost point of land on the Hook section of CNWR, has been similarly accreting. This mass movement of sand dictates where exposed sandy beach habitat will be available for piping plovers and sea turtles in any given year.

Storms occur frequently, with widely varying effects on the shoreline and beach habitats. Both tropical storms and nor-easters (winter low pressure systems that tend to hug the Atlantic coast) can greatly alter the profile and amount of beach habitat among years, and these storms are what creates and maintains the overwash areas where most plovers nest.

The beach and dune habitat found on the seaward side of islands within the action area is prone to stabilization and vegetation succession proceeding from sheltered areas toward areas more exposed to overwash and erosion during storms. This can render areas unsuitable for piping plover use and sea turtle nesting. Wild bean (*Strophostyles holvola*) has been discovered on the southern end of Assawoman Island. The growth habit of this native plant may limit piping plover nesting habitat on the island in the future.

Recreational boating and fishing is common immediately offshore of all of the islands within the action area, and some boat landings and recreational use of the otherwise inaccessible beaches occurs, both permitted and illegally. The Chincoteague inlet is a maintained channel that provides boat passage from the ocean to Chincoteague Bay, and this well-used channel is located between CNWR and Wallops Island.

During launches, NASA implements closures of areas of both land and water adjacent to launch sites to ensure safety. The U.S. Coast Guard enforces such closures. NASA also has controlled airspace in the vicinity of both Wallops Island and Wallops Main Base. The airspace is closed during launches and potentially during military air operations and training. However, during periods when operations are not ongoing, civilian flight traffic may occur within the airspace.

<u>EFFECTS OF THE ACTION</u>

Noise

Ignition of rocket engines for orbital launches or static tests would produce instantaneous noise audible for a considerable distance from Launch Complex 0. The WFF Range Safety Office, using the NASA rocket size/noise equation (NASA 2009), has estimated noise levels expected to occur during launches of envelope vehicles from each launch pad in the complex. An LMLV-3(8) rocket launched from pad 0-B will produce a noise level of 129 dB at 1.1 km, attenuating to 108 dB up to 12.6 km from pad 0-B. As many as 12 such launches could be performed per year at pad 0-B. Noise levels from Taurus 2 rockets launched from pad 0-A would reach 124 dB within a 1.55 km radius, attenuating to 108 dB at a distance of 9.6 km from pad 0-A. Static tests would produce noise levels identical to those of Taurus 2 launches from pad 0-A. As many as six launches and two static tests could be performed per year at pad 0-A. These noise levels are expected to be sustained for 30 to 60 seconds during a launch and for up to 52 seconds during a static test.

Burger (1981) demonstrated startle effects in birds exposed to anthropogenic sound pressure of 108 dB. Such noise levels will occur within 12.6 km of pad 0-B as a result of rocket launches as many as 12 times per year. Within 9.6 km of pad 0-A, such noise levels will occur as a result of rocket launches or static tests as many as 20 times per year. Several other sources of loud noises exist in the action area. Anthropogenic sources include sounding rocket and drone target launches from Wallops Island, waste engine disposal at the open burn area on Wallops Island, and aircraft landing and taking off from Wallops Main Base and the UAV runway on Wallops Island. Collectively, several thousand such events take place within WFF annually (NASA 2005). Some of these activities produce noise levels similar to the noise expected to be produced by the large rocket launches. While many of these sounds are of similar intensity, the frequency of the sounds varies, with noise generated from rocket launch generally in the low frequency range and aircraft noise generally in higher frequency ranges.

The responses of plovers to these noises are hard to predict. Responsiveness of birds to noise disturbance may be determined by the species; the frequency, duration, and intensity of noise; habituation; and other factors (Manci et al. 1988, Federal Highway Administration 2004, Radle 2007). Plovers exposed to these levels of sound are expected to exhibit a startle response that interferes with normal behaviors, including breeding, feeding, and sheltering. This may include flushing from nests when incubating eggs, interruption of feeding or courtship, or similar responses. Because most of the noises are of short duration, plovers are expected to return to normal behavior within a few minutes of the noise. The combination of the sound with a visual stimulus such as a rocket in flight is expected to exacerbate the startle response of the plovers, particularly for those in close proximity to the launch sites for which the visual and auditory disturbance will be very close together, likely resulting in additive disturbance.

It is not likely that plovers will startle or flush from all of the relatively intense sound disturbances. Individual plovers may become habituated to the noises or types of noises that occur as a result of the proposed action and stop exhibiting the startle response. Some of the noises are also likely below the disturbance threshold, will be attenuated by atmospheric conditions, or may occur during periods of elevated natural noise intensity (e.g., strong winds, large waves) so that the noises would be less intense relative to background noise levels. Other sources of noise of similar intensity include thunder from occasional storms and waves continually breaking in the surf. Both thunder and loud surf can produce peak noise levels of around 120 dB (McKinley Health Center 2007), comparable to noise levels expected to be generated by the proposed action throughout most of the action area.

These events will have a relatively minor effect on an individual plover's physiological condition, requiring expenditure of energy and interrupting foraging. Plovers are not expected to permanently abandon nests, but they may flush from nests. More significant effects result from exposure to predators, particularly for nesting plovers. This species relies largely on its cryptic coloration and concealment for protection from predators, and flushing from nests will alert predators to the location of the nest and leave eggs or chicks exposed. Startle responses to noises and associated visual stimuli are expected to result in an incremental reduction in nest success and/or chick survival.

Noise from rocket launches is instantaneous upon ignition of the rocket engine. While no potential nesting habitat or foraging habitat is available within 1.1 km of pad 0-B and 1.55 km of pad 0-A, individual birds may be flying through the area within these radii when a launch is initiated. Noise levels within the 1.1 km radius of pad 0-B will exceed 129 dB during a launch, while those within the 1.55 km radius of pad 0-A will exceed 124 dB. Deafening is not expected at these decibel levels resulting from short-duration noises, but progressively closer to the rockets, the noise intensity may reach levels that could cause tissue damage. While not known in birds specifically, sound intensity of near 180 dB can result in nearly instantaneous tissue damage (McKinley Health Center 2007). Exposure to noises within these radii could deafen piping plovers present during ignition if exposed to high intensity noise. Deafness would significantly impair a piping plover's ability to breed, shelter, and behave normally. Because the launch complex is located between areas of habitat suitable for plover breeding and feeding, it is expected that individual plovers may occasionally fly through the area exposed to the highest sound levels during orbital launches, resulting in deafening. Birds may be able to recover from sound-induced deafening over time (Adler et al. 1995), but some period of deafness may result from loud noises.

Atmospheric noise has been demonstrated to prevent sea turtles from entering an area. However, noise levels required to show such an effect were higher than those likely to be produced by the proposed and on-going operations. Given the distance between the launch pads and potential sea turtle nesting habitat, noise is not expected to have an effect on sea turtles that come ashore to nest. Noise is not expected to have an effect on seabeach amaranth.

Vibration
Some energy from rocket launches and static tests on Wallops Island will manifest as vibration in the ground near the launch pad. Vibration may be significant from rocket launches, engine tests, and open burns. Effects from vibrations are likely to be confined to an additive disturbance to adult piping plovers and nesting sea turtles that may cause birds and turtles to temporarily cease normal behaviors. Because the distance from sources of vibrations to nesting habitat for turtles and plovers is generally over 500 ft, it is unlikely that vibrations will be significant enough to affect egg viability, and vibration at other NASA launch facilities has not been demonstrated to harm bird or sea turtle eggs (NASA 2009). Vibrations are not expected to have an effect on seabeach amaranth.

Rocket Exhaust
Rocket exhaust from Pad 0-B is directed out over the Atlantic Ocean by a vent located in the base of the gantry. Exhaust from launches and static tests at Pad 0-A will be directed out over the Atlantic Ocean through a flame trench in the launch pad. Wildlife within 200 to 300 m of the exhaust ports during engine ignition is expected to be injured or killed. Piping plovers or sea turtles exposed directly to the exhaust could be burned by hot gas or by caustic combustion products. However, no sandy beach exists near the launch pads. To be exposed, plovers would need to be flying through the path of the exhaust plume at the time of ignition. Given the distribution of plover habitat north and south of the launch complex and the likelihood that individual plovers will move around while establishing breeding territories or feeding and pass through the area during migration, plovers may be affected as a result of injury due to rocket exhaust, but the likelihood of this occurring is low. The lack of sandy beach in the path of the exhaust ports precludes the possibility of injury to nesting sea turtles or seabeach amaranth and

reduces the chance that plovers will be affected because they are not likely to stay within the affected area.

Combustion products in solid propellant rocket exhaust include aluminum oxide particles and hydrogen chloride. Estimates of peak concentrations of aluminum oxide on the nearest beach available to piping plovers, sea turtles, or seabeach amaranth range from a low of 0.55 parts per million during a spring launch in calm conditions to 1.7 parts per million following a launch during an onshore sea breeze. Estimates of peak concentrations of hydrogen chloride on the nearest beach available to piping plovers, sea turtles, or seabeach amaranth range from a low of 0.21 parts per million during a spring launch in calm conditions to 1.12 parts per million following a launch during an onshore sea breeze. While these contaminants have the potential to affect wildlife, neither of these combustion products is projected to reach a concentration harmful to piping plovers, sea turtles, or seabeach amaranth (NASA 2005, 2009).

Aluminum oxide particles in the atmosphere are efficient scavengers of water vapor and hydrogen chloride, and these particles produce hydrochloric acid. The combination of atmospheric and oceanic dilution and the buffering capacity of the ocean will prevent hydrochloric acid from impacting pH of habitats within the action area. Hydrogen chloride vapor may exist in hazardous quantities in the immediate vicinity of launch pad 0-B at the completion of a launch. A piping plover flying through the area could be exposed to a caustic cloud of such vapor, however the disturbance of the launch event itself would likely repel plovers from the immediate area for some time after engine ignition. Therefore, hydrochloric acid is not expected to adversely affect piping plovers, sea turtles, or seabeach amaranth (NASA 2005, 2009).

Estimates of carbon monoxide concentrations on the beach at the south end of Wallops Island following a launch or static test at either pad in Launch Complex 0 are between 0.9 and 1.1 parts per million, depending on weather conditions. These are below human exposure thresholds and believed to be below observable effects thresholds in wildlife. Atmospheric mixing and conversion of carbon monoxide to carbon dioxide will quickly diminish these concentrations. Therefore, the concentration of carbon monoxide is not expected to adversely affect piping plovers, sea turtles, or seabeach amaranth (NASA 2005, 2009).

Aircraft Operation

Most of the effects of aircraft noise to listed species are similar to the effects of rocket noise discussed above. Plovers may be additionally disturbed by the operation of aircraft maneuvering or overflying the area where nesting occurs. In a 2004 letter, the Service concurred that operation of UAVs would not be likely to adversely affect plovers if they avoided known nesting areas by at least 1,000 feet. However, operation of aircraft, including UAVs, has potential to affect plovers outside of nesting season, and during nesting season if nests are not detected and avoided. Plovers are thought to be susceptible to this type of disturbance because they perceive aircraft as potential avian predators. Balloons may have a similar effect on plovers. However, not all aircraft operation is likely to result in disturbance, and plovers are most likely to be disturbed by flights at low altitude down the beach or just offshore. Effects to plovers may include flushing from nests when incubating eggs, interruption of feeding or courtship, or similar responses. Because most of the noises are of short duration, plovers are expected to return to normal behavior within a few minutes of the noise. Aircraft operations are not expected to have an effect on sea turtles or seabeach amaranth.

Rocket and Equipment Transportation and Construction

Support activities prior to a rocket launch may disturb sea turtles attempting to nest and nesting plovers on the sound end of Wallops Island. Construction noise will be confined to the vicinity of Pad 0-A and existing infrastructure within Wallops Island and is not expected to result in more than minor behavioral responses. Construction occurring on the north end of Wallops Island at the boat dock, PFF, and PPF will be far from both sea turtle and plover nesting habitat (approximately 1,400 m and 475 m, respectively). These structures are also located in a forested area and will not be visible from the beach. These activities are expected to result in temporary increases in ambient noise, lighting, and human activity, but these activities are mostly distant from beaches and suitable habitat. Any effects to sea turtles and piping plovers that result from the construction of these facilities or transportation of rocket parts between them and the launch complex on the south end of the island are expected to be insignificant and discountable. Because these activities do not occur on the beach, they are not expected to adversely affect the seabeach amaranth.

Lighting

Rockets staged at Launch Complex 0 are uplit with metal halide lighting for two days prior to and two days following launch. Bright full-spectrum or white lighting within view from the beach can cause female sea turtles to abandon nest attempts or sufficiently disorient hatchling turtles to such an extent as to prevent them from reaching the surf. The location of the launch complex away from current sea turtle nesting habitat and the local topography will help reduce the effects these lights have on turtles, but some adverse effects to sea turtles, either in the form of hatchling disorientation or reducing the likelihood of nesting may occur when launches occur within the season when turtles may be nesting.

Other structures within the launch complex, as well as PFF, PPF, and HIF, use amber LEDs or low pressure sodium bulbs for exterior night lighting. Most of these facilities are not located immediately adjacent to the beach, which limits the potential effects on listed species. However, they do contribute to elevated levels of ambient lighting, and are some of the only lights on the barrier islands within the action area. Such night lighting can negatively impact nesting plovers and sea turtles.

Anthropogenic light sources have had documented negative effects on sea turtles. Adult females looking for nesting beaches seek dark stretches of suitable shoreline. Unshielded lights can deter females from crawling onto a beach to nest. At hatching, juveniles emerge and seek the nearest available light source, which on an undeveloped beach is the horizon over the ocean. Lights shining in the vicinity of a nest can disorient emerging hatchlings, leading them away from the ocean and leaving them more vulnerable to predation, desiccation, or crushing by vehicles. Hatchlings that have reached the surf can also become disoriented by lighting, and have been documented to leave the surf (NMFS and Service 2007a). Some of these behavioral effects on adult turtles and disorientation of young turtles are expected to occur. Lighting is not expected to have an effect on seabeach amaranth.

Recreational Beach Use and Security Patrols

The recreational use of the north end of Wallops island by WFF personnel and their families outside of NASA operations periods and security patrols have similar effects on plovers because they involve operation of vehicles on the beach, in addition to people on foot in areas where plovers, seabeach amaranth, and sea turtles may occur. Security patrols have been ongoing at WFF for a number of years, and have likely presented some level of disturbance to piping plovers and nesting sea turtles, and perhaps seabeach amaranth.

Effects of human activity to nesting piping plovers can range from relatively minor disturbance that temporarily interferes with normal breeding, feeding, and sheltering behavior to injury or death of chicks or destruction of an entire nest, or sustained disturbance resulting in nest abandonment. The presence of people near plover nests can result in disturbance, and foot traffic and vehicle use on the beach could crush nests, eggs, or hatchlings. Vehicles can also create ruts capable of trapping hatchlings.

Closure of a plover nesting area will avoid these effects within that area to the extent that the closure is observed, but plovers are expected to nest outside of the established closure area in some cases. In these cases, monitoring, placing nest exclosures, and posting signage will minimize the potential effects, but will not avoid them. After hatching, young plovers may move away from nesting areas, making them vulnerable to these effects throughout a much larger area. Even with surveys and monitoring conducted at a high frequency, there is potential to disturb nesting that is not detected and injure or kill young plovers.

Outside of the nesting season, it is likely that there is some small impact to plovers that migrate along the barrier islands during fall migration to their wintering grounds. This impact would be from interference with foraging due to human activity and vehicle use on the beaches.

Similar effects are expected for nesting sea turtles. Security patrols and recreational use may inadvertently disturb nesting females, crush eggs within the nest, or crush, entrap, or disturb hatchlings attempting to leave the nest. Vehicle use on the beaches may compact beach sand and/or disturb female turtles attempting to nest. Monitoring for turtle activity followed by erecting exclosures to protect nests will avoid some adverse impacts, but is not sufficient to avoid all impacts.

Indirect effects to piping plovers and sea turtles are likely to include an increased predation rate due to human activity. Human activity may result in trash on the ground, which could both attract predators and increase the carrying capacity of the predators due to increased food availability. The increased numbers of predators may increase risk of disturbance, nest loss, and adult mortality of plovers and increase losses of sea turtle eggs and nests. Plovers may expend more energy in predator surveillance and avoidance and that energy expenditure could decrease overall fitness. Continued vehicle use on the beaches may also increase ruts, compact sand, and destabilize some portions of the beach resulting in changes to habitat suitability. Likelihood of adverse effects to piping plovers and sea turtles is low because recreational use of these sites and security patrols are generally light and not continuous.

Crushing of seabeach amaranth plants by the public, security patrols, or other vehicles may occur in some circumstances. Conducting surveys to identify and protect plants will help to minimize these effects, but are not sufficient to avoid adverse effects.

The security contractor at WFF is in the process of installing a closed circuit monitoring system to allow surveillance from a central location. Upon completion of the closed circuit system, frequent perimeter patrols are expected to substantially decrease or cease altogether. Visits by security personnel to the beach of Wallops Island would occur only in response to a shoreline incursion by non-credentialed individuals. We therefore expect impacts to all listed species in the action area as a result of security patrols to diminish over time.

Monitoring

While the intent of conducting frequent surveys, implementing area closures and posting signage, placing plover nest enclosures, and similar actions is to reduce or avoid impacts to listed species by detecting them early, these activities themselves, because they result in increased human activity within the beach habitats, result in some adverse effects to listed species. Plovers being monitored are generally disturbed to some degree during monitoring and during efforts to locate nests, and this disturbance, while limited, may increase the likelihood of nest predation. Observers may also inadvertently crush plover and sea turtle nests or young while accessing areas to conduct monitoring or management, and the same activities may result in crushing seabeach amaranth plants.

The proposed monitoring protocols are less than what is recommended in the plover management guidelines within the Recovery Plan (Service 1996a), and would increase risk to plovers from human disturbance, crushing of nests and/or young, nest abandonment, or egg mortality resulting from exposure. If a nest is crushed, it could result in the destruction or loss of one to four eggs. Any pairs that successfully hatch chicks may be forced to move their broods into territories of pairs already established or into recreational use areas, inducing agonistic interactions, increasing risk of disturbance, injury or death, and entrapment, and reducing overall chick survival.

Additive Effects of Different Types of Activities

In addition to the effects of the various actions considered and described above, the additive effects of a variety of different types of activities result in greater impacts than each activity conducted independently. For example, operations of UAVs within the parameters described may result in infrequent disturbance and some launch operations, rocket tests, and monitoring may have similar effects. The combination of all of these activities, when considered together, results in more frequent disturbance and as a result we expect plovers and turtles to experience low levels of disturbance in the action area on a regular basis.

CUMULATIVE EFFECTS

Cumulative effects include the effects of future state, tribal, local, or private actions that are reasonably certain to occur in the action area considered in this biological opinion. Future federal actions that are unrelated to the proposed action are not considered in this section because they require separate consultation pursuant to section 7 of the ESA.

Federal agencies own and administer the islands within the action area and most actions will consequently be subject to section 7 consultation. Those areas inland and within the action area are lightly populated and the Service is unaware of any state, tribal, local, or private actions that will occur in this area beyond light farming. Lagoon and estuarine areas between the barrier islands and the mainland are considered either navigable waters of the U.S. or jurisdictional wetlands and would therefore be subject to Clean Water Act or Rivers and Harbors Act permitting and subsequent section 7 consultation, as appropriate. The Service is consequently unaware of any cumulative effects to listed species within the action area.

SUMMARY OF EFFECTS

The combined effects of a variety of different activities on plovers and sea turtles are expected to result in relatively frequent but usually minor disturbance. In combination, these effects are over time expected to result in either reduction in reproductive output or success. Nesting that occurs close to launch pads is most likely to be disturbed. The recreational use, security patrols, and species monitoring are all expected to pose some risk to plover, sea turtles, and seabeach amaranth because they occur within the habitats that these species occupy and may directly and indirectly impact the species, including crushing, injury, death, and indirect effects such as habitat change. Because of the amount of habitat present, the management and monitoring that is proposed, and the relatively low intensity of these activities, we expect that only a small portion of the occurrences of each of these species will be affected significantly, and none of the activities are expected to significantly reduce the suitability of the habitats for these species.

As a result of the low likelihood that leatherback and green sea turtles will occur in the action area and be adversely affected by the on-going and proposed actions, we believe that effects described above are insignificant and discountable for these species.

CONCLUSION

After reviewing the status of the piping plover, green sea turtle, leatherback sea turtle, loggerhead sea turtle, and seabeach amaranth, the environmental baseline for the action area, the effects of the proposed action, and the cumulative effects, it is the Service's biological opinion that the ongoing and expanded orbital rocket program at WFF and other ongoing operations and use of the facility, as proposed, is not likely to jeopardize the continued existence of the piping plover, green sea turtle, leatherback sea turtle, loggerhead sea turtle, or seabeach amaranth, and is not likely to destroy or adversely modify designated critical habitat. Critical habitat for the piping plover and sea turtles has been designated, however, this action does not affect that area and no destruction or adverse modification of that critical habitat is anticipated.

INCIDENTAL TAKE STATEMENT

Section 9 of the ESA and federal regulation pursuant to section 4(d) of the ESA prohibit the take of endangered and threatened species, respectively, without a special exemption. Take is defined as to harass, harm, pursue, hunt, shoot, wound, kill, trap, capture or collect, or to attempt to engage in any such conduct. Harm is further defined by the Service to include significant habitat modification or degradation that results in death or injury to listed species by significantly impairing essential behavioral patterns such as breeding, feeding, or sheltering. Harass is defined by the Service as intentional or negligent actions that create the likelihood of injury to listed species to such an extent as to significantly disrupt normal behavior patterns, which include, but are not limited to, breeding, feeding, or sheltering. Incidental take is defined as take that is incidental to, and not the purpose of, the carrying out an otherwise lawful activity. Under the terms of section 7(b)(4) and section 7(o)(2), taking that is incidental to and not intended as part of the agency action is not considered to be prohibited taking under the ESA provided that such taking is in compliance with the terms and conditions of this incidental take statement.

The measures described below are nondiscretionary, and must be undertaken by NASA so that they become binding conditions of any grant or permit issued to any applicant/contractor, as appropriate, for the exemption in action 7(o)(2) to apply. NASA has a continuing duty to regulate the activity covered by this incidental take statement. If NASA (1) fails to assume and implement the terms and conditions or (2) fails to require any applicant/contractor to adhere to the terms and conditions of the incidental take statement through enforceable terms that are added to the permit or grant document, the protective coverage of section 7(o)(2) may lapse. To monitor the impact of incidental take, NASA must report the progress of the action and its impact on the species to the Service as specified in the incidental take statement.

Section 7(b)(4) and 7(o)(2) of the ESA generally do not apply to listed plants species. However, limited protection of listed plants from take is provided to the extent that the ESA prohibits the removal and reduction to possession of federally listed endangered plants or the malicious damage of such plants on areas under federal jurisdiction, or the destruction of endangered plants on non-federal areas in violation of state law or regulations or in the course of any violation of a state criminal trespass law.

AMOUNT OR EXTENT OF TAKE

The Service anticipates incidental take of piping plovers and sea turtles will be difficult to detect for the following reasons: incidental take of actual species numbers may be difficult to detect when finding a dead or impaired specimen is unlikely and losses may be masked by seasonal fluctuations in numbers and other environmental factors that the species.

Based on historic and recent use of the action area by these species and the effects that are expected to occur as a result of the on-going and proposed actions:

Piping Plover - The Service anticipates that up to two clutches of piping plovers, which equates to 8 eggs or young plovers, could be taken per year through injury, direct mortality, and harassment affecting an entire nest and its contents, or individual young plovers after they leave the nest. This is most likely to occur in suitable habitat as a result of human activities that occur on the beach that interfere with breeding, feeding, or sheltering. In addition, take in the form of harassment may result in reduced productivity of up to one plover pair. This will result from effects of disturbance that prevent a pair from nesting.

Loggerhead Sea Turtle - The Service anticipates that no more than one loggerhead sea turtle nest or the equivalent number of hatchling turtles could be taken per year. Incidental take is expected to be in the form of injury or death of turtle eggs and hatchlings, as well as harm and harassment of both adult and hatchling turtles. No adult turtles are anticipated to be killed. This take may result from vehicles crushing nestling turtles resulting in injury or death, crushing an undetected turtle nest by either staff- or civilian-operated vehicles, creation of ruts in sand that impede hatchlings from moving from nest to water, interference with sea-finding behavior in hatchling turtles leading to disorientation resulting from artificial and vehicle lighting, and impacts to nests resulting from sand compaction or vibration caused by vehicle use. This amount of take may also result from the disturbance of a nesting female that prevents her from nesting successfully.

Green Sea Turtle and Leatherback Sea Turtle - Because of the low likelihood that green or leatherback sea turtles will occur or nest in the action area due to their rarity, no incidental take of these species is anticipated.

The Service will not refer the incidental take of any migratory bird for prosecution under the Migratory Bird Treaty Act of 1918, as amended (16 U.S.C. §§ 7 03-712) if such take is in compliance with the terms and conditions (including amount and/or number) specified herein.

EFFECT OF THE TAKE

In the accompanying biological opinion, the Service determined that this level of anticipated take is not likely to result in jeopardy to the species or destruction or adverse modification of critical habitat. The action area encompasses a relatively small portion of the rangewide habitat of each of the species addressed in this opinion and a small portion of each species' population. The proposed action includes a variety of protective measures that are intended to minimize incidental take. For these reasons, the effect of the take anticipated in this biological opinion is not expected to significantly affect any of the species considered.

REASONABLE AND PRUDENT MEASURES

The Service believes the following reasonable and prudent measures are necessary and appropriate to minimize impacts of incidental take of listed species:

1) Conduct routine surveys and monitoring for all species addressed in this biological opinion and implement closures or other protections whenever possible.

2) Actively manage habitats and human activity on the beaches to avoid and minimize potential impacts to listed species.

TERMS AND CONDITIONS

To be exempt from the prohibitions of section 9 of the ESA, NASA must comply with the following terms and conditions, which implement the reasonable and prudent measures described above and outline required reporting/monitoring requirements. These terms and conditions are nondiscretionary.

1) Continue to implement the Wallops Island Protected Species Monitoring Plan for the duration of the proposed action, and provide an annual report summarizing the survey and monitoring efforts, the location and status of all occurrences of protected species that are recorded, and any additional relevant information. Reports should be provided to the Service's Virginia Field Office in digital format at the address provided on the letterhead by December 31 of each year.

2) Report any evidence of potential nesting activity of green sea turtles or leatherback sea turtles on Wallops Island to the Virginia Field Office at the address provided on the letterhead within 1 business day of observing the activity.

3) Implement video monitoring of plover nests most likely to be affected by launch activities (those located closest to launch pads) during launches to measure and record bird responses. This monitoring shall be conducted for at least each of the first 10 large rocket launches (those launches for which noise levels are expected to exceed 100 dB within potential plover nesting habitat) that occur after issuance of this biological opinion. If no plover nests are active within areas expected to be subjected to sound levels > 100 dB, other similar shorebird species nesting in similar habitat should be monitored as surrogates to provide information on species responses. Monitoring shall include measurement of actual sound intensity at the monitoring site during launch, weather conditions, and other factors which may contribute to responses. Monitoring shall take place 2 hours prior to, during, and at least 2 hours after the launch. Within five business days of each launch, a DVD of the monitoring and a report in digital format containing the additional measurements will be provided to the Service's Virginia Field Office at the address provided on the letterhead. Following documentation of avian responses from the first launches, NASA may request Service concurrence to discontinue this monitoring. If this is not requested or if concurrence is not provided, this monitoring will continue.

4) Develop a training and familiarization program for all security personnel conducting patrols in areas where listed species may occur. This training program shall include basic biological information about all listed species and be sufficient to allow personnel to at

least tentatively identify the species and provide basic information to recreational users about appropriate avoidance and minimization measures. This training should be offered to interested recreational beach users.

5) Develop a reporting system so that any personnel who observe listed species or potential occurrences of listed species on WFF can provide the information to personnel who can investigate the report. The intent of this is to use every opportunity possible to implement avoidance and minimization measures. Within 60 days of the date of this biological opinion, provide the Service with an electronic draft of the reporting system for review and approval.

6) Care must be taken in handling any dead specimens of proposed or listed species that are found to preserve biological material in the best possible state. In conjunction with the preservation of any dead specimens, the finder has the responsibility to ensure that evidence intrinsic to determining the cause of death of the specimen is not unnecessarily disturbed. The finding of dead specimens does not imply enforcement proceedings pursuant to the ESA. The reporting of dead specimens is required to enable the Service to determine if take is reached or exceeded and to ensure that the terms and conditions are appropriate and effective. Upon locating a dead specimen, notify the Service's Virginia Law Enforcement Office at 804-771-2883, 7721 South Laburnum Avenue, Richmond, Virginia 23231, and the Service's Virginia Field Office at 804-693-6694 at the address provided on the letterhead above.

CONSERVATION RECOMMENDATIONS

Section 7(a)(1) of the ESA directs federal agencies to utilize their authorities to further the purposes of the ESA by carrying out conservation programs for the benefit of endangered and threatened species. Conservation recommendations are discretionary agency activities to further minimize or avoid adverse effects of a proposed action on listed species or critical habitat, to help implement recovery plans, or to develop information.

1) The Service recommends that NASA work with the Service to develop a candidate conservation agreement for the red knot. The information provided in the BA and the NASA Protected Species Management Plan will provide a good foundation for such an agreement.
2) NASA should develop an integrated habitat conservation and management plan for the property. Due to the significance of the area for the conservation of migratory birds and other species, nearly all of the habitats that occur on NASA WFF provide value to these species, and active efforts to manage them, including activities such as control of non-native invasive plants and similar activities may significantly improve the value of these areas as habitats.

For the Service to be kept informed of actions minimizing or avoiding adverse effects or benefitting listed species or their habitats, the Service requests notification of the implementation of any conservation recommendations.

REINITIATION NOTICE

This concludes formal consultation on the actions outlined in the request. As provided in 50 CFR § 402.16, reinitiation of formal consultation is required where discretionary federal agency involvement or control over the action has been retained (or is authorized by law) and if: (1) the amount or extent of incidental take is exceeded; (2) new information reveals effects of the agency action that may affect listed species or critical habitat in a manner or to an extent not considered in this opinion; (3) the action is subsequently modified in a manner that causes an effect to the listed species or critical habitat not considered in this opinion; or (4) a new species is listed or critical habitat designated that may be affected by the action. In instances where the amount or extent of incidental take is exceeded, any operations causing such take must cease pending reinitiation.

If you have any questions, please contact Tylan Dean of this office at 804-693-6694, extension 166.

Sincerely,

Cynthia A. Schulz

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APPENDIX 1

Estimated abundance of breeding pairs of Atlantic Coast piping plovers, 1986 – 2009 **PARENTHESES DENOTE PRELIMINARY ESTIMATES**

State/RECOVERY UNIT	Pairs																							
	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
Maine	15	12	20	16	17	18	24	32	35	40	60	47	60	56	50	55	66	61	55	49	40	35	24	27
New Hampshire												5	5	6	6	7	7	7	4	3	3	3	3	5
Massachusetts	139	126	134	137	140	160	213	289	352	441	454	483	495	501	496	495	538	511	488	467	482	558	566	(575)
Rhode Island	10	17	19	19	28	26	20	31	32	40	50	51	46	39	49	52	58	71	70	69	72	73	77	84
Connecticut	20	24	27	34	43	36	40	24	30	31	26	26	21	22	22	32	31	37	40	34	37	36	41	44
NEW ENGLAND	184	179	200	206	228	240	297	376	449	552	590	612	627	624	623	641	700	687	657	622	634	705	711	(735)
New York	106	135	172	191	197	191	187	193	209	249	256	256	245	243	289	309	369	386	384	374	422	457	443	(437)
New Jersey	102	93	105	128	126	126	134	127	124	132	127	115	93	107	112	122	138	144	135	111	116	129	111	105
NY-NJ	208	228	277	319	323	317	321	320	333	381	383	371	338	350	401	431	507	530	519	485	538	586	554	(542)
Delaware	8	7	3	3	6	5	2	2	4	5	6	4	6	4	3	6	6	6	7	8	9	9	10	10
Maryland	17	23	25	20	14	17	24	19	32	44	61	60	56	58	60	60	60	59	66	63	64	64	49	45
Virginia	100	100	103	121	125	131	97	106	96	118	87	88	95	89	96	119	120	114	152	192	202	199	208	193
North Carolina	30	30	40	55	55	40	49	53	54	50	35	52	46	31	24	23	23	24	20	37	46	61	64	54
South Carolina	3		0		1	1		1			0					0						0		
SOUTHERN	158	160	171	199	201	194	172	181	186	217	189	204	203	182	183	208	209	203	245	300	321	333	331	302
U.S. TOTAL	550	567	648	724	752	751	790	877	968	1150	1162	1187	1168	1156	1207	1280	1416	1420	1421	1407	1493	1624	1596	(1579)
EASTERN CANADA*	240	223	238	233	230	252	223	223	194	200	202	199	211	236	230	250	274	256	237	217	256	266	253	(252)
ATLANTIC COAST TOTAL	790	790	886	957	982	1003	1013	1100	1162	1350	1364	1386	1379	1392	1437	1530	1690	1676	1658	1624	1749	1890	1849	(1831)

* includes 1-5 pairs on the French Islands of St. Pierre and Miquelon, reported by CWS

Estimated productivity of Atlantic Coast piping plovers, 1987 – 2009

PARENTHESES DENOTE PRELIMINARY ESTIMATES

State/RECOVERY UNIT	Chicks fledged/pair																						
	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
Maine	1.75	0.75	2.38	1.53	2.50	2.00	2.38	2.00	2.38	1.63	1.98	1.47	1.63	1.60	1.98	1.39	1.28	1.45	0.55	1.35	1.06	1.75	1.70
New Hampshire											0.60	2.40	2.67	2.33	2.14	0.14	1.00	1.00	0.00	0.67	0.33	2.00	0.40
Massachusetts	1.10	1.29	1.59	1.38	1.72	2.03	1.92	1.81	1.62	1.35	1.33	1.50	1.60	1.09	1.49	1.14	1.26	1.38	1.14	1.33	1.25	1.41	(0.90)
Rhode Island	1.12	1.58	1.47	0.88	0.77	1.55	1.80	2.00	1.68	1.56	1.34	1.13	1.79	1.20	1.50	1.95	1.03	1.50	1.43	1.03	1.48	1.68	1.46
Connecticut	1.29	1.70	1.79	1.63	1.39	1.45	0.38	1.47	1.35	1.31	1.69	1.05	1.45	1.86	1.22	1.87	1.30	1.35	1.62	2.14	1.92	2.49	1.68
NEW ENGLAND	1.19	1.32	1.68	1.38	1.62	1.91	1.85	1.81	1.67	1.40	1.39	1.46	1.62	1.18	1.53	1.26	1.24	1.40	1.15	1.34	1.30	1.51	(1.04)
New York	0.90	1.24	1.02	0.80	1.09	0.98	1.24	1.34	0.97	1.14	1.36	1.09	1.35	1.11	1.27	1.62	1.15	1.46	1.44	1.55	1.15	1.21	(0.93)
New Jersey	0.85	0.94	1.12	0.93	0.98	1.07	0.93	1.16	0.98	1.00	0.39	1.09	1.34	1.40	1.29	1.17	0.92	0.61	0.77	0.84	0.67	0.64	1.05
NY-NJ	0.86	1.03	1.08	0.88	1.04	1.02	1.08	1.25	0.97	1.07	1.02	1.09	1.35	1.19	1.28	1.49	1.07	1.23	1.28	1.36	1.03	1.10	(0.96)
Delaware		0.00	2.33	2.00	1.60	1.00	0.50	2.50	2.00	0.50	1.00	0.83	1.50	1.67	1.50	1.17	2.33	1.14	1.50	1.44	1.33	0.30	1.30
Maryland	1.17	0.52	0.90	0.79	0.41	1.00	1.79	2.41	1.73	1.49	1.02	1.30	1.09	0.80	0.92	1.85	1.56	1.86	1.25	1.06	0.78	0.41	1.42
Virginia		1.02	1.16	0.65	0.88	0.59	1.45	1.66	1.00	1.54	0.71	1.01	1.21	1.42	1.52	1.19	1.90	2.23	1.52	1.19	1.16	0.87	1.19
North Carolina			0.59	0.43	0.07	0.41	0.74	0.36	0.45	0.86	0.23	0.61	0.48	0.54	0.50	0.17	0.46	0.65	0.92	0.87	0.26	0.30	0.70
SOUTHERN	1.17	0.85	0.88	0.72	0.68	0.62	1.18	1.37	1.05	1.34	0.68	0.99	1.04	1.09	1.22	1.27	1.63	1.95	1.38	1.12	0.92	0.67	1.14
U.S. (average)	1.04	1.11	1.28	1.06	1.22	1.35	1.47	1.56	1.35	1.30	1.16	1.27	1.45	1.17	1.40	1.34	1.24	1.43	1.24	1.30	1.13	1.19	(1.03)
EASTERN CANADA*		1.65	1.58	1.62	1.07	1.55	0.69	1.25	1.69	1.72	2.10	1.84	1.74	1.47	1.77	1.18	1.62	1.93	1.82	1.82	1.14	1.47	(1.22)

* includes St. Pierre and Miquelon, reported by CWS