Appendix C

Biological Assessment for Proposed and Ongoing Orbital Launch Operations at Wallops Flight Facility

FINAL Biological Assessment for Proposed and Ongoing Orbital Launch Operations at Wallops Flight Facility

National Aeronautics and Space Administration
Goddard Space Flight Center
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Wallops Island, VA 23337

August 2009

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Table of Contents

1. Introduction **1**
1.1. Purpose of Document 1
1.2. Previous ESA Consultations 1
2. Description of the Actions **2**
2.1. Proposed Action 2
2.2. Ongoing Action 5
2.3. Action Area 5
2.3.1. Assateague Island 8
2.3.2. Wallops Island 8
2.3.3. Assawoman and Metompkin Islands 9
3. Species Potentially in the Action Area **9**
3.1. Piping Plover 9
3.1.1. Description and Distribution 9
3.1.2. Nesting 9
3.1.3. Status of Species in the Action Area 9
3.2. Loggerhead Sea Turtle 12
3.2.1. Description and Distribution 12
3.2.2. Nesting 12
3.2.3. Status of Species in the Action Area 12
3.3. Green Sea Turtle 12
3.3.1. Description and Distribution 12
3.3.2. Nesting 13
3.3.3. Status of Species in the Action Area 13
3.4. Leatherback Sea Turtle 13
3.4.1. Description and Distribution 13
3.4.2. Nesting 13
3.4.3. Status of Species in the Action Area 14
3.5. Seabeach Amaranth 14
3.5.1. Description and Distribution 14
3.5.2. Status of the Species in the Action Area 15
3.6. Red Knot 15
3.6.1. Description and Distribution 15
3.6.2. Status of the Species in the Action Area 15
4. Effects of the Actions **16**
4.1. Piping Plover 16
4.1.1. Direct and Indirect Effects 16
4.1.2. Actions to Reduce Adverse Effects 17
4.1.3. Conclusion 18
4.2. Loggerhead, Green, and Leatherback Sea Turtles 18
4.2.1. Direct and Indirect Effects 18
4.2.2. Actions to Reduce Adverse Effects 20
4.2.3. Conclusion 21

4.3. Seabeach Amaranth 21
4.3.1. Direct and Indirect Effects 21
4.3.2. Actions to Reduce Adverse Effects 21
4.3.3. Conclusion 21
4.4. Red Knot 22
4.4.1. Direct and Indirect Effects 22
4.4.2. Actions to Reduce Adverse Effects 22
4.4.3. Conclusion 22
5. Cumulative Effects 22
6. Literature Cited 24

Tables

Table 1: Record of Piping Plover Pairs and Number of Young Fledged at CNWR.
Table 2: Piping Plover Nesting Activities at the Hook and Overwash Areas on Assateague Island, Assawoman Island, and North Metompkin Island.
Table 3: Record of Piping Plover Pairs and Number of Young Fledged at WFF.

Figures

Figure 1: Proposed Facility Construction on North Wallops Island
Figure 2: Proposed Facility Construction and Ongoing Operations on South Wallops Island
Figure 3: Action Area

1. Introduction

1.1. *Purpose of Document*

Section 7(c) of the Endangered Species Act (ESA) of 1973 requires that a Biological Assessment (BA) be prepared for all federal actions that may affect federally listed or proposed endangered or threatened species. The federal action considered in this BA is the funding and authorization of proposed and ongoing orbital launch operations at the National Aeronautics and Space Administration (NASA) Goddard Space Flight Center's Wallops Flight Facility (WFF) in Wallops Island, Virginia.

NASA has prepared this BA to consider the potential impacts to listed species under the jurisdiction of the U.S. Fish and Wildlife Service (USFWS) that may occur within the proposed project area. Listed species that may occur within the action area include the threatened piping plover (*Charadrius melodus*), the threatened loggerhead sea turtle (*Caretta caretta*), endangered green (*Chelonia mydas*) and leatherback (*Dermochelys coriacea*) sea turtles, the federally threatened seabeach amaranth (*Amaranthus pumilus*), and the federal candidate red knot (*Calidris canutus rufa*). In previous discussions regarding the proposed project, NASA and USFWS have concluded that Kemp's ridley and hawksbill sea turtles are unlikely to occur within the action area. Two other protected species are known to occur on the Delmarva Peninsula; the federally endangered Delmarva Peninsula Fox Squirrel (*Sciurus niger cinereus*) and the federally threatened Northeast Beach Tiger Beetle (*Cincinela dorsalis dorsalis*). Though it occurs on nearby Assateague Island, the Delmarva Peninsula Fox Squirrel does not occur on those parts of the island (Overwash and Hook) deemed to be part of the action area (Buffa, pers. comm., 2009). The Northeast Beach Tiger Beetle does not inhabit those portions of the Delmarva Peninsula fronting the Atlantic Ocean including the action area. It is found on Chesapeake Bay beaches (Dean, 2009).

1.2. *Previous ESA Consultations*

During construction and operation of the Mid-Atlantic Spaceport's (MARS) launch pad 0-B, NASA formally consulted with USFWS regarding potential impacts to listed species; USFWS issued its Biological Opinion (BO) on July 14, 1997. The BO considered the impacts of the proposal on the piping plover; no incidental take was authorized. The following year, a series of discussions between NASA and USFWS in February, 1998 led to the agreement that NASA could operate its Open Burn area for the destruction of rocket motors year-round. The Open Burn Area is located approximately 400 meters (1,310 feet) north of the Assawoman Island division of the Chincoteague National Wildlife Refuge and its piping plover nesting area. In 2003, after informal consultation, USFWS issued guidelines for the operation of Uninhabited Aerial Vehicles (UAVs) from the improved road on the southern end of Wallops Island. These guidelines were designed to avoid the impacts of UAV operations on nesting piping plovers. Recent discussions with USFWS indicate that the referenced 1997 formal consultation should be reconsidered to include more current information regarding the piping plover and to include potential effects to listed sea turtles, seabeach amaranth, and the candidate red knot. This BA is intended to provide the requisite information to enable USFWS to prepare a single BO addressing the ongoing actions considered in the 1997 BO and those actions currently proposed at WFF that would enable greater orbital launch capabilities at the MARS on Wallops Island.

In April 2009, NASA informally consulted with the National Marine Fisheries Service (NMFS) regarding potential effects to listed marine mammals and sea turtles under its jurisdiction. In a July 8, 2009 letter, NMFS determined that the effect of proposed and ongoing launch operations at WFF on listed species under NMFS jurisdiction were" insignificant or discountable" and concluded that the proposed project is not likely to adversely affect those species (NMFS, 2009). As such, when addressing potential effects to listed sea turtles, this document will focus on nesting sea turtles.

2. Description of the Actions

2.1. Proposed Action

NASA and MARS are proposing to expand infrastructure on Wallops Island to support the transportation, processing, and launching of up to an additional six medium-class Expendable Launch Vehicles (ELVs) and spacecraft from Pad 0-A on south Wallops Island (Figures 1 and 2).

Figure 1 – Proposed Facility Construction on North Wallops Island

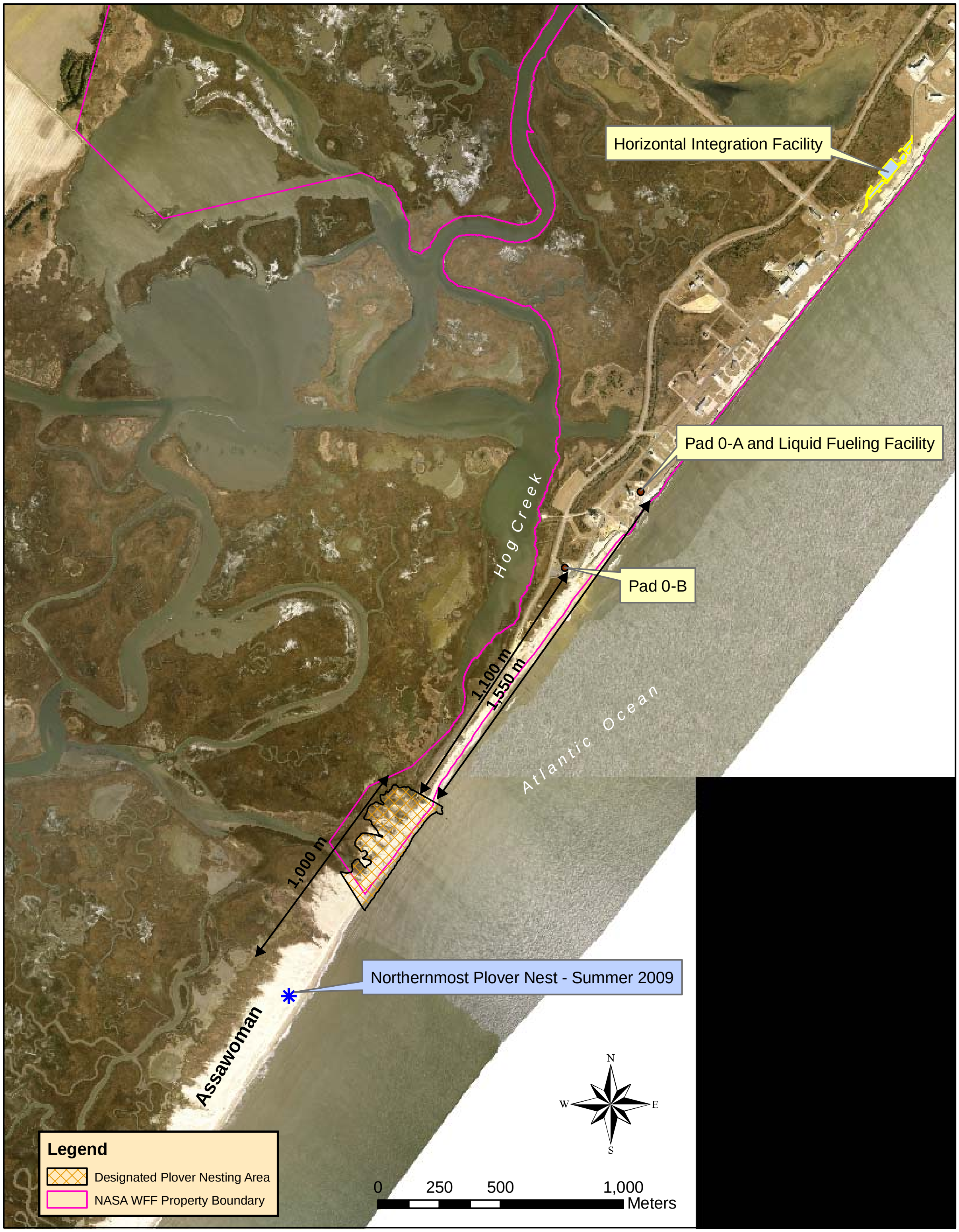

Figure 2 – Proposed Facility Construction and Ongoing Operations on South Wallops Island

Under the proposed action, NASA would:

- Install additional sheet piling at the north Wallops Island boat dock;
- Construct a Payload Fueling Facility on north Wallops Island;
- Construct a Payload Processing Facility on north Wallops Island;
- Construct a Horizontal Integration Facility in the middle of Wallops Island;
- Make improvements to existing roads; and
- Perform minor interior modifications to several existing buildings.

MARS would construct and operate a liquid fueling facility and larger launch complex in approximately the same location as existing Pad 0-A. A variety of ELVs and spacecraft would be processed at WFF and launched from Pad 0-A; however none would be larger than Orbital Sciences Corporation's Taurus II. A more detailed description of the proposed action is provided in NASA's April 2009 *Draft Environmental Assessment for the Expansion of the Wallops Flight Facility Launch Range*.

2.2. Ongoing Action

NASA and MARS would continue transporting, processing, and launching up to twelve orbital-class ELVs from existing Pad 0-B, which is located approximately 450 meters (m) (1,475 feet [ft]) south of the proposed larger Pad 0-A. A variety of ELVs would be launched, with the largest being the equivalent of the solid-fueled Lockheed Martin Launch Vehicle-3 with 8 Castor IV solid rocket motor strap-ons (LMLV-3 [8]). A more detailed description of Pad 0-B and its operations is included in the April 2009 Draft EA and the *Final Environmental Assessment for Range Operations Expansion at the National Aeronautics and Space Administration Goddard Space Flight Center Wallops Flight Facility, Wallops Island Virginia 23337* (NASA, 1997).

2.3. Action Area

The action area is defined as a 12.6 kilometer (km) (7.8 mile [mi]) radius around the launch pad 0-B (Figure 3). This radius was chosen as the distance it would take to attenuate the launch noise from the largest vehicle that could launch from that pad to 108 decibels (dB). Noise of that sound level has been demonstrated to disturb shorebirds (Burger, 1981). Noise levels were predicted by a formula that equates noise to rocket motor thrust (NASA, 1973). The method is commonly used by the WFF Range Safety Office and is very conservative as it assumes noise levels to be distributed radially about the source.

This radius is also large enough to include noise effects from static test firing and launching the smaller Taurus II from Pad 0-A (108 dB at 9.6 km [6 mi]), lighting effects from launch support infrastructure on Wallops and nearby beaches, and NASA security patrols along the Wallops beach. The area encompasses the areas known as the Overwash and Hook on south Assateague Island, all of Wallops Island and the marsh areas to its west, all of Assawoman Island, and north Metompkin Island. Although estimated to be subject to the same sound intensities as all areas within the action area radius, the mainland area to the west of Wallops Island will not be discussed further as it is either residentially developed or farmland. This habitat would not be suitable for any of the listed species discussed in this BA with the possible exception of the Delmarva Peninsula Fox Squirrel. However, according to a USFWS fact sheet on this species it is unlikely to occur in Accomack County except on Assateague Island (USFWS, 2008c). The ocean to the east of Wallops Island was considered under the previously cited 2009 informal consultation with NMFS and also will not be further discussed.

Other direct and indirect impacts would be expected to occur within the boundaries of the action area. These include lighting associated with launch infrastructure as well as emissions and vibrations from launch events and engine tests. The impacts of vehicular security patrols along the Wallops Island beach would also be within the defined action area.

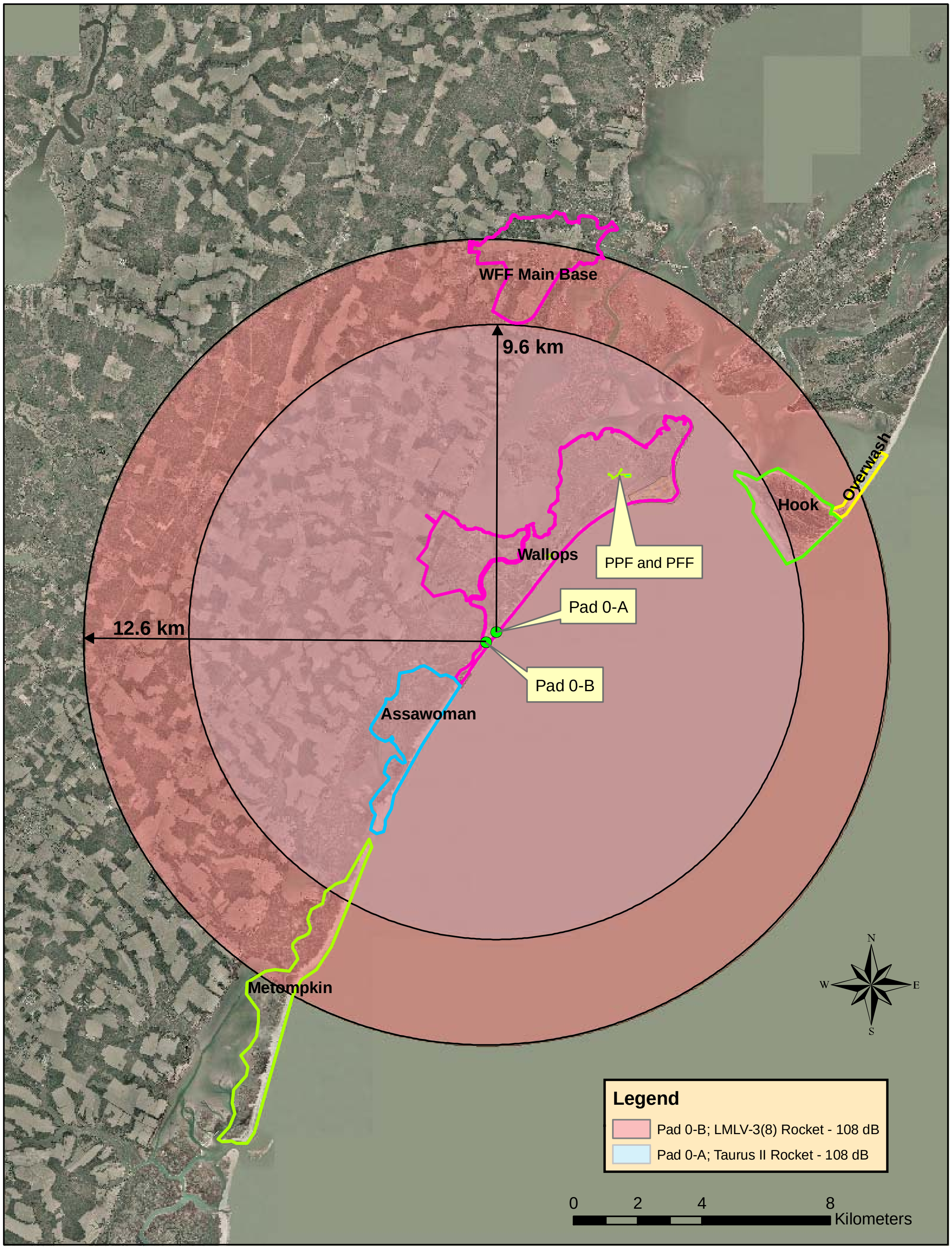

Figure 3 – Action Area

2.3.1. Assateague Island

Assateague Island is a 60 km (37 mi) long barrier island located off the eastern coast of Maryland and Virginia. The portion of the Island within the action area is managed by the USFWS as part of the Chincoteague National Wildlife Refuge (CNWR).

The two principal areas on Assateague potentially affected by the proposed action include those referred to as the Hook and the Overwash. The Hook is the southernmost portion of Assateague Island. The area begins south of the Assateague Beach Coast Guard Station and extends for 5.5 km (3.4 mi). The Hook consists of tidal flats and pools, small-vegetated dunes, wide beach areas, and shrub-scrub habitat. The Overwash is the area between the southernmost public beach parking lot and the Assateague Beach Coast Guard Station. The Overwash is 2.6 km (1.6 mi) in length. The area consists of small dunes and low-lying shell flats.

2.3.2. Wallops Island

Wallops Island is an 11 km (6.8 mi) long barrier island located southwest of Assateague Island; Chincoteague Inlet separates the two islands. The island has been utilized by NASA since WFF's establishment in 1945.

The island is generally classified into three portions. The northern portion is largely undeveloped. It consists of a rapidly accreting beach, backed by an Atlantic maritime forest residing on an ancient dune and swale system which gradually descends to an estuarine salt marsh to the west. Large stands of the invasive species of common reed (*Phragmites australis*) are found in this area.

The center of the Wallops Island is highly developed, with numerous facilities, mown grass areas, scattered areas of scrub shrub species, and large areas of *Phragmites.* Poison ivy (*Toxicodendron radicans)* and greenbriar (*Smilax rotunidifolia*) are present as well. There is no beach in the central portion of Wallops Island. The eastern side of the Island is fronted by a riprap seawall built in the 1990s to protect Wallops infrastructure from the erosion endemic to Atlantic barrier islands. The beach in front of the seawall has washed away. The saltmarsh is to the west and dominated by saltmeadow cordgrass (*Spartina patens*) in the high marsh areas, and saltmarsh cordgrass (*Spartina alterniflora*) in the lower areas.

The southern portion of Wallops Island consists of several rocket launch pads, an Unmanned Aerial Vehicle (UAV) Runway, and an Open Burn area for the destruction of off-specification rocket motors. The southern portion of the Island is subject to severe erosion. In 2006, storms devastated the beach to the east of the UAV runway and presented immediate danger to the runway itself. Geotextile tube structures have been placed along the ocean-land interface as an emergency measure until a more permanent method of protecting the shoreline can be implemented. Wallops Island is narrow at this point, with a thin ribbon of beach seaward of the geotextile tubes, mowed areas and common reed west of the geotextile tubes, and scrub-shrub species such as bayberry, wax myrtle (*Morella spp.)* and groundsel (*Bacchris halmifolia)* fringing the salt marsh to the west.

2.3.3. Assawoman and Metompkin Islands

Assawoman Island is 4.3 km (2.7 mi) long and is immediately south of Wallops Island. Metompkin Island is just south of Assawoman Island; these two islands are separated by Gargatha (Gargathy) Inlet. Assawoman and Metompkin Islands are both undeveloped. Assawoman is owned wholly by the USFWS and is managed as part of the CNWR; USFWS also manages the northern 79 hectares (195 acres) of Metompkin Island. The remainder of Metompkin is owned by The Nature Conservancy. Both islands consist of sandy beaches backed by low dunes and are characterized by frequent overwash areas which provide ideal nesting habitat for shorebirds, including the piping plover.

3. Species Potentially in the Action Area

3.1. Piping Plover

3.1.1. Description and Distribution

The Atlantic Coast piping plover population was listed as threatened on January 10, 1986.

Piping plovers are small, beige and white shorebirds with a black band across their breast and forehead. The plover breeds on coastal beaches from Newfoundland and southeastern Quebec to North Carolina and winter primarily on the Atlantic Coast from North Carolina to Florida, although some migrate to the Bahamas and West Indies. Plovers typically feed on invertebrates such as marine worms, fly larvae, beetles, crustaceans, and mollusks. Feeding areas include intertidal portions of ocean beaches, washover areas, mudflats, sandflats, wrack lines, and shorelines of coastal ponds, lagoons, or salt marshes (USFWS, 2000b)

3.1.2. Nesting

After they establish nesting territories and conduct courtship rituals beginning in late March or early April, piping plover pairs form shallow depressions (nests) in the sand to lay eggs. Nests are situated above the high tide line on coastal beaches, sandflats at the ends of sand spits and barrier islands, gently sloping foredunes, blowout areas behind primary dunes, and washover areas cut into or between dunes. Nest sites are shallow scraped depressions in substrates ranging from fine grained sand to mixtures of sand and pebbles, shells or cobble. They may also nest on areas where suitable dredge material has been deposited. Nests are usually found in areas with little or no vegetation although, on occasion, piping plovers will nest under stands of American beachgrass (*Ammophila breviligulata*) or other vegetation (USFWS, 2000b). Plovers typically lay four eggs that hatch in about 25 days (USFWS, 2007).

3.1.3. Status of Species in the Action Area

Since 1996, when monitoring was initiated at all CNWR units, (including Assateague, Assawoman, and Metompkin) there has been an increasing trend in the number of nesting pairs (Table 1). However, since 2004, nesting has remained static and decreased at the Hook and Overwash areas, respectively, and has increased slightly at Assawoman and north Metompkin. The number of chicks fledged per nesting pair has decreased for all four areas (Table 2).

Table 1. Record of Piping Plover Pairs and Number of Young Fledged at CNWR.

Year	# Pairs	# Young Fledged	Comments
1988[a]	32	27	0.84 young fledged/pair
1989[a]	32	36	1.13 young fledged/pair
1990[a]	42	24	0.57 young fledged/pair
1991[a]	38	30	0.79 young fledged/pair
1992[a]	36	19	0.53 young fledged/pair
1993[b]	41	56	1.37 young fledged/pair
1994[b]	41	71	1.73 young fledged/pair
1995[b]	45	44	0.98 young fledged/pair
1996[c]	51	83	1.63 young fledged/pair
1997[c]	62	43	0.69 young fledged/pair
1998[c]	62	69	1.11 young fledged/pair
1999[c]	55	74	1.35 young fledged/pair
2000[c]	63	98	1.56 young fledged/pair
2001[c]	73	134	1.84 young fledged/pair
2002[c]	76	95	1.25 young fledged/pair
2003[c]	72	147	2.04 young fledged/pair
2004[c]	97	221	2.28 young fledged/pair
2005[c]	118	167	1.42 young fledged/pair
2006[c]	117	121	1.03 young fledged/pair
2007[c]	98	110	1.12 young fledged/pair
2008[c]	117	96	0.82 young fledged/pair

[a] Data from Assateague Island
[b] Data from Assateague, Assawoman, and Metompkin Islands
[c] Data from Assateague, Assawoman, Metompkin, and Cedar Islands

USFWS, 2008a

Table 2. Piping Plover Nesting Activities at the Hook and Overwash Areas on Assateague Island, Assawoman Island, and North Metompkin Island.

AREA	YEAR	NESTING PAIRS	NESTS ATTEMPTS	NO. EGGS	EGGS HATCHED	CHICKS FLEDGED	FLEDGLINGS / NESTING PAIR
Hook	2004	27	30	105	90	70	2.59
	2005	32	39	143	91	58	1.81
	2006	27	30	102	72	37	1.37
	2007	22	30	94	18	24	1.09
	2008	30	36	108	71	21	0.70
Overwash	2004	11	11	43	33	26	2.36
	2005	8	12	48	27	16	2.00
	2006	8	10	29	16	4	0.50
	2007	6	8	22	6	6	1.00
	2008	6	6	20	13	5	0.84
Assawoman	2004	23	23	92	87	61	2.65
	2005	30	37	123	62	34	1.14
	2006	23	25	84	64	28	1.22
	2007	23	25	88	68	40	1.74
	2008	26	35	114	74	30	1.15
North Metompkin	2004	4	4	7	7	7	1.75
	2005	3	6	21	5	3	1.00
	2006	6	7	22	10	9	1.50
	2007	6	6	21	13	10	1.67
	2008	7	8	N/A	N/A	8	1.14

USFWS, 2008b

Piping plover nesting habitat has been delineated on Wallops Island dune and overwash areas at the northern and southern reaches of the property. As south Wallops Island has experienced substantial erosion (3.3 m [11 ft]/year), suitable habitat is increasingly less abundant. According to Mitchell (2009, pers. comm.), no nesting plovers have been observed on south Wallops Island since at least 2000. Simultaneously, north Wallops Island has been accreting, thus presenting additional potential habitat for plover nesting.

Annually between 1996 and 2008, piping plovers were observed feeding, although exact numbers were not recorded. Five nesting attempts were made on north Wallops Island during 2007 and 2008 but none were successful in producing fledglings. During 2006, one pair of plovers nested but the nest was abandoned due to attempted predation by a fox. Nests were also observed in 2005 (2 pairs, 1 nest lost to fox predation and second pair chicks were lost); 2004 (1 pair – 3 chicks fledged); 2001 (1 pair unsuccessful); 1998 (1 pair unsuccessful); 1996 (3 pairs with 2 chicks total fledged). There were no nests observed in 2003, 2002, 2000, 1999, and 1997 (Table 3).

In 2009, four piping plover pairs have attempted nests on north Wallops Island. Of these, three have been successful at producing at least seven fledglings (Scharle, 2009).

Table 3. Record of Piping Plover Pairs and Number of Young Fledged at WFF.

Year	# Pairs	# Young Fledged	Comments
1986	2	0	All at south end of Island
1987	2	3	1.5 young fledged/pair; All at south end
1988	0	0	No nesting
1989	5	Unknown	All at south end
1990	5	Unknown	All at south end
1991	3	Unknown	All at south end
1992	4	5	1.25 young fledged/pair; All at south end
1993	3	4	1.33 young fledged/pair; All at south end
1994	3	2	0.67 young fledged/pair; All at south end
1995	2	4	2.00 young fledged/pair; All at south end
1996	3	2	0.67 young fledge/pair; 1 pair, 0 fledged at south end
1997	0	0	No nesting
1998	1	0	
1999	0	0	No nesting
2000	0	0	No nesting
2001	1	0	
2002	0	0	No nesting
2003	1	0	A pair of plovers scraped, but made no other attempts at nesting
2004	1	3	3.00 young fledged/pair
2005	2	0	One nest was predated (fox), the other nest hatched by the chicks were later lost
2006	1	0	Nest was set up with enclosure; a fox tried digging under enclosure to get nest but did not succeed. The nest however was abandoned due to this event.
2007	3	0	All nests were exclosed. One nest was predated by a fox, one nest lost to tide
2008	2	0	2 pairs of plovers scraped at north end, but made no other attempts at nesting

NASA, 2008

3.2. Loggerhead Sea Turtle

3.2.1. Description and Distribution

The loggerhead sea turtle was listed as a federally threatened species on July 28, 1978.

The loggerhead is perhaps the most common of the sea turtles and the only one that still regularly nests on the U.S. Atlantic Coast, on beaches from New Jersey to Florida. This reddish-brown turtle averages 0.9 m (3 ft) in length and weighs about 136 kilograms (kg) (300 pounds [lbs]). The loggerhead sea turtle's powerful jaws are well suited to eating hard-shelled prey. It feeds on crabs and other crustaceans, mollusks, jellyfish, and sometimes fish and eelgrass (New York DEC, 2006a). Loggerhead sea turtles are found globally, preferring temperate and subtropical waters. In the western Atlantic, they range from the Canadian Maritime Provinces south to Argentina. Within its range, the species inhabits warm waters on continental shelves and areas among islands. Estuaries, coastal streams, and salt marshes are preferred habitats. The loggerhead is the only recurrent nesting species of sea turtle in southeastern Virginia, occurring, during summer, in the Chesapeake Bay south of Baltimore and within all the major tributaries to the Bay, along the Virginia and Maryland Atlantic coast, and in the lagoons and channels in the barrier island systems (Lutcavage and Musick, 1985; Dodd, 1988).

3.2.2. Nesting

Loggerhead nesting in the U.S. typically occurs from Florida to Virginia Beach, Virginia, although there are some recorded nestings as far north as New Jersey (Pritchard, 1979). Musick (1988) concluded that the occasional nestings on beaches as far north as Virginia Beach are beyond the periphery of the normal breeding range. Loggerhead females nest on ocean beaches and occasionally on estuarine shorelines with suitable sand. Nests are typically made between the high tide line and the dune front. Females deposit eggs on a 2-4 year cycle, and produce an average of 1-7 nests in any one breeding season (Ehrhart, 1979; Dodd, 1988; Ernst et al., 1994). Nesting in southeastern Virginia generally occurs from late May through July, with an occasional nest produced in August.

3.2.3. Status of Species in the Action Area

From 1974 to 2006, there were 17 confirmed sea turtle nests on CNWR, all of which were loggerheads (USFWS, 2008a). Seven of these nests were located within the action area (six in the Overwash area, and one on the Hook).

In mid-July 2008, a loggerhead nest was discovered by NASA personnel on north Wallops Island (Figure 1). Following flood inundation from several fall storms, CNWR personnel recovered approximately 170 eggs from the nest in October 2008. None were viable.

3.3. Green Sea Turtle

3.3.1. Description and Distribution

The green sea turtle was listed as a federally protected species on July 28, 1978. The breeding populations in Florida and the Pacific coast of Mexico are listed as endangered; elsewhere the species is listed as threatened.

Green sea turtles are the largest of all the hard-shelled sea turtles, but have a comparatively small head. While hatchlings are just 50 millimeters (2 inches [in]) long, adults can grow to more than 1.2 m (4 ft) long and weigh 136 to 159 kg (300 to 350 lbs). Adult green sea turtles are unique among sea turtles in that they are herbivorous, feeding primarily on seagrasses, sea lettuce, and algae. Other organisms living on sea grass blades and algae add to the diet (Mager, 1985). This diet is thought to give the turtles greenish colored fat, from which they take their name. A green sea turtle's carapace is smooth and can be shades of black, gray, green, brown, and yellow. Their plastron is yellowish white. In U.S. Atlantic and Gulf of Mexico waters, green turtles are found in inshore and nearshore waters from Texas to Massachusetts, the U.S. Virgin Islands, and Puerto Rico. In Virginia waters, green sea turtle are occasionally seen, but in concentrations less dense than those of loggerheads (Mansfield, 2001).

3.3.2. Nesting

Within the U.S., green sea turtles nest in small numbers in the U.S. Virgin Islands, Puerto Rico, Georgia, South Carolina, and North Carolina, and in larger numbers in Florida. The Florida green turtle nesting aggregation is recognized as a regionally significant colony (USFWS, 2009a). In August 2005, the first documented green sea turtle nest was discovered in Virginia. (MSTJ, 2005) at Virginia Beach, 75 miles southwest of the action area.. Mature females may nest three to seven times per season at about 10- to 18-day intervals. Average clutch sizes vary between 100 and 200 eggs that hatch usually within 45 to 60 days (Hopkins and Richardson, 1984). Hatchlings emerge, mostly at night, travel quickly to the water, and swim out to sea (Carr, 1986).

3.3.3. Status of Species in the Action Area

There have been no documented occurrences of green sea turtle nesting activity on south Assateague, Wallops, Assawoman, or Metompkin Islands (Daisey, 2009b).

3.4. Leatherback Sea Turtle

3.4.1. Description and Distribution

The leatherback sea turtle was listed as a federally endangered species on June 2, 1970.

The leatherback is the largest, deepest diving, most migratory, and widest ranging of all sea turtles. Leatherbacks normally weigh up to 300 kilograms (660 lbs), and attain a carapace length (straight line) of 140 cm (55 in) (Pritchard, 1983). Its shell is composed of a mosaic of small bones covered by firm, rubbery skin with seven longitudinal ridges or keels. The diet of the leatherback consists primarily of soft-bodied animals such as jellyfish and tunicates, juvenile fishes, amphipods, and other soft organisms but it also feeds on sea urchins, squid, crustaceans, blue-green algae, and floating seaweed (USFWS, 2006a). Leatherback turtles may pass through the mid-Atlantic during migration. Concentrations may be found between the Gulf of Maine and Long Island, New York (Shoop and Kenney, 1992). They may also be found in coastal areas of New Jersey and Delaware, as well as around the mouth of the Delaware Bay (USACE, 1995).

3.4.2. Nesting

In the U.S., leatherbacks nest mainly on the Florida coast, although they have been known to nest infrequently as far north as North Carolina. Leatherback females tend to nest on high wave energy, sandy ocean beaches. Females emerge from the swash 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. Mature females may nest 1 to 9 times per season at about 9- to 17-day intervals. Average clutch sizes vary between 50 and 170 eggs that hatch usually within 50 to 70 days (Hopkins and Richardson, 1984). Hatchlings emerge, mostly at night, travel quickly to the water, and swim out to sea.

3.4.3. Status of Species in the Action Area

There have been no documented occurrences of leatherback nesting activity on south Assateague, Wallops, Assawoman, or Metompkin Islands (Daisey, 2009b).

In 1996, a leatherback was observed 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.

3.5. Seabeach Amaranth

3.5.1. Description and Distribution

Seabeach amaranth was listed as a federally threatened species on April 7, 1993.

Seabeach amaranth is an annual plant found on the dunes of Atlantic Ocean beaches. The stems are fleshy and pink-red or reddish, with small rounded leaves that are 1.3 to 2.5 cm (0.5 to 1.0 in) in diameter. The leaves, with indented veins, are clustered toward the tip of the stem and have a small notch at the rounded tip. Flowers and fruits are relatively inconspicuous, borne in clusters along the stems. Germination occurs over a relatively long period of time, generally from April to July. Upon germination, the species forms a small unbranched sprig, but soon begins to branch profusely into a clump. This clump often reaches 30 cm (12 in) in diameter and consists of five to 20 branches. Occasionally, a clump may get as large as a meter (3 ft) or more across, with 100 or more branches.

Historically, seabeach amaranth occurred in 31 counties in nine states from Massachusetts to South Carolina. Seabeach amaranth occurs on barrier island beaches, where its primary habitat consists of overwash flats at accreting ends of islands and lower foredunes and upper strands of noneroding beaches. It occasionally establishes small temporary populations in other habitats, including sound-side beaches, blowouts in foredunes, and sand and shell material placed as beach replenishment or dredge spoil. Seabeach amaranth occupies a narrow beach zone that lies at elevations from 0.2 to 1.5 m (0.7 ft to 5 ft) 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 (Weakley and Bucher, 1992).

Landward, seabeach amaranth does not occur more than approximately one meter (3 ft) 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 that are experiencing high rates of erosion. Seabeach amaranth is never found on beaches where the foredune is scarped by undermining water at high or storm tides (Weakley and Bucher, 1992).

Seabeach amaranth appears to be intolerant of competition and does not occur on well-vegetated sites. The species appears to need extensive areas of barrier island beaches and inlets, functioning in a relatively natural and dynamic manner. These characteristics allow it to move around in the landscape as a fugitive species, occupying suitable habitat as it becomes available.

The species is currently found in New York, New Jersey, Delaware, Maryland, Virginia, North Carolina, and South Carolina (USFWS, 2009b).

3.5.2. Status of the Species in the Action Area

The species was rediscovered on Assateague Island in 1998, the first time in more than 30 years that amaranth had been observed on the island. Data from CNWR indicate that plant numbers have varied substantially. Since 2001, as many as 69 plants and as few as 0 plants have been identified on CNWR; of those, only 1 plant has been found in the action area. A single plant was identified in the Hook area in 2004 (USFWS, 2008a).

Although suitable habitat exists to support the species on both north and south Wallops Island and the beaches of Assawoman and Metompkin Islands, no known occurrences have been recorded.

3.6. Red Knot

3.6.1. Description and Distribution

The red knot is currently a candidate species for protection under the Endangered Species Act.

The red knot is a medium-sized shorebird that undertakes an annual 30,000 km (19,000 mi) hemispheric migration, from breeding grounds in the high Arctic to wintering grounds in Patagonia and Tierra del Fuego. The birds' final stopover during the northern migration is the Delaware Bay, which is the most crucial spring stopover because it is the final stop at which the birds feed on the eggs of spawining horseshoe crabs in preparation for their nonstop leg to the Arctic. The birds rest and feed in the Delaware Bay between late April and early June with the population peaking May 15th through 30th (Baker et al., 2004).

The red knot principally uses marine habitats during migration. Coastal habitats along the mouths of bays and estuaries are preferred, providing sandy beaches to forage (Harrington, 1996; 2001). High wave-energy is associated with these areas (Harrington et al., 1986; Vooren and Chiaradia, 1990; Blanco et al., 1992). Red knots are also known to use tidal flats in more sheltered bays or lagoons in search of benthic invertebrates or horseshoe crab eggs (Harrington et al. 1986; Harrington 1996, 2001; Tsipoura and Burger, 1999).

3.6.2. Status of the Species in the Action Area

During its northern migration, the Virginia barrier islands provide an important stopover area for a large number of individuals In the mid-1990s, 3 years of aerial surveys showed that numbers of red knots moving through the barrier islands of Virginia between mid-May and the second week of June reach 8,000 to 10,000 individuals (Watts and Truitt, 2000). During the 2009 migration season flock sizes of 100 to 145 birds were observed in the Overwash and Hook areas of Assateague Island. In late May 2009, flocks of 5 to 30 individuals were observed on south Assawoman Island. On May 8, USFWS observed a flock size of almost 1,300 individuals on north Wallops Island (USWS, 2009c). In late May 2009, flocks of approximately 20 to 200 red knots were observed on north Wallops Island (USFWS, 2009c).

4. Effects of the Actions

4.1. Piping Plover

4.1.1. Direct and Indirect Effects

Under the proposed action, no construction is planned for areas within known piping plover nesting habitat. Noise from the construction activities would be of short duration and would likely present minor startle reactions. Temporary interruption of foraging and nesting activities for piping plover may occur as a result of static fire tests and launch activities. The nesting area designated on the northern end of Wallops Island is approximately 6.7 km (4 mi) from Pad 0-A and 7.2 km (4.5 mi) from Pad 0-B. Calculations were performed using a formula employed by the WFF Range Safety Office to estimate noise levels based upon rocket motor thrust and distance from the launch pad (NASA, 1973). Taurus II launches and static fire tests would generate noise levels of approximately 111 dB at the northern Wallops Island nesting area. This area is not expected to be adversely affected by emissions or noise. The northernmost point of the designated plover habitat on the southern end of the island is approximately 1.55 km (1.0 mi) from Pad 0-A and 1.1 km (0.7 mi) from Pad 0-B. Noise levels of 124 dB would be expected from Taurus II launches and static fire tests at this northernmost point; 129 dB would be expected from the ongoing LMLV-3(8)-class launches.

Noise generated from rocket launches is generally low-frequency, of short duration, and occurs infrequently. Naturally occurring background noises in the nesting area, such as heavy wave action (up to 119 dB at 300 hertz) and nearby thunder 120 dB, (Stewart, 1994; LHH, 2005) are more frequent and of longer duration than noise from a rocket launch. Moreover, USFWS monitoring of piping plover nests on Assawoman Island after the only orbital launch to occur from Pad 0-B during plover nesting season found no apparent anomalous behavior among the nesting plovers (Daisey, pers. comm., 2009a).

The 1997 USFWS guidance for managing fireworks near piping plover habitats recommends that a minimum 1.2 km (0.75 mi) distance be established between the piping plover nests and fireworks. These same guidelines were referenced by USFWS in its July 14, 1997, Biological Opinion for construction of Pad 0-B. Fireworks noise outputs would be comparable to the noise intensity at Pad 0-A or 0-B during a launch or static fire and would likely last for a considerably longer period of time. As launches and static fire tests under the Proposed Action would occur at a greater distance and shorter duration than those discussed in the 1997 USFWS fireworks guidance, no substantial effect on the piping plover is anticipated. Ongoing launches from Pad 0-B would occur closer than guidance distance of 1.2 km (0.75 mi) from the nearest potential habitat, however the noise would be of short duration, also presenting no substantial effects.

Open burning of sounding rocket motors occurs approximately 75 m (250 ft) north of the piping plover habitat on the southern end of Wallops Island. Employing the same formula referenced above that correlates rocket motor thrust to noise, expected noise levels at the northernmost plover nesting boundary would be approximately 138 dB for a mid-sized sounding rocket motor. In a letter dated February 27, 1998, from NASA to USFWS, NASA summarized a telephone conference between USFWS, VDGIF, and NASA. The telephone conference discussed the 1997 USFWS Biological Opinion on impacts to the piping plover and the agreement that NASA could conduct year-round open burning of rocket motors at the open burning site located north of the southern piping plover habitat without adversely impacting the piping plovers. Consequently, the twice per year 52-second static firing related to the Proposed Action also would not result in adverse impacts on the piping plover or its habitat.

Air quality modeling conducted for the launch of Taurus II at WFF showed that the limit of the near-field exhaust cloud ("near field" is defined as the region near the launch pad where the rocket exhaust cloud is formed) would extend approximately 200 m (660 ft) away from Pad 0-A during static fire and approximately 100 m (330 ft) away from Pad 0-A during launch. The cloud would then begin to rise into the atmosphere where it would reach a "ceiling," and then drift back down to the ground (NASA, 2009b). Because of wind and atmospheric mixing, the exhaust cloud is predicted to move a minimum of approximately 5 km (3 mi) downwind from Pad 0-A before "touching down." By the time the exhaust cloud has moved downwind and resettled, the constituents from the rocket exhaust would be significantly dispersed and their concentrations significantly lowered. No adverse effect upon piping plover would be expected.

NASA's 1997 Launch Range Expansion EA assessed the peak concentrations of hydrogen chloride, carbon monoxide, and aluminum oxide from a solid rocket motor (the LMLV-3[8]) at a distance of 1.4 km (0.87 mi); this distance was selected because it is the boundary to the nearest sensitive receptor from Launch Pad 0-B, piping plover nesting habitat. A comparison of the estimated peak concentrations of the three exhaust compounds at a distance of 1.4 km (0.87 mi) to the OSHA Threshold Limit Values (TLV)-Time Weighted Average (TWA) for Chemical Substances demonstrated that their levels were well below exposure standards established to protect human worker health. TLV-TWA values were chosen for comparison purposes because these limits are more conservative than the TLV-Short Term Exposure Level exposure indices. Human health exposure standards have been established well below levels shown to affect laboratory animals (NASA, 1997).

Indirect effects to nesting plovers may occur from security patrols on the Wallops beach during times prior to launch, however with the active plover monitoring program currently in use along the WFF beach, such effects are highly unlikely.

4.1.2. Actions to Reduce Adverse Effects

NASA would continue to coordinate with CNWR and U.S. Department of Agriculture (USDA) personnel in monitoring the Wallops Island beach for piping plover activity. These personnel routinely monitor Assateague, Wallops Island, Assawoman, and Metompkin Island beaches for piping plovers during nesting season. Any nests discovered would be appropriately marked with a Global Positioning System (GPS) unit, identified with signage, and closed to personnel or visitor access.

Additionally, educational signs would be posted at all beach access points to raise awareness of the species and to provide contact information. Basic species identification would be included in the natural resources training module of the WFF Environmental Management System (EMS), a requirement of all new employees at the facility. WFF would continue to distribute its annual piping plover nesting announcement; this annual message is sent to all WFF employees informing them of the potential for encountering the protected species.

Frequency of roving security patrols is expected to decrease in the future as closed circuit TV cameras are installed on Wallops Island to survey all of the beach areas. Patrols would be limited to responses to incursions detected by these cameras.

4.1.3. Conclusion

The effects from the proposed and ongoing actions would be infrequent and given historical nesting sites of piping plovers, likely be limited to startle effects, and NASA will continue to monitor for plovers and implement mitigation measures. However, NASA cannot discount the possibility that plovers will nest in areas that have not been heretofore utilized for that purpose, whereupon effects upon the species may be more substantial. Therefore, NASA concludes that the actions “may affect,” and are “likely to adversely affect” the piping plover. However, with implementation of the above monitoring and mitigation measures, the effects will be minimized to the greatest extent possible.

4.2. Loggerhead, Green, and Leatherback Sea Turtles

4.2.1. Direct and Indirect Effects

Under the Proposed Action, interior and exterior facility lighting would be necessary to maintain required visibility for safety, security, and mission preparation requirements. The proposed Payload Processing Facility, approximately 650 m (2,130 ft) from the north Wallops Island Beach; and the proposed launch complex at existing Pad 0-A, approximately 200 m (650 ft) from the south Wallops Island beach, would present sources of artificial light during times when sea turtles may be nesting. Additionally, under current operations, Pad 0-B, which is located immediately west of the south Wallops Island beach, would be lit during pre-launch preparations. It is expected that lighting would be visible to nesting turtles and hatchlings within the action area.

Artificial lighting can be detrimental to sea turtles in several ways. Field observations have shown a correlation between lighted beaches and reduced sea turtle nesting (Mortimer, 1982, Raymond 1984, Mattison et al., 1993). Witherington (1992a) directly correlates artificial lighting with deterring sea turtles from nesting. In these experiments, loggerhead turtles showed a strong tendency to avoid beaches with artificial lights that have predominantly blue and green wavelengths.

Adult females rely on visual brightness cues to find their way back to the ocean after nesting, those that nest on lighted beaches may be disoriented and have difficulty finding their way back to the ocean. In the lighted beach experiments described by Witherington (1992a), few nesting turtles returning to the sea were misdirected by lighting; however those turtles that were distracted spent a large portion of the night wandering in search of the ocean.

Hatchling sea turtles, which typically emerge from nests at night, move toward the brightest, most open horizon, which is over the ocean. However, bright light sources on or near the beach may attract hatchlings in the wrong direction, exposing them to predation, desiccation, entrapment in debris or vegetation, and exhaustion. Artificial lights can also disorient hatchlings once they reach the water. Hatchlings have been observed to exit the surf onto land where lighting is nearby (Daniel and Smith, 1947; Carr and Ogren, 1960; Witherington, 1986).

Loggerhead turtles demonstrate a strong preference for short-wavelength light (Witherington and Bjorndal, 1991, Witherington, 1992b). Loggerheads are most strongly attracted to light in the near ultraviolet to green region and showed differing responses to light in the yellow region of the spectrum depending on light intensities. At intensities of yellow light comparable to a full moon or a dawn sky, loggerhead hatchlings showed an aversion response to yellow light sources, but at low, nighttime intensities, loggerheads were weakly attracted to yellow light.

Witherington and Martin (1996) draw a simple conclusion regarding problem lighting: “an artificial light source is likely to cause problems for sea turtles if light from the sources can be seen by an observer on the beach.” If any glowing portion of a luminaire is directly visible on the beach, then this source of light is likely to be a problem for sea turtles. Bright or numerous sources of lights, especially those directed upward, will illuminate sea mist and low clouds, creating a distinct sky glow visible from the beach.

Nesting turtles could also be directly affected by rocket exhaust immediately adjacent to launch pad 0-A. Effects could include burns, auditory effect (deafening), and potential asphyxiation from elevated levels of carbon monoxide in the exhaust plume. Effects from pad 0-B would be similar; with the exception that hydrogen chloride gas would be expected in exhaust from solid-fueled rockets (NASA, 1997).

Such effects are highly unlikely as noise and lighting from pre-test and launch operations would likely deter the female turtle from nesting nearby. Additionally, as estimated from the rocket exhaust modeling performed for the proposed launch of the Taurus II launch vehicle, toxic plumes at ground level would only be expected within approximately the first 100 m (330 ft) of the launch pad (NASA, 2009b). The nearest beach is approximately 200 m(660 ft) south of pad 0-A and is immediately adjacent to pad 0-B, however that area is regularly inundated by the tides, precluding it from being a viable sea turtle nest site. The area with the nearest beach suitable for turtle nesting (i.e., contains sand above the high tide line) is more than 1,000 m and 550 m (42,000 ft and 1,800 ft) away from 0-A and 0-B, respectively.

The low frequency vibrations caused by a static fire test or rocket launch could affect the success of sea turtle nests. Sea turtle embryos become attached to egg walls within six to twelve hours after deposition (Boulon 1999, Sill et al. 2000, NCWRC 2003). The embryo is sensitive and can be dislodged from the egg wall with minimal movement or rotation resulting in death (Boulon 1999, Sill et al. 2000, Katz and Ambrosy 2001, NCWRC 2003). As with the effects of the exhaust, the potential for such effects is low as the nearest suitable nesting beach is more than 1,000 and 550 m (42,000 ft and 1,800 ft) south of launch pads 0-A and 0-B, respectively. Additionally, recent experience at Cape Canaveral Air Force Station indicates that the three Space Shuttle launches that have taken place during the 2009 turtle nesting season have not produced substantial adverse effects; over 900 nests were present with the closest nests approximately 500 m (1,600 ft) from Launch Complex 39 (Shaffer, pers. comm., 2009).

Indirect effects to nesting turtles and hatchlings may occur from security patrols during times prior to launch. Without proper minimization measures, vehicles can crush eggs, kill hatchlings, and disturb nesting adults; tire ruts can trap hatchlings attempting the reach the ocean (NMFS and USFWS 1991a, NMFS and USFWS 1991b, NMFS and USFWS 1992, Fangman and Rittmaster 1993, Nester and Frazer 2007).

4.2.2. Actions to Reduce Adverse Effects

To mitigate the effects of lighting from the proposed facilities, NASA and MARS would install "turtle friendly" exterior lighting on all new facilities. Low pressure sodium lighting, which are monochromatic and emit only yellow wavelengths, would be installed to the greatest extent allowable under safety, facility security, and operational requirements. Additionally, shielding measures would be employed to reduce the likelihood of adult and hatchling disorientations and misorientations.

Illumination of these facilities would be kept to a minimum until operations or pre-launch preparations dictated their necessity. Launch vehicle uplighting is currently employed at pad 0-B and is planned for Pad 0-A, however it would only be in use when the vehicle is physically sitting on the pad, which would typically be no more than 24-48 hours prior to launch. Employing similar lighting management measures at Cape Canaveral Air Force Station has successfully reduced estimated turtle hatchling misorientations from over 4 percent in 1989 to less than 0.01 percent in 1999 (USFWS, 2000a).

NASA would continue to coordinate with CNWR and USDA personnel in monitoring the Wallops Island beach for sea turtle activity. These personnel routinely monitor Assateague, Wallops Island, Assawoman, and Metompkin Island beaches for piping plovers during nesting season. Sea turtle nesting activity would be expected during this same time. Any nests discovered would be appropriately marked with a GPS unit, identified with signage, and closed to personnel and visitor access. During the expected hatch window, the path between the nest and the surf zone would be cordoned off to ensure that ruts from off-road vehicles do not preclude hatchlings from safely reaching the ocean.

Additionally, educational signs would be posted at all beach access points to raise awareness of the species and to provide contact information. Basic species identification would be included in the natural resources training module of the WFF Environmental Management System (EMS), a requirement of all new employees at the facility. WFF would add sea turtles to its annual piping plover nesting announcement; this annual message is sent to all WFF employees informing them of the potential for encountering the protected species.

Frequency of roving security patrols is expected to decrease in the future as closed circuit TV cameras are installed on Wallops Island to survey all of the beach areas. Patrols would be limited to responses to incursions detected by these cameras.

4.2.3. Conclusion

Lighting of the proposed and existing facilities would be a necessity for their safe and effective operation. Security patrols must occur to ensure facility security. Noise and vibrations would be inherent with test and launch operations. Therefore, NASA concludes that these actions “may affect,” and are “likely to adversely affect” the loggerhead, green, and leatherback sea turtles. However, with implementation of the above monitoring and mitigation measures, the effects will be minimized to the greatest extent possible.

4.3. Seabeach Amaranth

4.3.1. Direct and Indirect Effects

Under the proposed action, all construction activities would be located outside of the beach and dune environment within which the species is found. Under both the proposed and ongoing actions, the species could be susceptible to scorching from hot rocket exhaust, however as the nearest suitable habitat (beach above normal high tide line) is currently 1.1 km (0.7 mi) south of the southernmost launch pad, adverse effects would be highly unlikely.

Potential indirect adverse effects on seabeach amaranth from both the proposed and ongoing orbital launch operations include trampling or crushing of unprotected plants by pedestrian or vehicular traffic (e.g., roving security patrols) on the beach.

4.3.2. Actions to Reduce Adverse Effects

Seabeach amaranth would be expected to grow in areas suitable for both piping plover and sea turtle nesting. As such, NASA would continue to coordinate with CNWR and USDA staff during their monitoring efforts along the Wallops Island beach. If discovered, plants would be marked with a GPS unit and symbolically fenced to provide a minimum 3 m (10 ft) buffer zone around individual plants or groups of plants. Additionally, educational signs would be posted at all beach access points to raise awareness of the species and to provide contact information. Basic species identification would be included in the natural resources training module of the WFF EMS, a requirement of all new employees at the facility. WFF would also add seabeach amaranth to its annual piping plover nesting announcement to better communicate the potential for encountering the plant on the Wallops Island beach.

As discussed for sea turtles, the decrease in security patrols on the Wallops Island beach will likely reduce the potential for adversely affecting the protected plant.

4.3.3. Conclusion

Although the potential for individual plants to be affected by the proposed and ongoing operations exists, it is very remote. Based on very low species density in the area, and with the implementation of mitigation measures such as regular surveys, employee education, and exclusion if identified, NASA determines that the adverse effects of both the proposed and ongoing orbital launch operations at WFF "may affect," but are "not likely to adversely affect" seabeach amaranth.

4.4. Red Knot

4.4.1. Direct and Indirect Effects

Under the proposed action, all construction activities would be located outside of the beach and lagoon environments within which the species typically would stopover and/or feed.

Operations under the proposed and ongoing actions, including pre-launch preparations, static fire tests, and launches, could initiate a startle response in individuals foraging along the nearby beaches or in the lagoon environment toward the west. Effects would likely be temporary, with the birds leaving the area due to the high intensity, short duration noise event.

The potential for acute adverse effects including scorching, inhalation of toxic rocket exhaust gases, and deafening exists, however it is very unlikely as unnatural noise and lighting from pre-test and launch operations would likely deter the birds from inhabiting the areas within the immediate vicinity of the launch pads prior to and during orbital launch operations.

Indirect effects on the species could be expected from roving security patrols and would likely initiate a startle effect from those individual foraging or resting on the nearby beach.

4.4.2. Actions to Reduce Adverse Effects

Red knots would be expected to be present in areas suitable for both piping plover and sea turtle nesting during similar times of year. As such, NASA would continue to coordinate with CNWR and USDA staff during their monitoring efforts along the Wallops Island beach. Additionally, educational signs would be posted at all beach access points to raise awareness of the species. Basic species identification will be included in the natural resources training module of the WFF EMS, a requirement of all new employees at the facility. WFF would add the red knot to its annual piping plover nesting announcement; this annual message is sent to all WFF employees informing them of the potential for encountering the protected species.

4.4.3. Conclusion

The effects on the red knot would likely be confined to temporary startle effects that may disrupt feeding, and any adverse effects would be highly unlikely. Therefore, if the red knot is listed as a threatened or endangered species in the future, NASA determines that the proposed and continuing actions "may affect," but are "not likely to adversely affect" the red knot.

5. Cumulative Effects

NASA is unaware of any state, tribal, local, or private actions that are reasonably certain to occur within the action area considered in this BA. Federal agencies own and manage a majority of the property in the action area. Additionally, as nearly all of the non-federally owned lagoon areas in the western portion of the action area would be considered either navigable waters of the U.S. or jurisdictional wetlands, such areas would be subject to Clean Water Act and Rivers and Harbors

Act permitting, thus requiring Section 7 Endangered Species Act review. Therefore, NASA is not aware of any cumulative effects in the action area.

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