ES-02/331

Russel J. Wilson, Superintendent
Sandy Hook Unit, Gateway National Recreation Area
National Park Service
P.O. Box 530
Fort Hancock, New Jersey 07732

Dear Mr. Wilson:

This letter transmits the U.S. Fish and Wildlife Service's (Service) final Biological Opinion, in accordance with Section 7 of the Endangered Species Act of 1973, as amended (16 U.S.C. 1531 *et seq*.) (ESA), on the effects of the National Park Service's (NPS) proposed Interim Beach Fill at the Critical Zone and South Beach areas of the Sandy Hook Unit of Gateway National Recreation Area (Sandy Hook) on the federally listed (threatened) piping plover (*Charadrius melodus*) and seabeach amaranth (*Amaranthus pumilus*). The proposed project consists of a one-time placement of sand along approximately 915 meters (3,000 feet) of Sandy Hook's southern Atlantic shoreline. The NPS anticipates that work will begin during the first week of September 2002, and continue for approximately 3 weeks. Although the federally listed (threatened) northeastern beach tiger beetle (*Cicindela dorsalis dorsalis*) occurs within the project's action area, this species is not likely to be adversely affected by the Interim Beach Fill. Therefore, the northeastern beach tiger beetle is not included in this Biological Opinion.

The Service received your May 1, 2002 concurrence with our March 4, 2002 draft Biological Opinion. Your May 1 letter reiterates that all conservation measures proposed by the NPS, as summarized within this Biological Opinion (pages 13 and 14), will be included as part of the Interim Beach Fill project. Your letter also indicates that the NPS agrees to implement the reasonable and prudent measures included in the Incidental Take Statement found at the end of this Biological Opinion. The reasonable and prudent measures will be implemented as described in the terms and conditions of this Opinion.

Service biologists are available to provide technical assistance regarding fulfillment of the terms of this consultation, and any conservation recommendations that the NPS elects to carry out in furtherance of your Section 7(a)(1) responsibilities. In addition, the Service would like to conduct a site visit during project implementation; Service biologists will contact Bruce Lane of your staff to make arrangements.

The Service appreciates your cooperation in satisfying the requirements of Section 7(a)(2) of the ESA, and your efforts to minimize adverse effects to federally listed species from the Interim Beach Fill project. If you have any questions or concerns regarding this consultation, please contact John C. Staples or Wendy Walsh of my staff at (609) 646-9310, extensions 18 and 48, respectively.

Sincerely,

Clifford G. Day
Supervisor

Enclosure

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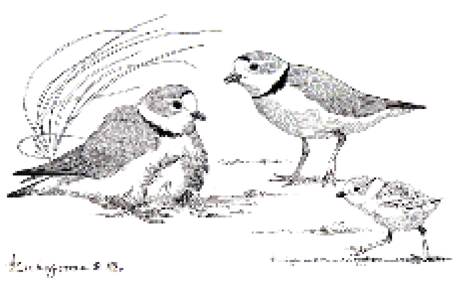
Final: jg 5/24/02

BIOLOGICAL OPINION ON THE EFFECTS OF AN INTERIM BEACH FILL AT THE CRITICAL ZONE AND SOUTH BEACH AREAS OF THE SANDY HOOK UNIT OF GATEWAY NATIONAL RECREATION AREA, MONMOUTH COUNTY, NEW JERSEY ON THE PIPING PLOVER (*Charadrius melodus*) AND SEABEACH AMARANTH (*Amaranthus pumilus*)



Prepared for:

National Park Service
Gateway National Recreation Area, Sandy Hook Unit
Fort Hancock, New Jersey 07732

May 2002

BIOLOGICAL OPINION ON THE EFFECTS OF AN INTERIM BEACH FILL AT THE CRITICAL ZONE AND SOUTH BEACH AREAS OF THE SANDY HOOK UNIT OF GATEWAY NATIONAL RECREATION AREA, MONMOUTH COUNTY, NEW JERSEY ON THE PIPING PLOVER (*Charadrius melodus*) AND SEABEACH AMARANTH (*Amaranthus pumilus*)

Prepared for:

National Park Service
Gateway National Recreation Area, Sandy Hook Unit
Fort Hancock, New Jersey 07732

Prepared by:

U.S. Fish and Wildlife Service
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May 2002

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I. INTRODUCTION

This document represents the U.S. Fish and Wildlife Service's (Service) Biological Opinion, in accordance with Section 7 of the Endangered Species Act of 1973, as amended (16 U.S.C. 1531 *et seq*.) (ESA), on the effects of the National Park Service's (NPS) proposed Interim Beach Fill at the Critical Zone and South Beach areas of the Sandy Hook Unit of Gateway National Recreation Area (Sandy Hook) on the federally listed (threatened) piping plover (*Charadrius melodus*) and seabeach amaranth (*Amaranthus pumilus*). The proposed project consists of a one-time placement of approximately 253,000 cubic yards of sand along approximately 915 meters (m) (3,000 feet) of Sandy Hook's southern Atlantic shoreline. Although the federally listed (threatened) northeastern beach tiger beetle (*Cicindela dorsalis dorsalis*) occurs within the action area, this species is not likely to be adversely affected by the Interim Beach Fill. Therefore, the northeastern beach tiger beetle is not included in this Biological Opinion.

Beach nourishment may potentially impact beach strand-dependent species, both directly and indirectly. Preclusion of natural habitat formation, such as creation of inlets and overwash, is often the most significant, and unavoidable, effect of beach nourishment on such species, including the piping plover and seabeach amaranth. If the current annual sand deficit at the Critical Zone persists, the proposed Interim Beach Fill project will forestall inlet formation by up to 6 years, in the absence of other projects or measures to intervene. An inlet in this area, and the overwash preceding a breach, would almost certainly provide highly productive habitat for piping plovers and seabeach amaranth. These events will be curtailed by the proposed project. The Interim Beach Fill will provide temporary benefits to piping plovers and seabeach amaranth by widening an eroding section of beach which would otherwise provide increasingly unsuitable habitat. However, the benefits to piping plovers of maintained habitat in the Critical Zone are negated by reproductive data suggesting that this nesting area constitutes a population sink for this species, probably due to less suitable habitat and higher levels of recreational disturbance than are found in other Sandy Hook nesting areas.

Other potentially severe adverse effects of beach nourishment include disturbance of nesting piping plovers, destruction of seabeach amaranth plants, and burial of the seabeach amaranth seed bank. By planning the Interim Beach Fill outside of the piping plover breeding season, the NPS will entirely avoid direct adverse effects to this species. To offset direct adverse effects to seabeach amaranth, the NPS has collected seed and propagated it at a qualified facility. Plants and/or seed will be returned to the project area after completion of the Interim Beach Fill to ensure that the present seabeach amaranth population persists in the Critical Zone. The NPS has also committed to assign additional staff at the Critical Zone as necessary to enforce shorebird area closures to minimize recreational disturbances to nesting piping plovers. These conservation measures, proposed by the NPS, effectively avoid, minimize, or offset many of the potential adverse impacts from the proposed Interim Beach Fill project. These conservation measures were central in the Service's formulation of this Biological Opinion.

A complete administrative record of this consultation is on file in the Service's Ecological Services, New Jersey Field Office.

II. CONSULTATION HISTORY

A. BACKGROUND

The proposed beach fill project is intended as an interim measure to address erosion at an area of Sandy Hook's southern Atlantic shoreline known as the Critical Zone. Persistent erosion at the Critical Zone threatens vehicular access to the Sandy Hook peninsula, park infrastructure, and important historic and natural features. Since 1974, the NPS has conducted beach nourishment projects every 5 to 7 years to maintain the shoreline at the Critical Zone. Previous fills were conducted in 1977, 1982-83, 1989-90, 1996-97, and 1997-98 (National Park Service, 2001a). In accordance with the ESA, the NPS has consulted with the Service on the effects of past fill projects on federally listed species.

Since 1990, management of the Critical Zone has involved responding to critical erosion situations as they arose, including a series of smaller beach fills. The NPS is currently developing a long-range proposal to provide cyclic, maintenance beach replenishment at the Critical Zone, in order to depart from the "crisis management" approach (National Park Service, 2001a). The long-term alternative currently preferred by the NPS involves the construction of a permanent slurry pipeline that will be used to pump sand from an on-shore borrow area at the Gunnison Beach section of Sandy Hook to the Critical Zone on a regular maintenance schedule (National Park Service, 2000a). The NPS has conducted ongoing informal consultation with the Service regarding the proposed Sand Slurry Pipeline since 1997. As part of this consultation, the NPS and the Service reached agreement on several points at a March 13, 2001 meeting, including the formation of a technical focus group that will work to avoid, minimize, and offset adverse impacts to listed species. The Service will issue a separate Biological Opinion if formal consultation is required for the Sand Slurry Pipeline project.

Until a long-range proposal can be designed and all of the possible environmental effects adequately evaluated, the NPS proposes to conduct a short-term, interim replenishment project in conjunction with an ongoing renourishment of northern Monmouth County beaches by the U.S. Army Corps of Engineers, New York District (Corps) (National Park Service, 2001a). This Biological Opinion addresses only the proposed 2002-2003 Interim Beach Fill of Sandy Hook's Critical Zone, including South Beach Areas D and E.

B. CHRONOLOGY OF KEY CORRESPONDENCE, MEETINGS, AND COMMUNICATIONS

July 23, 2001	Via letter, the NPS requested consultation regarding the Interim Beach Fill project, then scheduled between fall 2001 and March 2002.
August 10, 2001	The NPS provided profiles, prepared by the Corps, of the current and proposed Critical Zone shoreline.

September 10, 2001	Via letter, the NPS provided additional project information, and requested informal consultation.
September 21, 2001	Via letter, the Service informed the NPS that formal consultation was required, and requested that the NPS prepare a Biological Assessment (BA) pursuant to Section 7 of the ESA.
October 13, 2001	Via electronic mail, the NPS acknowledged that formal consultation was required, and indicated that its September 10, 2001 letter would serve as the BA required of the NPS.
October 15, 2001	Via letter, the NPS transmitted its Environmental Assessment (EA), prepared pursuant to the National Environmental Policy Act (83 Stat. 852; 42 U.S.C. 4321 *et seq*.).
November 7, 2001	The Service met with NPS staff to conduct a site visit of the Critical Zone. NPS staff verbally indicated that the Interim Beach Fill was postponed until after the 2002 piping plover nesting season.
November 9, 2001	Via letter, the Service acknowledged receipt of all information required to initiate formal consultation as of September 10, 2001.
January 22, 2002	Via telephone, NPS staff provided additional information.
January 29, 2002	Via telephone, NPS staff provided additional information. Service and NPS staff mutually agreed to extend the formal consultation period by 30 days, with delivery of the Biological Opinion postponed until March 4, 2002.
February 4, 2002	Via letter, the NPS provided written concurrence with the 30-day extension of the formal consultation period, and transmitted additional paper and electronic information.
February 11, 2002	Via telephone and U.S. Mail, NPS staff provided additional information.
February 15, 2002	Via facsimile, the Service provided a draft project description, including conservation measures, for NPS review.
February 18, 2002	Via telephone, the NPS provided two minor corrections to the draft project description, but otherwise concurred that the draft project description accurately reflected the proposed project and conservation measures.
March 4, 2001	The Service transmitted a draft Biological Opinion.

May 1, 2002	The NPS concurred in writing with the draft Biological Opinion, and agreed to carry out all conservation measures and all reasonable and prudent measures according to their implementing terms and conditions.

III. BIOLOGICAL OPINION

A. DESCRIPTION OF THE PROPOSED ACTION

1. Description of the Action Area

a. Sandy Hook

Located in Monmouth County, Sandy Hook is a recurved sand spit that extends north from central, coastal New Jersey into New York Bay (Figure 1). Approximately 11.25 kilometers (km) (7 miles) long and 690 hectares (1,700 acres) in area, Sandy Hook is bordered to the east by the Atlantic Ocean and to the west by Sandy Hook Bay (National Park Service, 2001a). Sandy Hook is the northern terminus of a barrier peninsula that continues approximately 6.8 km (4.3 miles) south into the Boroughs of Sea Bright and Monmouth Beach, where it separates the Navesink and Shrewsbury Rivers from the Atlantic Ocean. The Sandy Hook spit varies in width from less then 0.16 to 1.6 km (0.1 to 1.0 mile) (National Park Service, 2001a). A unit of the Gateway National Recreation Area, the entire Sandy Hook peninsula is managed by the NPS for natural and historic resources and recreation, except the northern tip, which is U.S. Coast Guard property.

Ringed by oceanfront beaches and bay-side marshes, Sandy Hook preserves one of the few remnant, relatively undisturbed barrier beaches in New Jersey, including various natural habitats (National Park Service, 2001a). Oceanfront beaches support several rare species, including piping plover, seabeach amaranth, northeastern beach tiger beetle, least tern (*Sterna antillarum*) (State-threatened), and seabeach knotweed (*Polygonum glaucum*) (State-endangered). The roseate tern (*Sterna dougallii dougallii*) (federally endangered) and the black skimmer (*Rynchops niger*) (State-endangered) have also used these oceanfront beaches in the past. Other habitats on Sandy Hook include shrubby back dune areas, about 21.5 hectares (53 acres) of heath land, approximately 40.5 hectares (100 acres) of fresh and salt water marshes, extensive tidal mud and sand flats, and two maritime forests including 115 hectares (284 acres) of American holly (*Ilex opaca*) (U.S. Fish and Wildlife Service, 1997; National Park Service, 1989; 2001a). The holly forest, unique locally and rare along the Atlantic Coast, is under consideration as a National Natural Landmark (National Park Service, 2001a).

The entire Sandy Hook peninsula is part of the Fort Hancock and Sandy Hook Proving Ground National Historic Landmark (National Park Service, 2001a). Approximately 220 structures of varying historic significance are found on the peninsula, including two structures individually listed in the National Register of Historic Places (National Park Service, 1989). The park provides recreational opportunities, such as swimming, sun-bathing, picnicking, beach-combing, surfing, hiking, and fishing, to 2.3 million visitors per year. In addition, approximately 1,000 employees work on Sandy Hook at several facilities housing State and federal agencies, schools, and private organizations (National Park Service, 2001a).

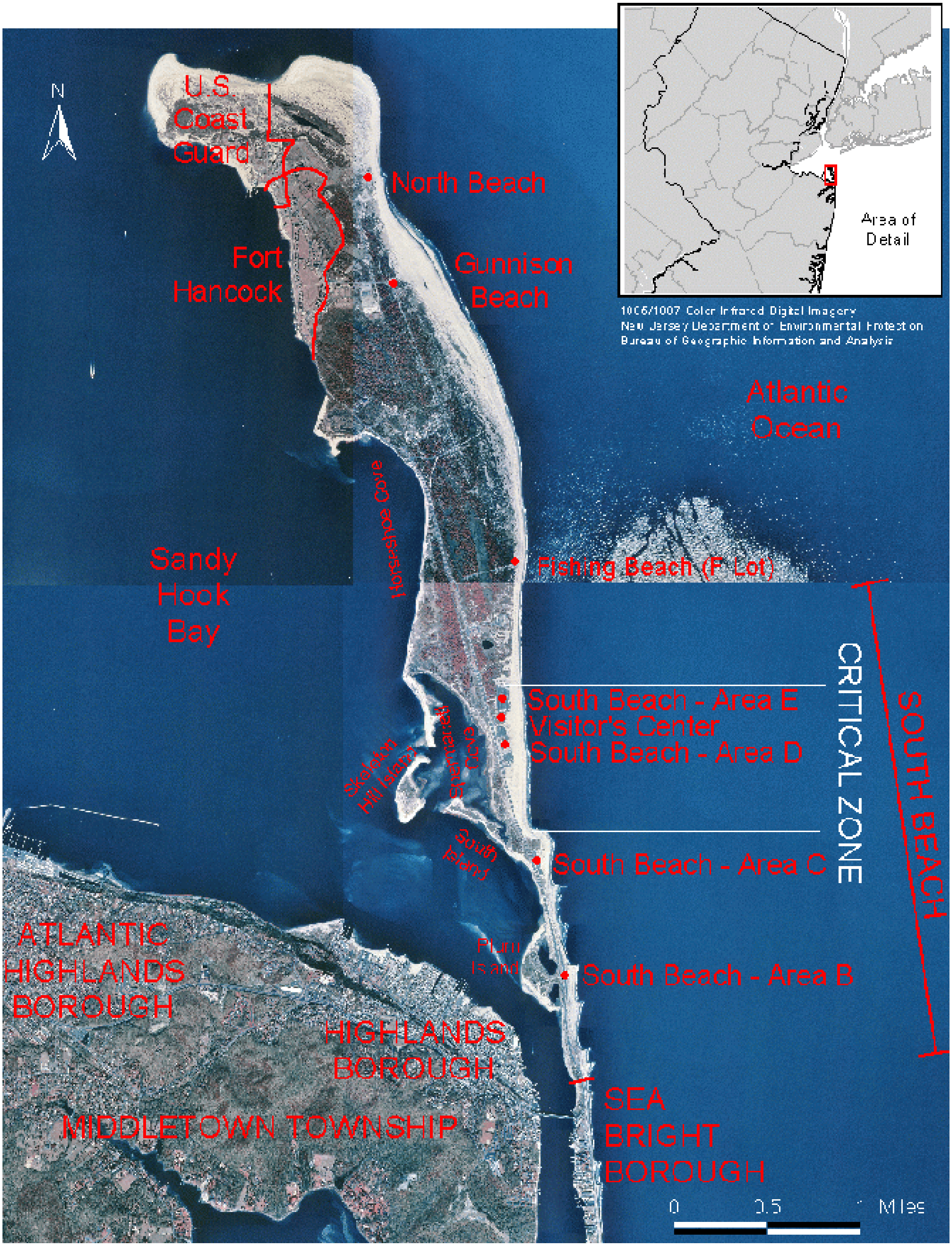

Figure 1. Project Location

The Atlantic shores of New Jersey are dynamic, high-energy beach environments, characterized by shifting sands, pounding surf, strong wave action, and a semi-diurnal tidal cycle (U.S. Army Corps of Engineers, 1990). Alongshore currents on the central New Jersey coast run from south to north. These currents cause a northbound littoral drift, which tends to erode sand from Monmouth Beach, Sea Bright, and Sandy Hook's southern beaches and eventually deposit it at the accreting northern end of the spit. In the past, natural episodes of overwash and breaching have occurred at the narrow, southern portion of Sandy Hook. The peninsula was breached and became an island at least six times during the 18th and 19th Centuries (Hoffman, pers. comm., 2001). Later periods of deposition restored the peninsular connection.

In recent decades, erosion of southern Sandy Hook has accelerated because of man-made coastal structures. Jetties and groins built over the previous century in Monmouth Beach, Sea Bright, and southern Sandy Hook, and a sea wall running approximately 2 km (1.5 miles) north from the park's southern boundary, prevent sand from reaching Sandy Hook's southern beaches. These beach protection structures, designed to prevent erosion, actually interfere with the northern littoral drift of sand along the shoreline (National Park Service, 2001a). Hard stabilization structures also interfere with coastal processes by attempting to freeze the shoreline in place, halting the natural process of shoreline migration. These structures generally have the effects of accelerating erosion and curbing accretion.

b. Critical Zone

Erosion is particularly intense just north of the seaward-curving northern terminus of Sandy Hook's seawall in an area known as the Critical Zone (Lane, pers. comm., 2002). Since the 1974 designation of Sandy Hook as a unit of the NPS, periodic overwash of the Critical Zone from both bay and ocean sides has occurred (Hoffman, pers. comm., 2001). Overwash has resulted in occasional closures of Hartshorne Drive, the only vehicle access onto the peninsula. Although sand is periodically deposited at the Critical Zone, the amount is insufficient to counter losses due to erosion (National Park Service, 2001a). Periodic beach fills using sand from various sources, such as harbor channel dredging, Gunnison Beach, and an off-shore borrow area, have forestalled a breach at the Critical Zone in recent years (U.S. Army Corps of Engineers, 1990; National Park Service, 2001a). Previous fills were conducted by the NPS in 1977, 1982-83, 1989-90, 1996-97, and 1997-98. Despite these measures, road closures continue, as recently as the late 1990s (National Park Service, 2001a). Since 1997, erosion rates at the Critical Zone have slowed considerably, and previously eroded beaches south of the Critical Zone have actually accreted significantly, due to several factors discussed below (Psuty, 2001; National Park Service, 2001a).

The current beach profile at the Critical Zone is the result of complex interactions among numerous factors, both natural and the result of human interference. The primary influences on Critical Zone beach widths and elevations include: (1) ongoing erosional forces intensified by man-made coastal structures to the south; (2) the 287,500-cubic-yard beach fill conducted between December 1997 and

March 1998; (3) Corps beach nourishment projects south of Sandy Hook, particularly the 1995-96 fill in Sea Bright and Monmouth Beach; (4) a transitory shoal that periodically forms at the northern end of the seawall; and (5) an artificial dune line stabilized by sand fencing and planted vegetation (Psuty, 2001; National Park Service, 2001a).

A generalized cross section of Sandy Hook is shown in Figure 2. Moving east from Hartshorne Drive, the Critical Zone profile rises about 2 m, then levels off in a 6-m-wide plateau. From this elevation, the artificial dune rises about another 2-3 m, stabilized landward by woody vegetation plantings, seaward by beach grass plantings and sand fencing arranged in a zig-zag pattern. In front of the dune, a sloping berm lies at a maximum elevation of about 3 m above the National Geodetic Vertical Datum (NGVD), varying in width from roughly 15 to 30 m (Lane, pers. comm., 2002).

In the Critical Zone in 2000, the total distance from the nearest park infrastructure to the water varied from approximately 50 to 150 m. In 2000, this “distance to the water” measurement showed a net increase in the southern two-thirds of the Critical Zone, but a net decrease in the northen third (near Beach Areas D and E). Current distances to the water are adequate to protect park infrastructure, but visitor facilities at Beach Areas D and E are less protected than is Hartshorne Drive at the southern end of the Critical Zone. The Critical Zone shoreline was extended seaward by the 1997-98 beach replenishment, but subsequently moved landward due to erosion. The location of the shoreline in 2000 was about mid-way between its maximum and minimum positions during the post-fill period (Psuty, 2001).

Intensive monitoring of Critical Zone beaches since 1997 has allowed the NPS to measure changes in total sand volumes in the area, and to detect patterns of volume change. The total annual sand deficit in the Critical Zone has decreased in recent years. For at least a decade prior to the 1997-98 replenishment, the annual sand deficit was approximately 200,000 cubic yards (Lane, pers. comm., 2002). From the 1998 post-fill maximum volume through the end of 2000, the annual deficit was roughly 55,000 cubic yards (Psuty, 2001). Erosion rates fell even further in 2001, with the annual deficit from the 1998 post-fill maximum volume through the end of 2001 dropping to approximately 43,000 cubic yards (Psuty, pers. comm., 2002). The reduced sand deficit is due to a series of relatively storm-free years, the transfer of sand from 1997-98 beach fill north along the Critical Zone, and the transport of fill material from beach nourishment projects south of Sandy Hook into the Critical Zone. A pulse of sand released from the shoal in 2000 was also a contributing factor to the lowered annual deficit. Sand volumes show a seasonal pattern, with maximum volumes tending to occur in mid- to late summer, minimum volumes in winter. Spatial patterns have also been observed. There is pulsing of sediment through the Critical Zone, suggesting that the distal (north) portion responds to the accumulation or release of sediment from the updrift (south) portion (Psuty, 2001).

Several storm protection structures have been constructed in the Critical Zone. The southern portion of the Critical Zone is backed by a sheet metal bulkhead, which runs about 180 m (600 feet) north along Hartshorne Drive from the northern end of the seawall. A large, conical dune is maintained in front of the Visitor’s Center, and a low, flat-topped linear dune is maintained in front of Beach Area D.

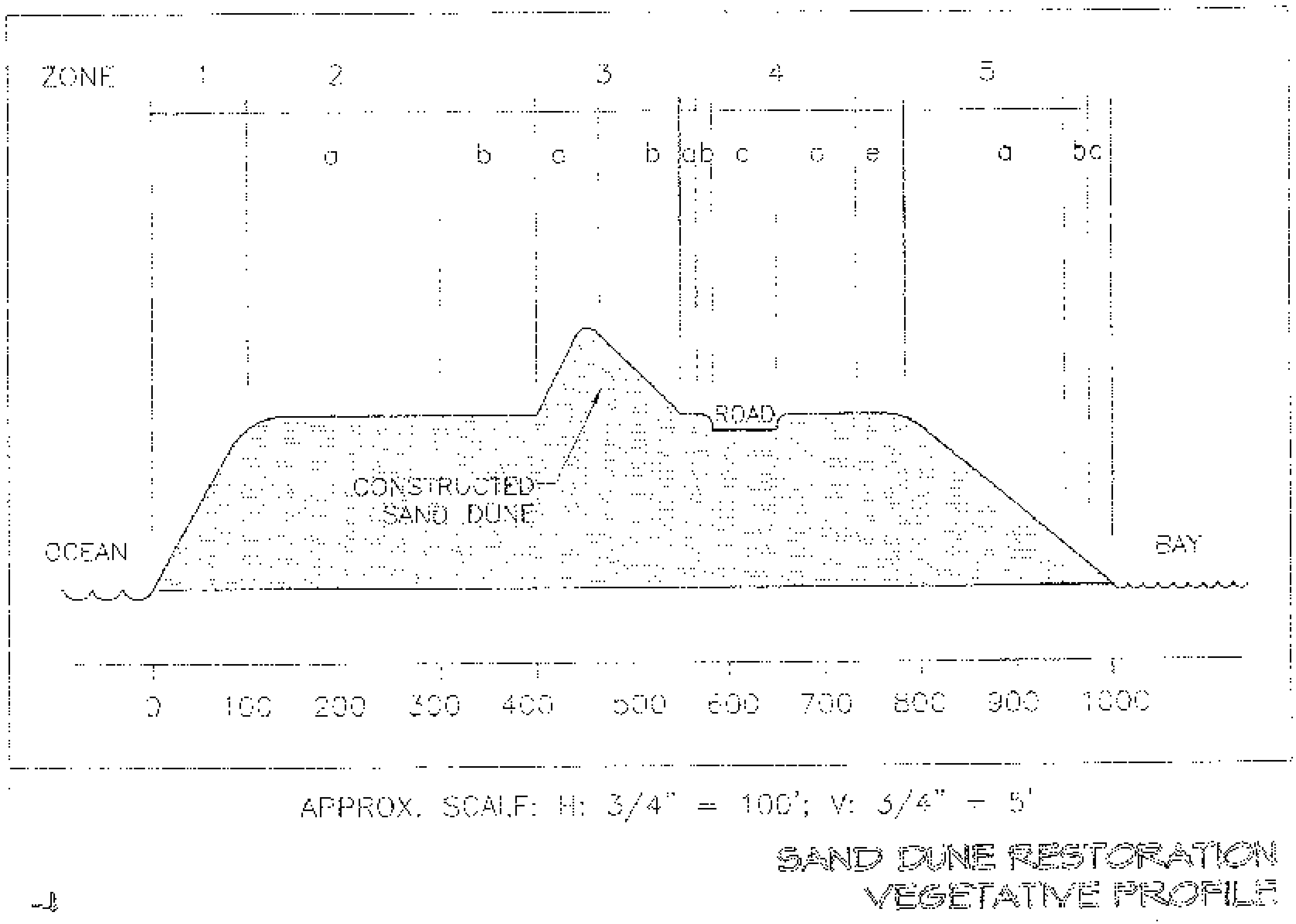

Figure 2. Generalized Cross Section of Sandy Hook (Duffy *et al*., 1998).

c. Definition of the Action Area

For the purposes of consultation pursuant to Section 7 of the ESA, federal regulations define the "action area" as all areas to be affected directly or indirectly by the federal action and not merely the immediate area involved in the action (50 CFR 402.02). Approximately 915 m (3,000 feet) of shoreline at the Critical Zone (hereafter referred to as the "project area") will be directly affected by sand deposition. This area runs from the northern end of the seawall to the southern end of Beach Area E (Figure 3). Engineering plans provided by the NPS show the proposed hydraulic beach fill varies in width from about 90 to 150 m (about 300 to 500 feet), including approximately 15 to 75 m (50 to 250 feet) of fill seaward of the present mean high water line (Figure 4). An additional 15 to 40 m (50 to 125 feet) of existing berm and dune areas landward of the hydraulic fill will be directly affected by construction activities (shown on plans as "Contractors Working Area") (U.S. Army Corps of Engineers, 2001a).

Offshore areas will also be directly affected, including the borrow area from which sand will be dredged (Figure 5), and the subtidal zone seaward of the project area (U.S. Army Corps of Engineers, 1990; 1995). Federally listed species occurring within offshore portions of the action area are under the jurisdiction of the National Marine Fisheries Service (NMFS), and are not included in this Biological Opinion. Separate consultation with the NMFS will be required if adverse impacts to federally listed marine species are anticipated as a result of project implementation.

Other areas will be indirectly affected by the proposed project, and are therefore included in the action area. The shoreline down-drift of the project area will be indirectly affected by the Interim Beach Fill. Sand volumes deposited in down-drift areas, including Gunnison Beach and North Beach, are expected to increase slightly for several years following completion of the project. Any areas that will receive storm protection will also be indirectly affected by the Interim Beach Fill. These areas include a portion of Hartshorne Drive; Beach Centers D and E; and natural and historic bay-side features along Spermaceti Cove, including salt marshes, tidal flats, and the holly forest. Finally, by forestalling a breach and thereby preserving vehicle access, the proposed Interim Beach Fill project indirectly affects the entire Sandy Hook peninsula from the Critical Zone north.

Based upon known species ranges and distributions, no federally listed species in areas other than those described above are likely to be adversely affected by the proposed project. Thus, the above-mentioned areas comprise the entire action area.

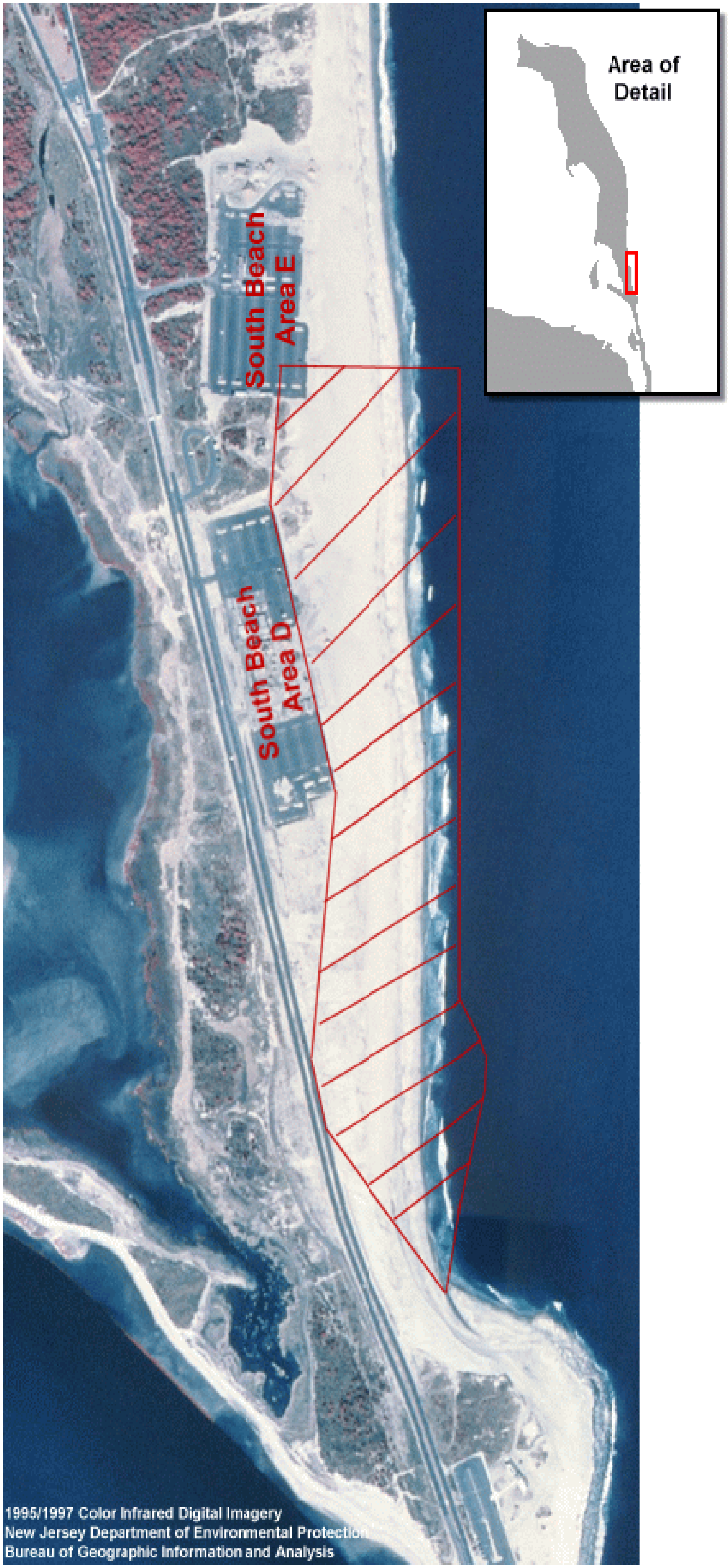

Figure 3. Project Area - Approximate Limits of Work

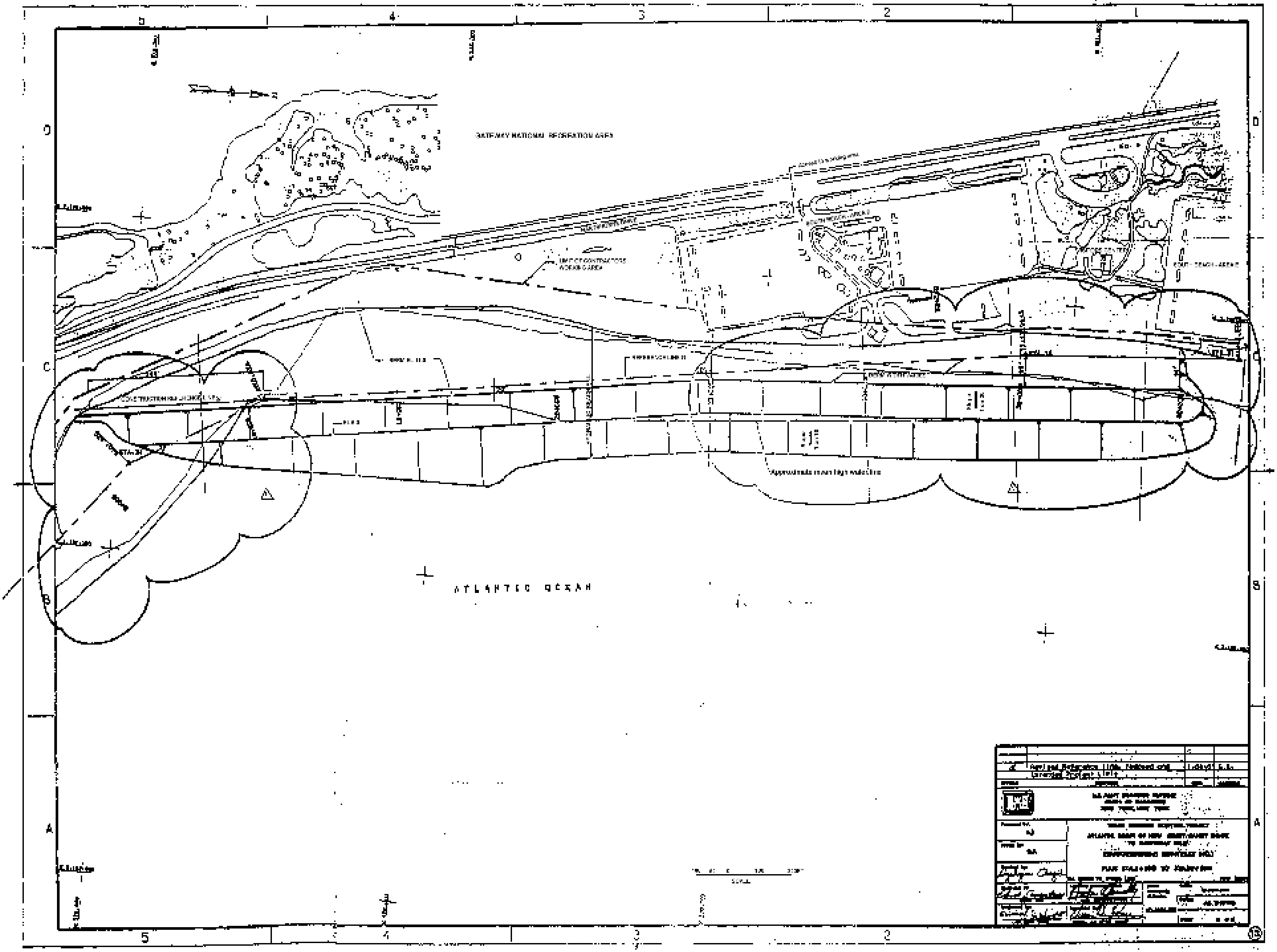

Figure 4. Project Area - Engineering Plans (U.S. Army Corps of Engineers, 2001a)

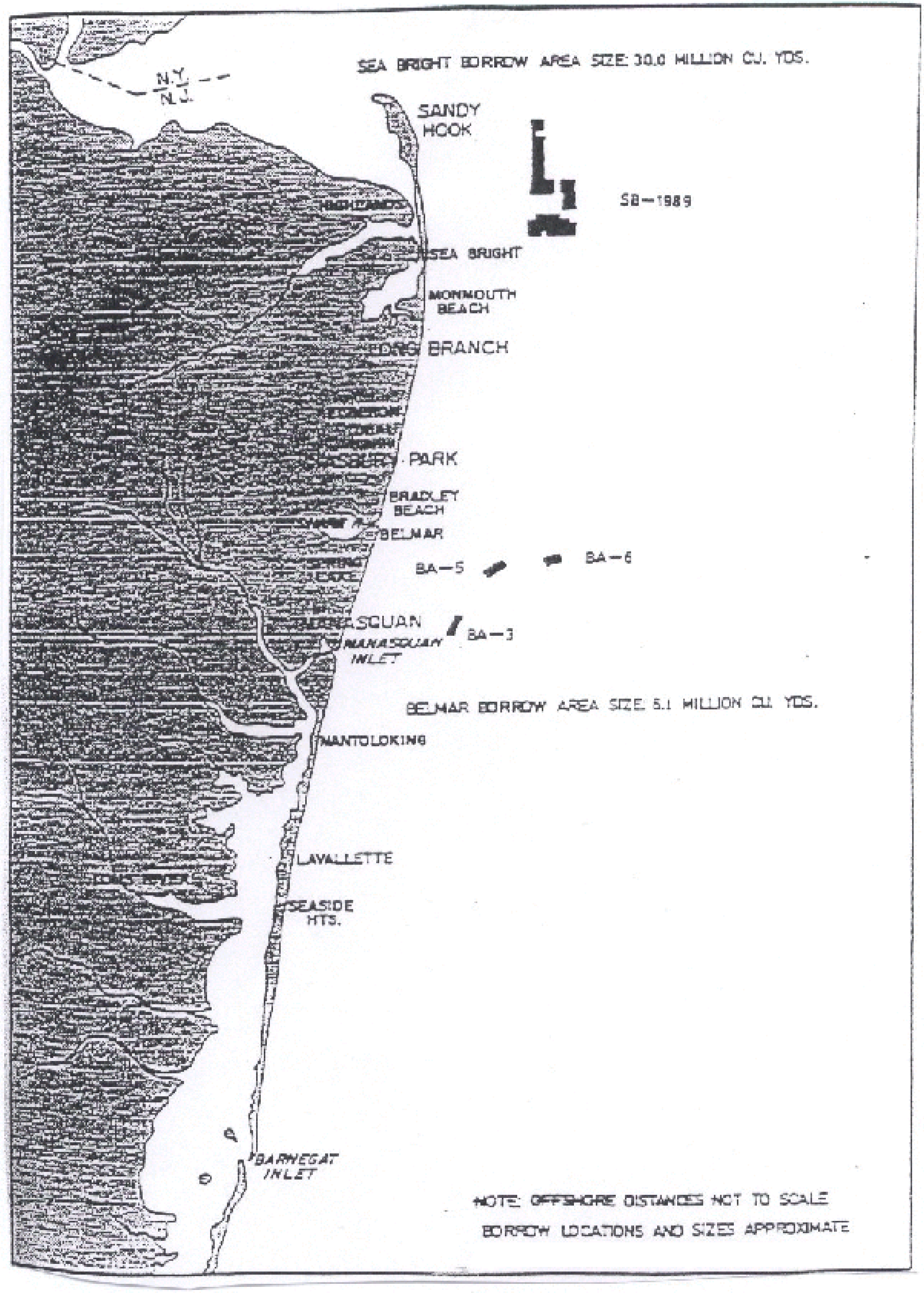

Figure 4. Sea Bright Borrow Area (SB-1989) (U.S. Army Corps of Engineers, 1995).

2. Project Overview and Schedule

The proposed Interim Beach Fill involves the transport 253,000 cubic yards of sand from the designated offshore borrow area to the project area, and the subsequent manipulation of fill to achieve the targeted beach profile. The 1989 Sea Bright borrow area is located approximately 2.9 km (1.8 miles) east of Sandy Hook (see Figure 5). The sand will be extracted from the borrow area using a hopper dredge, pumped out via a mooring platform, and transported directly to the project area by a temporary, floating pipeline. Once deposited on the beach, the sand will be graded by onshore earth-moving equipment (National Park Service, 2001a). The proposed project does not include vegetation planting or sand fencing.

Project plans call for a construction template (target beach profile) of a flat, variable-width berm lying at 3.3 m above the NGVD. Seaward of the berm, plans call for a 61-m-wide beach with a slope of 1:20 for the first 30.5 m, 1:10 for the second 30.5 m. This second, most seaward section of fill widens to about 60 m toward the southern end of the project area, then tapers to meet the shoreline (Figure 4) (U.S. Army Corps of Engineers, 2001a). No additional sacrificial subtidal fill volumes (advance fill or feeder beaches) are included in the proposed project (Lane, pers. comm., 2002). Plans allow for a 0.3-m (1-foot) construction tolerance on top of the planned template (U.S. Army Corps of Engineers, 2001a).

Plans show some areas receiving only small amounts of fill, generally in the intertidal area. Other areas, however, will receive fill along the entire beach profile seaward of the dune, in some places up to 3 m deep. Beach Areas C and/or D will be used to access the project area and for equipment staging (Lane, pers. comm., 2002). Equipment, machinery, and construction crews will be present throughout the entire Contractors Working Area during construction.

The Interim Beach Fill will begin on or after August 28, 2002. Project implementation is expected to take approximately 3 weeks. All beach fill work will be completed by March 1, 2003, including grading of fill and removal of all equipment, pipeline, and construction crews from the project area (Lane, pers. comm., 2002).

3. Conservation Measures

As part of the proposed Interim Beach Fill project, the NPS will carry out the following measures to avoid and minimize adverse effects to piping plovers and seabeach amaranth (National Park Service, 2001a).

1. The project is scheduled to take place outside the piping plover nesting season to avoid direct impacts to this species.

2. The sand used in the fill will be from the same borrow area as the 1997-98 fill and will conform

with the existing sand on the beach at the Critical Zone.

3. If piping plovers nest on renourished areas, all protection measures that have previously been implemented in the park to protect nesting areas from predators and public use will be implemented, including closing the beach for a distance of 100 m from any nest site. Protection measures and monitoring efforts are those outlined in the Service recovery plan for Atlantic Coast piping plovers (U.S. Fish and Wildlife Service, 1996a) and the Sandy Hook Unit Piping Plover Management Plan (National Park Service, 1992). The latter document includes closure of the intertidal zone in nesting areas while chicks are present.

4. Due to the proximity of the Critical Zone to recreational bathing beaches, additional NPS staff will be assigned as necessary to enforce shorebird area closures.

5. The project area will be surveyed for seabeach amaranth in mid- to late August. If work does not begin by September 15, the project area will be surveyed again within 1 week prior to the start of work.

6. During the survey immediately preceding the start of work, the location of seabeach amaranth plants outside of the fill template will be marked and protected with string lines to prevent any disturbance of the immediate area by construction personnel or vehicles involved in the fill project.

7. To offset anticipated mortality of any plants within the fill template and burial of the seed bank, and to ensure that seabeach amaranth populations persist within the Critical Zone, plants and seeds have been collected and stored for a post-fill restoration project. In early October 2001, approximately 10 plants were removed from the fill template and transported to the U.S. Department of Agriculture Cape May Plant Materials Center (CMPMC). Two plants survived the transport. In addition, a vacuum was used to collect seed from several of the remaining plants in the Critical Zone. Six bags containing a mix of sand and seed, weighing about 55 kilograms each, were transported to the CMPMC for cold storage. A portion of the collected seed will be germinated in a greenhouse, and established plants will be transplanted to the project area in early summer 2003. Adjusted for the expected level of mortality, the number of transplants will be sufficient to ensure that the 2003 population of seabeach amaranth in the Critical Zone is returned to at least the level documented in the August 2002 survey. Additional plants and seed above this level may be returned to the project area at the discretion of the NPS.

B. SPECIES STATUS

Relevant biological and ecological information considered by the Service in formulating this Biological Opinion is presented below. Appropriate information on the species life histories, habitats, distribution, and other factors affecting species survival is included to provide background for analyses in later sections. This section also documents the effects of past human and natural activities or events that have led to the current status of the piping plover and seabeach amaranth.

1. Piping Plover

a. 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). On January 10, 1986, the piping plover was listed as endangered and threatened pursuant to the ESA. Protection of the species under the ESA reflects the species' precarious status range-wide. Three distinct populations were identified and listed separately: Atlantic Coast (threatened), Great Lakes (endangered), and Northern Great Plains (threatened). 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 (U.S. Fish and Wildlife Service, 1985). On July 10, 2001, the Service designated critical habitat for wintering piping plovers, including areas used by wintering plovers from the Atlantic Coast population. Critical habitat was also designated in the Great Lakes breeding area on May 7, 2001, and proposed for the Northern Great Plains breeding area on June 12, 2001 (U.S. Fish and Wildlife Service, 2001a). No critical habitat has been designated or proposed in the Atlantic Coast breeding area.

The recovery plan for the Atlantic Coast population of the piping plover (U.S. Fish and Wildlife 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 (see Table 1 for goals and current status). 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 re-colonization of any sites that experience declines or local extirpations due to low productivity or temporary habitat succession. The plan further states: "A premise of this plan is that the overall security of the Atlantic Coast piping plover population is profoundly dependent upon attainment and maintenance of the minimum population levels for the four recovery units. Any appreciable reduction in the likelihood of survival of a recovery unit will also reduce the probability of persistence of the entire population." In accordance with the Endangered Species Consultation Handbook (U.S. Fish and Wildlife Service and National Marine Fisheries Service, 1998), since recovery units have been established in an approved recovery plan, this Biological Opinion considers the effects of the proposed project on piping plovers in the New York - New Jersey Recovery Unit, as well as the Atlantic Coast population as a whole.

Table 1. Comparison of Piping Plover Population Estimates and 10-Year Average Productivity with Recovery Criteria by Recovery Unit[1]

Recovery Unit	1999 Population Estimate (Number of Breeding Pairs)	Minimum Subpopulation Needed for Recovery (Number of Breeding Pairs)	1999 Population Estimate as Percent of Recovery Goal (%)	Average Productivity 1990-1999 (Number of Chicks Fledged per Pair)	Percent of Breeding Population 1990-1999 on Which Productivity Estimate is Based (%)	Average Productivity Needed for Recovery (Number of Chicks Fledged per Pair)
Atlantic Canada	230	400	57.5	1.56	51.7	1.5
New England	624	625	99.8	1.59	96.7	1.5
New York-New Jersey	350	575	60.9	1.09	82.5	1.5
Southern	182	400	45.5	1.00	75.0	1.5
U.S. Total	1156	1600	72.3	1.33	87.6	1.5
Atlantic Coast	1386	2000	69.3	--	--	1.5

1 Final 2000 and preliminary 2001 Atlantic Coast nesting season results were unavailable as of the date of this Biological Opinion

b. Life History

Piping plovers 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 1 year of age (MacIvor, 1990; Haig, 1992); however, the percentage of birds that breed in their first adult year is unknown.

Piping plover nests can be found 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. 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.*, 1990; 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 (*Ammophila breviligulata*) or other vegetation (Patterson, 1988; Flemming *et al.*, 1990; MacIvor, 1990). Plover nests may be very difficult to detect, especially during the 6- to 7-day egg-laying phase when the birds generally do not incubate (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 4 to 8 hours of each other.

Piping plovers generally fledge only a single brood per season, but may renest several times if previous nests are lost. Chicks are precocial (Wilcox, 1959; Cairns, 1982). They may move hundreds of meters from the nest site during their first week of life (U.S. Fish and Wildlife Service, 1994), and chicks may increase their foraging range up to 1,000 m before they fledge (are able to fly) (Loegering, 1992). Chicks remain together with one or both parents until they fledge at 25 to 35 days of age. Depending on 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; nests, 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 also respond to intruders (avian and mammalian) in their territories by displaying a variety of distraction behaviors, including squatting, false brooding, running, and injury feigning. 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). Studies have shown that 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 piping plover 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 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).

Migration patterns are poorly understood. Most piping plover surveys have focused on breeding or wintering sites. Northward migration occurs during late February, March and early April, and southward migration extends from late July to August and September. Both spring and fall migration routes are believed to occur primarily within a narrow zone along the Atlantic Coast (U.S. Fish and Wildlife Service, 1996a).

c. Status on the Atlantic Coast and in the New York-New Jersey Recovery Unit

(1) Historical Population Trends

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, 1987). 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, 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 Cairns and McLaren (1980) and Haig and Oring (1985). While Wilcox (1939) estimated more than 500 pairs of piping plovers on Long Island, New York, the 2000 population estimate was 289 pairs (U.S. Fish and Wildlife Service, 2001b). 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). Further, recent experience of biologists surveying piping plovers has shown that counts of these cryptic birds sometimes goes up with increased census effort. This suggests that some historic counts of piping plover numbers by one or a few observers, who often recorded occurrences of many avian species, may have underestimated the piping plover population. Thus, the magnitude of the species decline may have been even more severe than available numbers imply.

(2) Population Trends Since Listing Under the Endangered Species Act

Table 2 summarizes nesting pair counts for the Atlantic Coast piping plover population 1986, when the species was listed, through 2000.

The apparent increase in numbers of pairs between 1986 and 1989 (Table 2) is thought at least partially to reflect the effects of increased survey efforts following the proposed listing in 1985. Intensified survey effort may have played an especially important role in population estimates for New York and New Jersey. For example, Wich (1993) surmised that, although protection of beach-nesting birds in New York increased after 1983, survey effort also intensified, especially at sites such as Breezy Point, Queens County, and Westhampton Beach, Suffolk County. While the relative contributions of each cannot be determined, he believes that “the stability of more recent [early 1990s] estimates probably accurately reflects the status of New York's plover population.” Ducey-Ortiz *et al.* (1989) documented an increasing plover monitoring effort in New York between 1984 and 1988 and found that, when results from 54 uniformly monitored sites were analyzed, the population trend did not increase or decrease significantly. The New Jersey plover coordinator conjectured that one quarter to one third of the apparent population increase observed in that State between 1987 and 1989 was due to increased survey effort (Jenkins, 1993).

The Atlantic Coast population increased from approximately 950 pairs in 1989 to over 1,400 pairs in 2000, but the increase has been unevenly distributed. From 1989-2000, the New England subpopulation has increased by 424 pairs while the New York-New Jersey subpopulation gained only 58 pairs and the Southern and Atlantic Canada subpopulations declined by 16 pairs and 10 pairs, respectively (U.S. Fish and Wildlife Service, 2001b). While rapid overall population growth between 1991 and 1995, driven largely by the New England subpopulation, was encouraging, recent growth has been more modest, with an essentially flat population trend from 1998 to 2000. The New York-New Jersey subpopulation experienced a net decrease of 43 pairs (11 percent) between 1996 and 1998 and a rebound of 39 pairs by 2000 (U.S. Fish and Wildlife Service, 2001b).

Table 2. Summary of Atlantic Coast Piping Plover Population Estimates, 1986-2000

STATE/UNIT	PAIRS															Goal
	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	
Maine	15	12	20	16	17	18	24	32	35	40	60	47	60	56	50	
New Hampshire	-	-	-	-	-	-	-	-	-	-	-	5	5	6	6	
Massachusetts	139	126	134	137	139	160	213	289	352	441	454	490	495	501	496	
Rhode Island	10	17	19	19	28	26	20	31	32	40	50	51	46	39	49	
Connecticut	20	24	27	34	43	36	40	24	30	31	26	26	21	22	22	
NEW ENGLAND	184	179	200	206	227	240	297	376	449	552	590	619	627	624	623	625
New York[a]	106[b]	135[b]	172[b]	191	197	191	187	193	209	249	256	256	245	243	289	
New Jersey	102[c]	93[c]	105[c]	128	126	126	134	127	124	132	127	115	93	107	112	
NY-NJ UNIT	208	228	277	319	323	317	321	320	333	381	383	371	338	350	401	575
Delaware	8	7	3	3	6	5	2	2	4	5	6	4	6	4	3	
Maryland	17	23	25	20	14	17	24	19	32	44	61[d]	60	56	58	60	
Virginia	100	100	103	121	125	131	97	106	96	118	87	88	95	89	96	
North Carolina	30[e]	30[e]	40[e]	55	55	40	49	53	54	50	35	52	46	31	24	
South Carolina	3	-	-	-	1	1	-	1	-	-	0	-	-	-	-	
SOUTHERN UNIT	158	160	171	199	201	194	172	181	186	217	189[d]	204	203	182	183	400
U.S. TOTAL	550	567	648	724	751	751	790	877	968	1150	1162[d]	1194	1168	1156	1207	1600
ATLANTIC CANADA	240	223	238	233	229	236	236[f]	236[f]	182	199	186	197[g]	204	230	231	400
ATLANTIC COAST	790	790	886	957	980	987	1026	1113	1150	1349	1348[d]	1391	1372	1386	1438	2000

Table 2, continued:

a The only statewide count tallied in New York in 1994-1999 is the window census.

b The recovery team believes that this estimate reflects an incomplete survey effort.

c The New Jersey plover coordinator conjectures that one quarter to one third of the apparent population increase between 1986 and 1989 is due to increased survey effort.

d Reflects correction in 1996 Maryland population from 60 pairs reported in 1996 Status Update to 61 pairs.

e The recovery team believes that the apparent 1986-1989 increase in the North Carolina population is due to intensified survey effort. No actual surveys were made in 1987; estimate is that from 1986.

f 1991 estimate.

g Assumes that the number of pairs in Newfoundland in 1997 was 11 pairs, the same as 1996; Newfoundland reported 35 adults in 1997, up from 27 in 1996, but provided no 1997 estimate for breeding pairs.

(3) Productivity

Productivity needed to maintain a stationary population for Atlantic Coast piping plovers is estimated at 1.24 fledged chicks per pair (Melvin and Gibbs, 1994). However, because small populations may be highly vulnerable to extinction due to variability in productivity and survival rates, the average productivity for a stationary population may be insufficient to assure a high probability of species survival (see discussion of effects of productivity rates on vulnerability to extinction below). Therefore, the recovery plan establishes productivity goals needed to assure a secure 2000-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.

Table 3 provides a summary of piping plover productivity from 1990 to1999[1]. Ten-year (1990-99) average productivity for piping plovers in the Atlantic Coast portion of their range is 1.33 chicks per pair. Peak productivity in the U.S. was observed in 1993 and 1994, when average productivity approached or exceeded the recovery plan productivity goal of 1.5 chicks per pair. However, productivity in 1997 was only 1.16 chicks per pair (based on data from 93 percent of the total U.S. breeding population), the lowest level since 1990 and well below the 1.24 chicks per pair required to produce a stationary population. While weather events were major contributors to egg and chick losses in 1997 (U.S. Fish and Wildlife Service, 1998), 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 impinge on productivity. Productivity results for the 2000 breeding season show a total U.S. average of only 1.17 chicks per pair, again well below that needed for a stationary population (U.S. Fish and Wildlife Service, 2001b).

Mirroring the regional population trends, productivity rates have been unevenly distributed, with other recovery units lagging substantially behind New England. Average productivity from 1990 to 1999 in the New York-New Jersey Recovery Unit was 1.09 chicks per pair. The 1.24 chicks per pair productivity needed to maintain a stationary population has been attained only twice, in 1994 when productivity reached 1.25 chicks per pair and 1999 when productivity reached 1.36 chicks per pair. In addition, productivity estimates for this recovery unit reflect a substantial gap between the number of pairs for which productivity is monitored and the total breeding population, with the 10-year average based on productivity data from only 83 percent of the total. Nearly all pairs in the recovery unit for which productivity is unknown nested in New York. Productivity in the New York-New Jersey Recovery Unit for the 2000 nesting season was 1.19 chicks per pair, slightly under the productivity needed for a stationary population (U.S. Fish and Wildlife Service, 2001b).

1 Final 2000 or preliminary 2001 Atlantic Coast nesting season results were unavailable as of the date of this Biological Opinion

Table 3. Summary of Piping Plover Productivity Estimates for the U.S. Atlantic Coast, 1990-1999

STATE/UNIT	CHICKS FLEDGED PER PAIR										
	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999[a]	10 year AVG[b]
Maine	1.53	2.5	2	2.38	2	2.38	1.63	1.98	1.47	1.63 (56)	1.88 (389/389)
New Hampshire	-	-	-	-	-	-	-	0.6	2.4	2.67 (6)	1.94 (16/16)
Massachusetts	1.38	1.72	2.03	1.92	1.8	1.62	1.36	1.32	1.5	1.60 (490)	1.59 (3388/3534)
Rhode Island	0.9	0.77	1.55	1.8	2	1.68	1.56	1.34	1.13	1.79 (39)	1.46 (357/363)
Connecticut	1.63	1.39	1.45	0.38	1.47	1.35	1.31	1.69	1.05	1.45 (22)	1.35 (299/299)
NEW ENGLAND	1.38	1.62	1.91	1.85	1.81	1.67	1.4	1.38	1.46	1.62 (613)	1.59 (4449/4601)
New York	0.8	1.09	0.98	1.24	1.34	0.97	1.14	1.36	1.09	1.35 (266[c])	1.17 (1641/2226)
New Jersey	0.93	0.98	1.07	0.93	1.16	0.98	1	0.39	1.09	1.34 (107)	0.98 (1196/1211)
NY-NJ UNIT	0.88	1.04	1.03	1.08	1.25	0.97	1.07	1.02	1.09	1.36 (373)	1.09 (2837/3437)
Delaware	2	1.6	1	0.5	2.5	2	0.5	1	0.83	1.50 (4)	1.39 (44/44)
Maryland	0.78	0.41	1	1.79	2.41	1.73	1.49[d]	1.02[e]	1.3	1.09 (58)	1.34 (385/385)
Virginia	0.65	0.88	0.59	1.45	1.65	1	1.54	0.71	1.01	1.21 (77)	1.08 (627/1032)
North Carolina	0.43	0.07	0.42	0.74	0.36	0.45	0.86	0.23	0.61	0.48 (31)	0.49 (388/465)
SOUTHERN UNIT	0.72	0.68	0.62	1.18	1.37	1.06	1.34[r]	0.68	0.99	1.04 (170)	1.00 (1444/1926)
U.S. AVERAGE	1.06	1.22	1.35	1.47	1.56	1.35	1.30[r]	1.16	1.27	1.45 (1156)	1.33 (8730/9964)
ATLANTIC CANADA	1.62	1.07	1.55	0.69	1.25	1.69	1.72	2.1	1.84	1.74 (189)	1.56 (1104/2135)

Table 3, continued:

a Parentheses indicate the number of pairs on which productivity is based.

b Parentheses denote number of pairs on which productivity is based/estimated number of pairs in the state or unit between 1990 and 1999.

c Number of pairs on which New York 1999 productivity is based exceeded the population estimate. Reasons for the relatively large discrepancy between the 1999 window estimate and the number of pairs on which the 1999 New York productivity estimate is based are currently unclear.

d Reflects a correction in 1996 Maryland productivity.

e Chicks surviving to 25 days projected from data collected through day 15 based on linear regression analysis.

(4) Habitat Utilization

A growing body of information shows that overwash habitats, including bayside flats, unstabilized and recently closed inlets, ephemeral pools (areas on the beach where sea and/or rain water pooled during storm overwashes and rains), and moist, sparsely vegetated barrier flats, are especially important to piping plover productivity and carrying capacity in the New England, New York-New Jersey, and Southern Recovery Units (Wilcox, 1959; Strauss, 1990; Massachusetts Division of Fisheries and Wildlife, 1996; Jones, 1997).

Research indicates that plovers utilizing New England beaches are attracted to, and highly productive on, a wider variety of habitats (Massachusetts Division of Fisheries and Wildlife, 1996; Jones, 1997) than in the other recovery units in the southern half of their range. However, studies in the New England Recovery Unit also recognize the optimal value of overwash habitats with open connections to bayside foraging habitats. Out of 80 piping plover nests observed by Strauss (1990), no nests were found seaward of steep foredunes in Sandy Neck, Massachusetts, where this habitat constituted 83 percent of the beach front. Many areas in Strauss's study site had been artificially plugged with discarded Christmas trees and/or snowfences. Goldin and Regosin (1998) found significantly higher chick survival and overall productivity among chicks with access to salt pond "mudflats" than those limited to oceanside beaches at Goosewing Beach, Rhode Island. Goldin and Regosin (1998) also reported that broods on the pondshore spent significantly less time responding to human disturbance (1.6 percent) than those limited to the ocean beach (17.0 percent). Since ocean beaches are highly attractive to recreational beach-goers, limiting plovers to these habitats may also increase the potential for disturbance from people and pets.

In New York, Wilcox (1959) described the effects on piping plovers of storms that breached the Long Island barrier islands in 1931 and 1938, forming Moriches and Shinnecock Inlets and leveling dunes across the south shore. Only 3 to 4 pairs of piping plovers nested on 27.4 km (17 miles) of barrier beach along Moriches and Shinnecock Bays in 1929. However, following the natural opening of Moriches Inlet in 1931, plover numbers increased to 20 pairs in 3.2 km (2 miles) of beach habitat by 1938. In 1938, a hurricane opened Shinnecock Inlet and also flattened dunes along both Shinnecock and Moriches Bays. In 1941, plover numbers along the same 27.4-km (17-mile) stretch of beach peaked at 64 pairs. Numbers then gradually decreased, a decline that Wilcox attributed to deposition of dredged sand to rebuild dunes, planting of beach grass, and construction of roads and summer homes.

A 1992-1993 study of nest site selection on 90 km (55.8 miles) of beach on Jones Beach Island, Fire Island, and Westhampton Island, New York (Elias *et al.*, 2000) found that all 1-km beach segments with ephemeral pools or bay tidal flats were used for nesting and brood rearing, whereas less than 50 percent of beach segments without these habitats were used. When the amount of time that plover broods used each habitat was compared with its availability, broods preferred ephemeral pools on segments where pools were present. Where present, bay tidal flats and wrack were the most preferred habitats. On segments with neither ephemeral pools or bay tidal flats, wrack was the most preferred habitat, and open vegetation was the second most preferred. Indices of arthropod abundance were highest on ephemeral pools and bay tidal flats. Chick peck rates were highest on ephemeral pools, bay tidal flats, and the ocean intertidal zone. To assist piping plover recovery, the authors recommend avoidance of beach management practices (*e.g.,* jetty construction, breach filling, dune building, sand renourishment) that typically inhibit natural renewal of ephemeral pools, bay tidal flats, and open vegetation habitats.

In New Jersey, Burger (1994) studied plover foraging behavior and habitat use at ocean, dune, and back bay habitats. The primary focus of that study was the effect of human disturbance on habitat selection. Results showed that both habitat selection and foraging behavior correlated inversely with the number of people present. In the absence of people, plovers fed in ocean and bayside habitats. Burger concluded that protection of the entire beach ecosystem with high habitat diversity will help mitigate effects of human beach recreation.

Based on observations by Service biologists during the 2000 nesting season, 7 of the 21 sites (33 percent) occupied by nesting plovers in New Jersey were areas with low recreational use and access to ephemeral pools and/or bayside tidal flats. These 7 sites supported 58 percent (65 pairs) of the 112 piping plover pairs nesting in New Jersey in 2000 and accounted for 62 percent of the Statewide productivity (97 of 157 chicks fledged).

On Assateague Island, Maryland, dramatic increases in productivity and breeding population occurred in response to overwash events between 1991 and 1992 on the northern 8 km of the island. Productivity, which had averaged 0.77 chicks per pair in a 5-year period before the overwash, averaged 1.67 chicks per pair from 1992 to 1996 following the overwash events. The nesting population also grew rapidly, doubling by 1995, and tripling by 1996, when 61 pairs nested there (MacIvor, 1990). Loegering and Fraser (1995) found that chicks on Assateague Island, which were able to reach bay beaches and the island interior, had significantly higher fledging rates than those that foraged solely on the ocean beach. The observed 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. Loegering and Fraser (1995) stressed the importance of sparsely vegetated cross-island access routes maintained by overwash, and the need to restrict or mitigate activities that reduce natural disturbance resulting from storms.

In Virginia, Watts *et al.* (undated) found that piping plovers nesting on 13 barrier islands in 1986-88 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 closer proximity to mudflats. Watts *et al.* noted that characteristics of beaches selected by plovers are maintained by storms.

Further south at Cape Lookout National Seashore, North Carolina, 32 to 39 pairs of plovers nested on North and South Core Banks each year since 1992. While these unstabilized barrier islands total 70.4 km (44 miles) in length, nesting distribution is extremely patchy, with all nests clustered on the highly dynamic ends of the barrier islands, recently closed and sparsely vegetated "old inlets," expansive barrier mudflats, or new ocean-to-bay overwashes (Cape Lookout National Seashore, 1998). 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).

d. Continuing Threats

Continuing threats to Atlantic Coast piping plovers in the breeding portion of their range include habitat loss and degradation, disturbance by humans and pets, increased predation, and oil spills. These threats are described within the revised recovery plan (U.S. Fish and Wildlife Service, 1996a), and discussion here is largely limited to the specific situation in the New York-New Jersey Recovery Unit. Many recent protection efforts in New York and New Jersey have been funded by revenues collected to restore oil spill damages (see below), and long-term funding for future protection efforts is uncertain.

(1) Predation

As noted in the revised recovery plan (U.S. Fish and Wildlife Service, 1996a) substantial evidence exists that human activities are exacerbating natural predation on piping plovers, their eggs, and chicks. Where Wilcox (1959) had observed 92 percent hatching success of nests observed between 1939-58 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 1992-93. Elias-Gerken (1994) also observed crows perching and nesting in exotic Japanese black pines along the Ocean Parkway on Jones Island, and hypothesized that this vegetation and other artificial perches exacerbated depredation by crows. 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*), and great black-backed gulls (*Larus marinus*) (Riepe, 1989; Jenkins and Nichols, 1994; Jenkins *et al.*, 1999a; Canale, 1997). Predators accounted for over half of all piping plover nest losses in New Jersey from 1995 to 1998 (Jenkins *et al.*, 1999a; Jenkins and Niles, 1999).

A variety of techniques that have been employed to reduce predation on plovers are discussed in the revised recovery plan (U.S. Fish and Wildlife Service, 1996a). Some of these techniques, most notably the use of predator exclosures (fences around nests), have been used with demonstrated success to reduce predation on piping plover eggs (Melvin *et al.*, 1992; Rimmer and Deblinger, 1990) and credited with an important role in population increases in some parts of their range (Jenkins and Nichols, 1994; Jenkins *et al.*, 1999a). 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" that 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 one day of hatching and move extensively along the beach to feed.

While plovers have derived important benefits from use of exclosures in the New York-New Jersey Recovery Unit (Jenkins and Nichols, 1994; Jenkins *et al.*, 1999a; Canale, 1997), the incidence of problems associated with these devices has been especially prevalent. At the Arverne site in Queens, New York for example, vandalism of exclosures has been a substantial problem (Davis, 1997; 1998). In 1995, foxes keyed in on exclosures at Westhampton Dunes, New York, causing high rates of abandonment. Trapping and removal of foxes at this site in 1996 and 1997 helped facilitate higher productivity (Houghton, 1997). At Sandy Hook, New Jersey, where exclosures had made important contributions to productivity between 1990 to 1996, heavy predation on exclosed and unexclosed nests was the major cause of a precipitous drop in productivity from 1.49 chicks per pair (1990-1996 average) to 0.36 chicks per pair in 1997 (McArthur, 1997).

(2) Oil Spills

Oil and "tar balls"from the June 1990 discharge of 267,000 gallons of number 6 fuel oil from the B.T. Nautilus spill in the Kill Van Kull were found on southern Long Island beaches from Breezy Point to Fire Island, and along the New Jersey coastline from Sandy Hook south to Brigantine. Evidence submitted in government claims for natural resource damages included direct visual confirmation of 27 oiled piping plovers, 10 in New York and 17 in New Jersey. Implementation of a restoration plan using funds collected from the responsible party was completed in New Jersey (1995-1999) and in New York (1997-2001).

The May 1996 ANITRA spill discharged 42,000 gallons of light crude oil into Delaware Bay and spread oil along more than 70 miles of the southern New Jersey coastline. Oiling was detected on 51 adult plovers, nine of which were captured and cleaned (New Jersey Department of Environmental Protection, U.S. Department of the Interior, and National Oceanic and Atmospheric Administration, 1999). Negotiations between State and federal agencies and the responsible party to determine natural resource damages are still in progress at this time.

(3) Disturbance from Humans, Pets, and Motorized Vehicles

Intensive management measures to protect piping plovers from disturbance by beach recreationists and their pets have been implemented at many New York-New Jersey plover nesting sites in recent years. In 2000, more than half of the occupied piping plover nesting sites in New Jersey were located on State or private land (12 out of 21 sites) (Jenkins, 2000). In New York, 95.8 percent of piping plover pairs nested on non-federal land in 1999 (Rosenblatt, 2000). Piping plover protection in this recovery unit, therefore, is highly dependent on the efforts of State and local government agencies, conservation organizations, and private landowners. Landowner efforts are often contingent on annual commitments. While many landowners are supportive and cooperative, others are not.

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 displace unfledged chicks (Strauss, 1990; Burger, 1991; Hoopes, 1993; Loegering, 1992; 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 then 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; biologists believe this may be because plovers perceive kites as potential avian predators (Hoopes, 1993).

Motorized vehicle use on beaches is a threat to piping plovers. 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 (ORVs) 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 that 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). Beginning in 1999 at the North Brigantine Natural Area, Atlantic County, New Jersey, a seasonal closure to all motorized vehicles was imposed during the period when unfledged chicks are present. The number of nesting pairs of piping plovers at this site rose from 8 pairs in 1998 to 11 pairs in 2000; productivity rose from 1.50 chicks per pair in 1998 to a State record of 3.17 chicks per pair in 1999, with 2.45 chicks fledged per pair in 2000 (Jenkins *et al.*, 1998; Jenkins *et al.*, 1999b; Jenkins, 2000).

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. These movements place chicks in the paths of vehicles driving along the berm or through the intertidal zone. Chicks stand, walk, and run along tire ruts, and sometimes have difficulty crossing deep ruts or climbing out of them (Eddings *et al.*, 1990; Strauss, 1990; Howard *et al.*, 1993). 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 also significantly degrade piping plover habitat or disrupt normal behavior patterns by crushing wrack into the sand and making it unavailable as cover or a foraging substrate (Hoopes, *et al.* 1992; Goldin, 1993). Additionally, vehicles create ruts that can trap or impede movements of chicks and may prevent plovers from using habitat that is otherwise suitable (MacIvor, 1990, Strauss, 1990; Hoopes *et al.*, 1992; Goldin, 1993; Hoopes, 1994). Vehicles that are driven too close to the toe of the dune may destroy vegetation that may also serve as piping plover habitat (Elias-Gerken, 1994).

While removal of human-created trash on the beach is desirable to reduce predation threats, the indiscriminate nature of mechanized beach-cleaning adversely affects piping plovers and their habitat. In addition to the danger of directly crushing piping plover nests and chicks and the prolonged disturbance from the machine's noise, this method of beach-cleaning removes the birds' natural wrack line feeding habitat (Eddings and Melvin, 1991; Howard *et al.*, 1993), and shell fragments, a preferred feature of nesting habitat.

(4) Habitat Loss and Degradation

While loss and degradation of habitat have been major contributors to the rangewide decline of the piping plover (U.S. Fish and Wildlife Service, 1996a), this threat is especially prominent in the New York-New Jersey Recovery Unit. Within the New York Bight, which includes the species entire range in New Jersey and the southern Long Island shoreline, more than half the beaches are classified as "developed" (U.S. Fish and Wildlife Service, 1997). The remaining beaches in the New York Bight, classified as “natural and undeveloped,” enjoy some protection from development through the Coastal Barrier Resources Act's (96 Stat. 1653; 16 U.S.C. 3501 *et seq*.) limitations on federal assistance and flood insurance. However, many of these areas are also subject to extensive stabilization activities that promote the formation of mature dunes, thus preventing overwash, inlet migration, and other natural coastal processes that create and maintain optimal plover habitat.

The beaches on the south shore of Long Island are affected by a variety of federal and non-federal management activities including inlet management, beach nourishment, dune construction, and dune stabilization. There are six inlets stabilized by hard structures along the barrier chain system from

Montauk Point west to East Rockaway Inlet. Within this stretch, multiple groin fields also exist. Gilgo Beach and Jones Beach on Jones Island, and Robert Moses State Park on Fire Island have been artificially nourished during the course of several Corps projects (see below). Dune construction and beach nourishment are implemented almost entirely to protect developments on the barrier island or mainland by reducing the potential for breaches and overwashes. Over the last 40 years, all major barrier island breaches have been artificially closed. Artificial plantings of American beachgrass and other species such as Japanese black pine (*Pinus thunbergii*), as well as the erection of snowfencing, are used to promote the formation of large, heavily vegetated dunes, thus reducing the potential for breaches and overwashes.

From 1986 to the present, the Corps has formally consulted with the Service's New York and Long Island Field Offices under the interagency ESA regulations for seven beach nourishment or navigation project activities between Jones Inlet and Montauk Point within the New York - New Jersey Recovery Unit. Biological Opinions (issuance date given in parentheses) were prepared for the following:

(1) Shinnecock Inlet Reformulation Project (December 8, 1986);
(2) Fire Island Inlet and Shore Westerly to Jones Inlet Combined Navigation and Beach Erosion Control Project (May 1987);
(3) 30-year Westhampton Interim Storm Damage Protection Project (December 1994);
(4) 3-year Breach Contingency Plan (BCP) (July 1995);
(5) Fire Island Inlet and Shore Westerly to Jones Inlet Combined Navigation and Beach Erosion Control Project, Seabeach Amaranth Transplantation Program (May 1995);
(6) 15-year Shelter Island, New York, Erosion Control Project (June 1995; revised October 1997); and
(7) 6-year West of Shinnecock Interim Storm Damage Protection Project (Draft Biological Opinion August 1999; final Biological Opinion pending).

The Service has also conducted informal section 7 consultations with the Corps for many projects in the New York portion of the New York-New Jersey Recovery Unit. Some recent examples are provided below. In the case of the navigation projects, these consultations are conducted consistent with the Corps channel maintenance schedule, or about every 2-3 years.

(1) Long Beach Island Beach Erosion Control (May 1994);
(2) Moriches Inlet Navigation Project (March 1996 and July 1998);
(3) Jones Inlet Jetty Rehabilitation Project (June 1995 and July 1998);
(4) Shinnecock Inlet Navigation Inlet Maintenance Dredging (July 1998);
(5) Fire Island Inlet and Shore Westerly to Jones Inlet Combined Navigation and Beach Erosion Control Project (June 1999);
(6) Coney Island; and
(7) East Rockaway Shore Protection Project.

Of approximately 200 km (125 miles) of Atlantic coastline in New Jersey, stretching from Sandy Hook to Cape May, all but approximately 21 km (13 miles) (Sandy Hook Unit, Gateway National Recreation Area and Little Beach Island within the Edwin B. Forsythe National Wildlife Refuge) are encompassed within a Corps beach nourishment project area. Shore protection projects within the New Jersey portion of the New York-New Jersey Recovery Unit for which the Service completed informal section 7 consultation with the Corps for the initial phase of beach nourishment include the following:

(1) Sea Bright to North Asbury;
(2) Asbury Park to Manasquan Inlet;
(3) Manasquan Inlet to Barnegat Inlet;
(4) Barnegat Inlet to Little Egg Inlet;
(5) Brigantine Inlet to Great Egg Harbor Inlet;
(6) Great Egg Harbor and Peck Beach (Ocean City Beachfill);
(7) Great Egg Harbor Inlet to Townsends Inlet;
(8) Townsends Inlet to Cape May Inlet;
(9) Cape May Inlet to Lower Township (Cape May Beachfill);
(10) Lower Cape May Meadows to Cape May Point; and
(11) Delaware Bay Coastline.

Authorized Corps navigation projects located within the New Jersey portion of the New York -New Jersey Recovery Unit include:

(1) Shark River Inlet;
(2) Manasquan Inlet;
(3) Barnegat Inlet; and
(4) Cape May and Ocean City.

The Service is currently conducting formal consultation with the Corps regarding renourishment activities at Sea Bright and Monmouth Beach in Monmouth County and Avalon and Stone Harbor in Cape May County, New Jersey. The Service is aware of the following future Corps beach nourishment / renourishment projects in New Jersey that will require formal consultation (listed below with anticipated project start dates in parentheses):

(1) Lower Cape May Meadows and Cape May Point (Fall 2002);
(2) Brigantine (2003);
(3) Southern Ocean City and Sea Isle City (2004);
(4) Long Beach Island (2004);
(5) Manasquan Inlet to Barnegat Inlet (2005); and
(6) Great Egg Harbor Inlet to Townsends Inlet (2005).

The above consultations are a part of the many Section 7 consultations that the Service performs for federal agency actions and do not reflect those undertaken by the Corps pursuant to Section 10 of the Rivers and Harbors Act (30 Stat. 1151; 33 U.S.C. 403 *et seq.*) and Section 404 of the Clean Water Act (33 U.S.C. 1344 *et seq.*) for State, local, or private beach nourishment or dredging activities. Ultimately, these projects accelerate the formation of mature dunes, and are implemented to substantially reduce the probability of inlet creation and overwash that would otherwise form sparsely vegetated, low-lying barrier beach habitats that are important to the piping plover. Under natural conditions, barrier beaches continually erode and accrete. Storms and high tides create overwash fans and flats behind and between dunes. Periodic breaches along barrier islands allow for the formation of new inlet areas, while accretion over time fills in inlets. The piping plover evolved in this highly dynamic ecosystem and has adapted to relocating nesting areas as natural coastal processes occur. As dune or back beach areas become established in accreting areas and vegetated through natural succession, these areas decline in suitability as piping plover habitat.

Throughout much of the New York-New Jersey Recovery Unit, periodic beach nourishment has interfered with natural coastal processes by precluding formation of newly forming inlets, overwash zones, and accreting beach habitats that would create, replace or revitalize piping plover nesting and foraging habitat.

(e) Vulnerability to Extinction

The Atlantic Coast piping plover recovery plan (U.S. Fish and Wildlife Service, 1996a) provides a discussion of the demographic and genetic factors that were used to assess the species vulnerability to extinction. A population viability analysis was conducted to estimate probabilities of extinction, as well as probabilities that populations of various sizes and rates of fecundity would fall below thresholds of 50, 100, and 500 pairs during the next 100 years. The modeled scenarios that most closely approximate the current status of the Atlantic Coast population (*i.e.*, 1,200 and 1,500 pairs with average productivity of 1.25 chicks per pair) showed extinction probabilities of 35 percent and 31 percent over 100 years, respectively. In addition, the model showed 95 percent and 92 percent probabilities of the population dropping below 500 pairs during the same period.

While the scenarios described above are based on survival rates observed in a 1985-1989 Massachusetts study, modeling also showed that even small drops in survival rates could very substantially increase the risk of extinction. Such long-term declines in survival rates could occur due to continuing declines in availability or quality of wintering or migration habitat, increased human disturbance on wintering grounds, increased mortality due to disease, parasites, or environmental contaminants, increased predation, or reduced longevity or fitness due to unforeseen genetic factors. When declines in adult and chick survival rates of just 5 percent and 10 percent, respectively, were modeled for a 1,500 pair population with average fecundity of 1.5 chicks per pair (far above the 1990-99 average of 1.33 chicks per pair), the extinction probability increased from 9 percent to 40 percent, and the probability that population size would drop below 500 pairs increased from 44 percent to 97 percent.

The assessments of continuing vulnerability to extinction based on modeling, described above, are validated by empirical data from 1986-1999 coast-wide population and productivity monitoring. For example, the nearly flat population trend between 1995 to 1996, following 1995 productivity of 1.35 chicks per pair (well above the estimated rate needed to maintain a stationary population) and productivity of 1.47 and 1.56 chicks per pair in 1993 and 1994, respectively, suggests that survival rates may have been lower in 1995 to 1996 than in preceding years. While fluctuations in survival rates are to be expected, their occurrence provides vivid illustration of the inherent vulnerability of such small populations.

Another graphic demonstration of the Atlantic Coast piping plover's continued precarious status is provided by the population trend in New Jersey. A 44 percent population increase in the State population, from 93 pairs in 1987 to 137 pairs in 1992, was followed by a flat trend between 1993 and 1995. The New Jersey population then dropped precipitously over the next 2 years, returning to 1987 levels by 1998, when only 93 pairs were counted in the State. Despite the intensive protection efforts, productivity in the New York - New Jersey Recovery Unit since listing (1986 to 2000) has been below that needed to maintain a stationary population in all but 2 years.

The overall probability of extinction for the Atlantic Coast piping plover population is exacerbated by the fact that increases in yearly productivity and abundance over the last 5 years are largely attributable to the New England Recovery Unit (see Tables 3 and 4). In contrast, populations of the other three recovery units have remained low, as has productivity in New York-New Jersey and the Southern Recovery Units (see Tables 3 and 4). The uneven distribution of population gains across recovery units increases overall vulnerability to catastrophes (such as oil spills or disease). It also leaves the population vulnerable in the event that a hiatus in the occurrence of large storms leads to a decline in habitat conditions in the New England portion of the range.

The New York-New Jersey Recovery Unit provides a vital link between the New England and Southern subpopulations. Available information demonstrates slow rates of dispersal between subpopulations (U.S. Fish and Wildlife Service, 1996a); movements of birds (adults or chicks) between recovery units are few, and movement large enough to span the distance between non-adjacent Recovery Units has never been documented. Thus, loss or even near-extirpation of the New York-New Jersey Recovery Unit could acutely destabilize the population by isolating the Southern Recovery Unit, thereby forestalling exchange of breeding birds and genetic material across more than half the species range. Accessible overwash habitats are important to both the productivity and carrying capacity of plovers in the recovery unit. Due to the scarcity of overwash habitats, systematically forestalling overwash formation in the New York-New Jersey Recovery Unit threatens the security of this subpopulation and the entire Atlantic Coast population.

2. Seabeach Amaranth

In 1993, seabeach amaranth was added to the List of Endangered and Threatened Wildlife and Plants as a threatened species. The listing was based upon the elimination of seabeach amaranth from two-thirds of its historic range, and continuing threats to the 55 extant populations that remained at the time (U.S. Fish and Wildlife Service, 1993).

a. Species Description

(1) Physical Description

Seabeach amaranth is an annual member of the Amaranth family (Amaranthaceae). Upon germination, the plant initially forms a small, unbranched sprig, but 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 of seabeach amaranth 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 of seabeach amaranth 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 (U.S. Fish and Wildlife Service, 1996b).

(2) Habitat

Seabeach amaranth is native to Atlantic coast barrier island beaches from Massachusetts to South Carolina. 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, temporary, and casual 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 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 a meter or so 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 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 usually occurs on a pure silica sand substrate, occasionally containing shell fragments. The U.S. 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 seabeach amaranth's vegetative associates have been found to 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 [1] [seabeach sandmat, seaside sandmat] (*Chamaesyce* [*Euphorbia*] *polygonifolia*) (Weakley and Bucher, 1992).

Other typical associates in the Carolinas include beach elder (*Iva imbricata*), southern seabeach spurge [southern seabeach sandmat] (*Chamaesyce bombensis*), saltwort [common Russian thistle] (*Salsola tragus* [*australis*]), cordgrass (*Spartina patens*), sea oats (*Uniola paniculata*), bitter panic (*Panicum amarum*), shoreline seapurslane [sea-purslane] (*Sesuvium portulacastrum*), slender seapurslane [sea-purslane] (*Sesuvium maritimum*), seabeach orach [crested saltbush] (*Atriplex cristata* [*arenaria*]), seablite (*Suaeda linearis*), beach pea (*Strophostyles helveola*), beach morning glory (*Ipomoea imperati*), hog spurge (*Croton punctatus*), sand grass (*Triplasis purpurea*), American beachgrass [beach grass] (*Ammophila breviligulata*), and seabeach knotweed [beach knotweed, seaside knotweed] (*Polygonum glaucum*) (Weakley and Bucher, 1992).

Maryland associates include scattered individuals of sea rocket, American beachgrass, and beach clotbur [cocklebur] (*Xanthium echinatum*). Seabeach spurge, bitter panic, and seaside goldenrod (*Solidago sempervirens*) have also been observed in association with seabeach amaranth in Maryland (Ramsey *et al.*, 2000). Common associates observed in Delaware include American beachgrass, sea rocket, sanddune sandspur (*Cenchrus tribuloides*), seabeach spurge, Russian thistle (*Salsola kali*), and sand grass (McAvoy, 2000).

The most common associates of seabeach amaranth in New Jersey are sea rocket, seabeach spurge, Russian thistle, and American beachgrass. Other common associates include clotbur, seaside goldenrod, goosefoot (*Chenopodium* sp.), and crab grass (*Digitaria sanguinalis*). Less common associates include sand grass, seabeach sandwort [sea sandwort, sea-purselane] (*Honkenya [Honckenya, Arenaria] peploides*), seabeach orach, wild bean (*Strophostyles* sp.), and seabeach

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1 Common taxonomic synonyms are provided in brackets.

knotweed (Service observation and Snyder, pers. comm., 2000). Seabeach knotweed is considered rare globally (G3) and in New Jersey (S1) by the New Jersey Natural Heritage Program, and is State-listed as endangered.

Common associates in New York include sea rocket, seabeach spurge, seabeach orach, halberd-leaf orache [spear saltbush, spear saltweed, seabeach orach] (*Atriplex patula*), Russian thistle, seabeach sandwort, beach wormwood (*Artemisia stelleriana*), American beachgrass, seabeach knotweed, narrowleaf goosefoot (*Chenopodium berlandieri* var. *macrocalycium*), and beach pea (*Lathyrus japonicus*) (U.S. Fish and Wildlife Service, 1996b).

Seabeach amaranth does not occur on well-vegetated sites, particularly where perennials have become strongly established (Weakley and Bucher, 1992). Pauley *et al.* (1999) documented a negative correlation between seabeach amaranth and several dominant foredune species. A particularly strong negative association has been reported between seabeach amaranth and beach grasses (*Ammophila* sp.) (U.S. Fish and Wildlife Service, 1996b). However, a positive correlation has been observed between seabeach amaranth and sea rocket, an annual (Hancock, 1995).

(3) Biogeography and Range

Seabeach amaranth is limited by its habitat requirements to a very narrow strip of barrier islands and mainland ocean front beach strands along the Atlantic. 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.

Seabeach amaranth is considered globally rare (G2) by the New Jersey Natural Heritage Program. 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. Seabeach amaranth is still considered extirpated from two States: Massachusetts and Rhode Island. Since 1990, the species has re-occupied five States from which it had previously been extirpated. Table 4 gives the dates of rediscovery and the last previously known occurrence of the plant in each State.

Table 4. Re-colonization Dates of Seabeach Amaranth in Five States

State	Date Rediscovered	Date of Last Previously Known Occurrence
New York	July 1990	1950 (Van Schoik and Antenen,1993)
New Jersey	July 2000	1913 (U.S. Fish and Wildlife Service, 1996b)
Delaware	August 2000	1875 (McAvoy, 2000)
Maryland	August 1998	1967 (Ramsey *et al.*, 2000)
Virginia	September 2001	1973 (U.S. Fish and Wildlife Service, 1996b)

To date, theories of seabeach amaranth's return to 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 known range of naturally occurring seabeach amaranth is Water Mill Beach on Long Island, New York to Debidue Beach in South Carolina (Young, 2001; Hamilton, 2000a). In 1999, seed and cultivated plants were transplanted to several sites south of Debidue Beach by the South Carolina Department of Natural Resources as part of a restoration program. The southernmost site in the restoration program was at Pritchards Island, approximately 200 km (124 miles) southwest of Debidue Beach (Hamilton, 2000a; 2000b), but to date plants are known to persist from the transplanted seed/cultivars only as far south as Otter Island, roughly 130 km (81 miles) southwest of Debidue Beach.

b. Life History

(1) Life History Strategy

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); this also 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 (U.S. Fish and Wildlife Service, 1996b).

Seabeach amaranth habitat exists in dynamic conditions. The same physical forces (*e.g.*, storms, extreme high tides) that create the plant's very specific and ephemeral coastal habitat also destroy it. 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 plant to move around in the landscape as a "fugitive" species, occupying suitable habitat as it becomes available (U.S. Fish and Wildlife Service, 1996b).

(2) 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 been found to have a strongly contagious (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). Anecdotal observations from New Jersey and Maryland suggest that plants within the wrack line tend to be larger (Service observation; Hudson, pers. comm., 2001). 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.

(3) Life Cycle and Phenology

Seabeach amaranth is an annual species. Individual plants live only one season, with only 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. Even very small plants can flower under certain conditions. 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 (U.S. Fish and Wildlife 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 (U.S. Fish and Wildlife Service, 1993).

(4) 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, probably 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 past the juvenile stage, 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 very 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).

(5) Seed Dispersal

Seabeach amaranth seeds are dispersed by a variety of mechanisms involving transport via wind and water. 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, 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).

(6) <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 of water, and gradual breakdown over time (Weakley and Bucher, 1992; Hamilton, 2000c; Jolls and Sellars, 2000; Hancock, 1995; Baskin and Baskin, 1994; 1998). Once dormancy is broken, light and high temperatures (25-35E 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 offset population mortality. 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 cm (Hancock, 1995) or 2 cm (Jolls, pers. comm., 2000). Deeper (6 cm) burial suppresses germination and delays emergence (Jolls, *et al.*, 2001). 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. 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).

(7) <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 seabeach amaranth survival and reproduction. Weather also limits abundance of the species through its effects on winds, 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 New Jersey (Service observation) and Maryland (Hudson, pers. comm., 2001).

Coastal storms are probably the single most important natural limitation on the abundance of seabeach amaranth. Storms erode habitat and curtail the reproductive season due to flooding and overwash. However, storm events also permit the species to survive by creating new habitat, and by providing long-distance seed transport. Through these combined effects, storms largely determine the distribution of the species in the landscape. A patchy distribution may itself limit the abundance of seabeach amaranth; colonization of suitable habitats is hampered by long distances to the nearest seed source (Weakley and Bucher, 1992).

Under natural conditions, interspecific competition for water and nutrients, especially with perennials, is perhaps the only 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 does limit 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 the porous sand. Predators and disease are discussed below under threats.

c. Population Dynamics

(1) Demography

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 (U.S. Fish and Wildlife Service, 1996b). In experimental plots in Maryland, a few late-season seedlings emerged from the current year's seed crop (Hudson, pers. comm., 2001), 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. Fecundity of seabeach amaranth under favorable conditions is generally considered high overall (thousands of seeds for a large plant), although reliable means of measuring this parameter in the field have yet to be developed (Jolls and Sellars, 2000). Based upon several laboratory studies, germination rates under favorable conditions are also high, 75-100 percent (Weakley and Bucher, 1992; Hancock, 1995; Jolls and Sellers, 2000; Baskin and Baskin, 1994; 1998).

Mortality rates of both fresh and banked seeds are unknown. More is known about mortality of the plants. Substantial mortality of young plants occurs in some years, prior to reproduction. Storm effects (*i.e.* flooding, overwash, erosion) during the early growing season or unfavorable weather conditions, such as drought, can substantially reduce survival to reproductive age (Weakley and Bucher, 1992).

Hancock (1995) found only 7 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 only 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 observation; Hudson, pers. comm., 2001). Unfavorable conditions early in the growing season, including drought, burial, and especially flooding and other storm damage, may reduce seed production by 90 percent (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.

(2) Genetic Variability

Preliminary results from two initial genetic studies of seabeach amaranth suggest that the species genetic variability is low. A study by Hunter (pers. comm., 2001; Hudson, pers. comm., 2001) 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 found to be 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. Higher levels of genetic variability were found within the sample of plants from Delaware. A second study by Strand (pers. comm., 2000) 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. To date, this study has 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; Jolls, pers. comm., 2000; Strand, pers. comm., 2000).

(3) Population Size and Variability

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 a 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 is so great, 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 5-10 year average is a more meaningful measure for assessing the vigor of a local seabeach amaranth population. However long-term, consecutive, annual data are only available for a few sites in New York. Estimates of aggregated population sizes for seabeach amaranth across its range are imprecise given available survey data. Early (pre-1987) survey data are limited. Range-wide surveys were conducted in 1987, 1988, and 1990 (excluding States where the species was considered extirpated at the time). Annual State-wide surveys have been conducted subsequently in New York, but no comprehensive surveys of North or South Carolina have been carried out since 1990. Suitable areas in New Jersey, Delaware, and Maryland were throughly surveyed in 2000, but these efforts did not necessarily extend State-wide. Approximately 14 locations in Virginia were surveyed in 2000. No seabeach amaranth was found (Belden, 2000; pers. comm., 2001). 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 (Davis, pers. comm., 2001). No recent surveys are known from Massachusetts or Rhode Island.

Table 5 presents the number of known extant sites and total plants from 1987 to 2000. The level of survey effort (number of sites surveyed) varied widely from year to year. Timing of surveys and survey methodologies were likewise variable from site to site and year to year. The estimated total number of seabeach amaranth plants in 2000 was approximately 140,000 at 39 sites. This figure is almost certainly an underestimate, because many known sites were not surveyed. In 2000, only 30 of 41 known sites were surveyed in North Carolina, and only 3 of 16 known sites were surveyed in South Carolina.

The term "extant" as used in Table 5 refers to a site or "population" with at least 1 plant documented during the growing season. Sites are not included in this total if they were not surveyed during a given year, or if they were surveyed but no plants were found. This later category is not necessarily considered extirpated. Because of natural population fluctuations, populations are not considered extirpated until several consecutive years of negative surveys and/or the habitat becomes strongly unsuitable.

The 2000 population of seabeach amaranth had an uneven geographic distribution, with almost 99 percent of the plants located on Long Island, New York. A single site on Long Beach Island, New York comprised 75 percent of the total plants range-wide. Of the 39 extant sites documented in 2000, 11 had 100 or more plants (7 in New York, 2 in New Jersey, and 2 in North Carolina), and 4 had 1,000 or more plants (all in New York). Seventeen sites had fewer than 10 plants (3 in New York, 1 in Maryland, 11 in North Carolina, and 2 in South Carolina) (Young, 2001; McAvoy, 2000; Hudson, pers. comm., 2001; National Park Service 2001b; 2001c; Jolls and Sellars, 2000; U.S. Army Corps of Engineers, 2001b; Hamilton, 2000a).

Table 5. Number of Documented Extant Seabeach Amaranth Sites [a] and Total Plants, 1987-2000

		1987	1988	1990	1991	1992	1993	1994	1995	1996 [b]	1997 [b]	1998 [b]	1999 [b]	2000 [b]
New York [c]	# sites surveyed			10	12	12	18	14	18	12	16	22	22	19
	# extant sites			10	10	9	9	9	6	7	11	11	12	13
	total # plants			331	2,100	422	195	182	599	2,263	7,990	8,599	19,150	138,600
New Jersey [d]	# sites surveyed									15			3	8
	# extant sites									0			0	4
	total # plants									0			0	1,019
Delaware [e]	# sites surveyed													2
	# extant sites													2
	total # plants													41
Maryland [f]	# sites surveyed											1	1	1
	# extant sites											1	1	1
	total # plants											2	1	4
North Carolina [g]	# sites surveyed	35	40	40	4	14	21	20	21	19	21	20	29	30
	# extant sites	26	36	33	4	13	20	17	18	16	15	17	16	18
	total # plants	10,399	41,851	10,780	1,506	26,588	17,016	10,673	39,457	7,769	973	13,430	739	381
South Carolina [h]	# sites surveyed	17	16	17					1		1	6	2	3
	# extant sites	12	8	9					1		1	56	0	2
	total # plants	1,341	1,800	188					84		77	406	0	4
TOTAL	# sites surveyed	52	56	67	16	26	39	34	40	46	38	50	57	77 [i]
	# extant sites	38	44	52	14	22	29	26	25	23	27	35	29	40
	total # plants	11,740	43,651	11,299	3,606	27,010	17,211	10,855	10,140	10,032	9,040	22,437	19,890	140,049

Table 5 (Continued)

[a] Sites are considered extant if at least 1 plant was documented during the growing season.

[b] Figures for these years include early season survey data from North Carolina. At some sites, substantial decreases in population sizes were noted later in the season, particularly following storms.

[c] Young, 2001.

[d] 1996 data from Snyder, 1996. 1999 surveys conducted by the Service's New Jersey Field Office (NJFO) at Sandy Hook North Beach, Sea Bright North, and Monmouth Beach (which extends a short distance into southern Sea Bright). 2000 data collected during August 2000 surveys by the NJFO and the U.S. Army Corps of Engineers, New York District. Four extant sites are Sandy Hook Gunnison, Sandy Hook South Beaches, Sea Bright North, and Monmouth Beach. Plants were actually found in a nearly continuous distribution across these sites [a stretch of about 15 km (9.3 miles)], interrupted by areas of heavy recreational use or mechanical beach raking. A significant drop in numbers of plants was anecdotally observed in early September 2000; many plants appeared to have been covered by blowing sand. Four additional sites were also surveyed in late August and September by the NJFO, but no plants were found: Sandy Hook North Beach/USCG, Long Beach Island (Barnegat Light to Surf City), Holgate (in the Edwin B. Forsythe National Wildlife Refuge), and Ocean City. Nine new sites were discovered during a 2001 State-wide survey, extending the species range approximately 140 km (90 miles).

[e] McAvoy, 2000. Two sites are Delaware Seashore and Fenwick Island State Parks, although the source indicates a fairly continuous distribution of plants across the two sites [a stretch of about 22 km (13.7 miles)].

[f] Hudson, pers. comm., 2001. All plants were found in Assateague Island National Seashore. Figures do not include approximately 1,156 cultivated plants transplanted in experimental plots in 2000.

[g] 1987-1990 data from Weakley and Bucher, 1992. 1991-1995 data from Jolls and Sellars, 2000. 1996-2000 data from National Park Service, 2001b; National Park Service, 2001c; Jolls and Sellars, 2000; and U.S. Army Corps of Engineers, 2001b. In a few cases, the last two sources reported different numbers for the same site, probably due to differences in survey dates. The higher of the two numbers was used.

[h] 1987-1990 data from Weakley and Bucher, 1992. 1995-2000 data from Hamilton, 2000a; Chicone, undated; and Pauley *et al.*, 1999. Where different numbers were reported for the same site, the highest figure was used. Figures do not include 4,033 cultivated plants transplanted in experimental plots in 1999 and 2000, or 54 plants that germinated in 1999 and 2000 from 26,000 seeds sown at 6 experimental sites in 1999.

[i] Includes 14 sites surveyed in Virginia: The Nature Conservancy's Virginia Coast Reserve (11 sites on 7 barrier islands), Fisherman's Island National Wildlife Refuge, Eastern Shore of Virginia National Wildlife Refuge, and the Virginia portion of Assateague Island National Seashore. No seabeach amaranth was found in Virginia (Belden, 2000; pers. comm., 2001). The species was found in the Virginia portion of

Assateague Island in 2001, most likely the result of the National Park Service restoration in Assateague Island National Seashore, Maryland (Davis, pers. comm., 2001).

d. Status and Distribution

(1) Reasons for Listing and Continuing Threats

(i) Habitat Loss and Degradation

The primary threats to seabeach amaranth are the adverse alterations of habitat caused by beach erosion and shoreline stabilization. Although seabeach amaranth does not persist on eroding beaches, erosion is not a threat to the continued existence of the species under natural conditions. Erosion in some areas is balanced with habitat formation elsewhere, such as accreting inlets and overwash areas, resulting in an equilibrium that allows the plant to survive by moving around in the landscape. 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 (U.S. Fish and Wildlife Service, 1996b).

Human alteration of the barrier island ecosystem generally tips the equilibrium between habitat destruction and creation in favor of destructive erosional forces. 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 are curbed. Erosion may also be increasing due to sea level rise and increased storm activity caused by global climate change (U.S. Fish and Wildlife Service, 1993).

Although storms and erosion threaten seabeach amaranth, attempts to stabilize beaches against these natural processes are generally more destructive to the species and to the beaches themselves in the long term (U.S. Fish and Wildlife Service, 1993). Any stabilization of the shoreline is generally detrimental to a pioneer, upper beach annual, whose niche or "life strategy" is the colonization of unstable, unvegetated, new land, and which is unable to compete with perennial grasses (U.S. Fish and Wildlife Service, 1996b).

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 riprap 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 upstream from a groin, accretion sometimes provides or maintains, at least temporarily, habitat for seabeach amaranth; immediately downstream, erosion usually destroys seabeach amaranth habitat. In the long term, groins (if they are successful) stabilize upstream beaches, allowing succession to perennials, and rendering even the upstream 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 during the first part of the 20th Century (U.S. Fish and Wildlife Service, 1996b).

Even minor structures and non-structural beach stabilization techniques, such as sand fences and beach grass planting, are generally detrimental to seabeach amaranth (U.S. Fish and Wildlife Service, 1993). Dune stabilization and vertical sand accretion caused by sand fences appear to be detrimental to seabeach amaranth and contradictory to its life history strategy. The effects of dune stabilization by planting vegetation are similar (U.S. Fish and Wildlife Service, 1996b). Seabeach amaranth only 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 (U.S. Fish and Wildlife Service, 1993). 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 range-wide 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 seabeach amaranth colonization or survival. Deeply burying seeds during any season can have serious effects on populations; this also applies to the placement of dredge spoil (U.S. Fish and Wildlife 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 (U.S. Fish and Wildlife Service, 1993). 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 apparently led to regional extirpation during the last century. Areas of suitable habitat were separated from one another by distances too great to allow re-colonization following natural catastrophes (Weakley and Bucher, 1992).

(ii) 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 (U.S. Fish and Wildlife Service, 1993). Problems generally arise only on narrow beaches, or beaches which receive heavy recreational use. In such areas, seabeach amaranth 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 extirpation of seabeach amaranth in those regions (U.S. Fish and Wildlife Service, 1996b).

Off-road vehicle (ORV) 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 to run over seabeach amaranth plants often show severe population declines. Dormant season ORV 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 ORV 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. Extremely heavy ORV use, even in winter, may have some negative impacts, however, 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 (U.S. Fish and Wildlife Service, 1996b). In New Jersey, plants were found along a nearly continuous length of beach, noticeably interrupted by stretches that are routinely raked.

(iii) 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 (U.S. Fish and Wildlife Service, 1993). 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*). In New York, herbivory by saltmarsh caterpillars (*Estigmene acraea*) has been observed (U.S. Fish and Wildlife Service, 1996b). Webworm herbivory of seabeach amaranth has not been documented in Delaware or Maryland.

Although the five webworms so far identified on seabeach amaranth are all native species, their use of barrier islands has probably been altered by changes in the coastal plain landscape (*i.e.*, extensive agricultural use), the development of barrier islands, and the introduction of weedy plants that can also serve as host plants. All five webworms are "weedy" species, probably much more abundant now than they were in pre-Columbian times. For this reason, the level of predation that seabeach amaranth is experiencing is likely unnaturally high (U.S. Fish and Wildlife 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).

(iv) 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 taking, vandalism, and the 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 U.S. Department of Agriculture 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 (U.S. Fish and Wildlife Service, 1993).

(2) New Threats

New threats to seabeach amaranth 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*), rabbits (*Sylvilagus floridanus*), and migratory song birds (Van Schoik and Antenen, 1993), as well as feral horses in Maryland (Hudson, pers. comm., 2001). Hancock (1995) suggests that grasshoppers may feed on seabeach amaranth, but does not indicate whether this was actually observed. Hamilton (pers. comm., 2001) observed strong circumstantial evidence for seabeach amaranth herbivory by grasshoppers. 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 to seabeach amaranth. This sedge is strongly rhizomatous and dune-forming (National Park Service 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.

The first known disease of seabeach amaranth was documented in South Carolina in 2000. During the 2000 growing season, an oomycete (*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 (Hamilton, pers. comm., 2001). Effects on infected individuals were significant, resulting in death of the plants 2-4 weeks after lesions were first observed. Anecdotal observations suggest that isolated plants tended to avoid infection (Strand and Hamilton, 2000).

(3) Rangewide Trends

Based on limited data from previous years, 1988 was a highly productive year for seabeach amaranth, and 1989 also began with favorable conditions for the species. Several coastal storms later in 1989 and 1990 caused severe erosion in the Carolinas. Subsequent dune reconstruction and bulldozing caused further damage in some areas (Weakley and Bucher, 1992). These storms may have also been responsible for the transport of seabeach amaranth to New York (U.S. Fish and Wildlife Service, 1993). Due to storm effects (erosion, reconstruction activities, and a curtailed reproductive season due to flooding and overwash), an approximate 75 percent decrease in population numbers occurred in 1990, even with new sites established in New York (see Table 5). Results from 1991 should be discounted because survey efforts were low in the Carolinas. Total population numbers rebounded in 1992, decreased in 1993, then leveled off at approximately 10,000 from 1994 through 1997. This population size is only about 23 percent of the 1988 peak, but is only slightly lower than 1987, which was considered a reasonably productive year (Weakley and Bucher, 1992). Population sizes from 1994 to 1997 reflect increasing survey efforts in New York, almost no surveys of South Carolina, and surveys of only about half of the known North Carolina sites. Despite documented storm losses in North Carolina in 1998 and 1999, a large range-wide population increase occurred in the 3-year period from 1998 to 2000. The 2000 population was more than 300 percent above the earlier 1988 peak. Somewhat increased survey efforts for the period 1998-2000 do not account for the large population increase relative to previous years.

Total population trends can disguise important regional trends. Recent population increases have occurred entirely in the northern part of the species range (see Table 5). 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 low numbers in the south. Although natural population variability and survey effort must be considered, the recent trend in North Carolina is clearly 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). The 1999-2000 average of 560 total plants is only about 1 percent of the 1988 peak for North Carolina, and only about 3 percent of the 1987-1998 State-wide average (excluding 1989 and 1991 because of insufficient data). The current status of seabeach amaranth in South Carolina is virtually unknown. The species experienced a 90 percent reduction in that State following 1988 storms, including Hurricane Hugo. However, spotty survey efforts in 1998 suggest that populations may have recovered in some areas of South Carolina.

The number of known, extant sites increased from 1987 to 1988 under favorable conditions in the Carolinas. Despite storm losses, the number of extant sites reached a peak of 52 in 1990, due to the species appearance in New York and a high level of survey effort in the Carolinas. The number of sites dropped off in 1992 and remained in the 20s through 1997, probably due to minimal survey effort in South Carolina. Numbers of sites rose in 1998 and 2000 because of a slightly higher survey effort in South Carolina, and expansion of the species into three new States.

Historically, seabeach amaranth was known from 31 counties in 9 States (U.S. Fish and Wildlife Service, 1993). Weakley and Bucher (1992) show 27 counties in the species historic range. Of these, 14 counties in 3 States had extant populations based upon 1987-1990 surveys. Based upon 1998-2001 surveys, 16 counties in 7 States have extant populations of seabeach amaranth.

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, and, if the lack of surveys in South Carolina are considered, in terms of number of extant sites. 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 extinction. The primary threat to seabeach amaranth, altered habitat, 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 (Young, 2001; McAvoy, 2000; Hudson, pers. comm., 2001; National Park Service 2001b; 2001c; Jolls and Sellars, 2000; U.S. Army Corps of Engineers, 2001b; Hamilton, 2000a). The uneven distribution of numbers of plants across the current known range leaves seabeach amaranth vulnerable to catastrophic events (*i.e.*, storms, oil spills, disease). In addition, the shift of the species numerical stronghold from south to north places great importance on its continued survival on northern beaches, which are more stabilized and developed, and experience more intensive recreational use, than southern beaches.

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 are under way in Delaware, Maryland, and South Carolina (McAvoy, 2000; National Park Service and Maryland Natural Heritage Program, 2000; and Hamilton, 2000b).

C. ENVIRONMENTAL BASELINE

1. Species Status Within the Action Area

a. <u>Piping Plover</u>

Piping plovers nest in six areas of Sandy Hook's ocean front beaches (Figure 6). Sandy Hook nesting areas are critical to New Jersey's piping plover population, providing habitat for more than one-fourth of the State's total nesting pairs in 2001 (Jenkins and Pover, 2001). The numbers and reproductive success of piping plovers have significant effects on the status of the species State-wide. New Jersey's overall population dropped in the late 1990s due in part to three consecutive years of high predation and low productivity on Sandy Hook (see Table 2). In 2001, 31 nesting pairs produced 49 fledged chicks in the park (National Park Service, 2001d). This productivity rate of 1.58 is slightly above the goal for the New York-New Jersey Recovery Unit of 1.50. Sandy Hook nesting data (all nesting areas combined) for 1990 to 2001 are presented in Table 6; 2001 nesting data by nesting area are given in Table 7.

Between two and six pairs of piping plovers nested at the Critical Zone each year between 1990 and 1995, following a large beach fill in 1989-90. Two pairs attempted unsuccessfully to nest in the Critical Zone in 1996, and no piping plover nesting occurred in the area between 1997 and 2000. In 2001, nesting resumed in the Critical Zone (Figure 7), with one pair producing one fledged chick, for a productivity of 1.00 (Jenkins and Pover, 2001). Summary Critical Zone nesting data for 1990 to 2001 are given in Table 8.

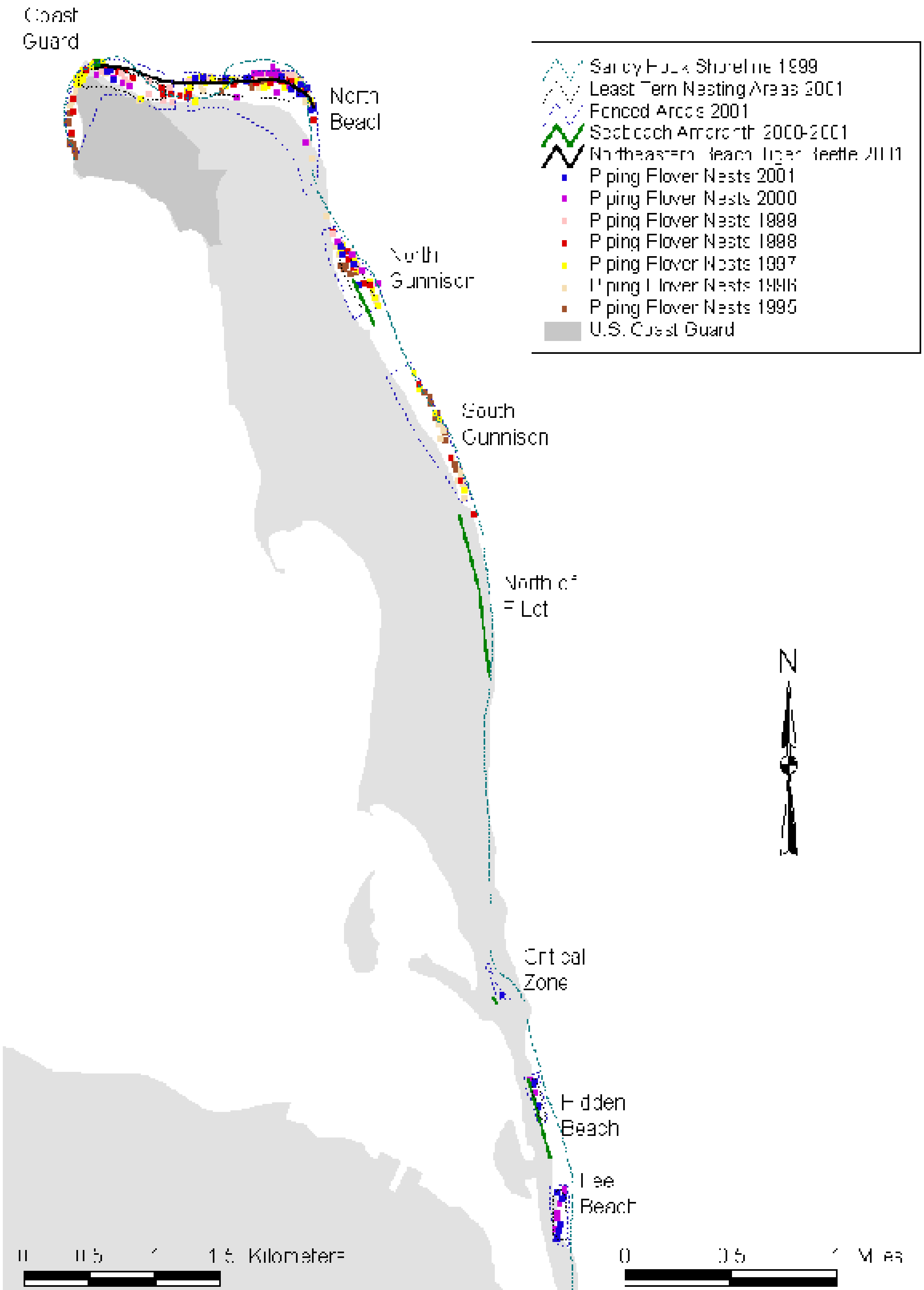

Figure 6. Distribution of Federally and State-Listed Beach Strand Species in Sandy Hook

Figure 7. Locations of Federally Listed Species in the Critical Zone, 2001

Table 6. Sandy Hook Piping Plover Nesting Data, All Nesting Areas Combined, 1990 - 2001
(National Park Service, 2000b; 2001d)

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
# of nesting pairs	18	20	21	25	36	43	40	42	29	27	29	31
# of eggs	75	83	87	100	146	193	200	195	145	107	124	140
# of eggs hatched	44	53	67	87	111	108	94	28	49	79	92	94
% of eggs hatched	58	63	77	87	76	54	47	14	34	74	74	67
# of chicks fledged	21	23	35	45	70	57	51	15	29	50	51	49
% of chicks fledged	48	45	52	52	63	53	54	54	59	63	55	52
FLEDGE RATE	1.17	1.15	1.70	1.80	1.94	1.32	1.27	0.36	1.00	1.85	1.76	1.58

Table 7. Sandy Hook Piping Plover Nesting Data by Nesting Area, 2001
(National Park Service, 2001d)

	Fee Beach	Hidden Beach	Critical Zone	South Gunnison	North Gunnison	North Beach	U.S. Coast Guard	Total
# of nesting pairs	7	3	1	0	3	11	6	31
# of eggs	31	12	4	0	17	53	24	140
# of eggs hatched	17	8	4	0	10	32	23	94
% of eggs hatched	55	66	100	0	59	62	96	67
# of chicks fledged	8	6	1	0	3	20	11	49
% of chicks fledged	47	75	25	0	30	63	48	52
FLEDGE RATE	1.14	2.00	1.00	0.00	1.00	1.82	1.83	1.58

Table 8. Critical Zone Piping Plover Summary Nesting Data, 1990-2001
(Jenkins, 1990; Jenkins *et al*., 1995; 1996; Jenkins and Pover, 2001)

Year	Numbers of Pairs	Productivity (chicks fledged/pair)
1990	2	0.00
1991	4	0.50
1992	5	1.20
1993	5	0.60
1994	5	1.60
1995	6	0.50
1996	2	0.00
1997	0	n/a
1998	0	n/a
1999	0	n/a
2000	0	n/a
2001	1	1.00

b. Seabeach Amaranth

In July 2000, seabeach amaranth was discovered within Monmouth Beach Borough, approximately 6 km south of Sandy Hook. Previously considered extirpated from the State, the species had last been observed in New Jersey in 1913, and in Monmouth County in 1899. Subsequent surveys in 2000 documented approximately 900 plants in Sea Bright and Monmouth Beach Boroughs. August 2000 surveys by the NPS also documented the species in Sandy Hook, with 120 plants at 6 sites (Figure 6). Seven of these plants occurred in the Critical Zone.

In 2001, the range of seabeach amaranth in New Jersey expanded almost 150 km (90 miles) south, with plants occurring in every ocean-front county. More than 5,800 plants were counted State-wide, including 561 plants in 6 locations on Sandy Hook. Of these, 57 plants were found in the Critical Zone. Numbers of seabeach amaranth on Sandy Hook for 2000 and 2001, are given in Table 9.

Table 9. Numbers of Seabeach Amaranth Plants on Sandy Hook, 2000-2001
(Lane, pers. comm., 2002)

	U.S. Coast Guard	North Gunnison	South Gunnison	North of F Lot (Fishing Beach)	Critical Zone	Hidden Beach	Fee Beach	Total
2000	0	6	1	8	7	57	41	120
2001	1	0	5	25	53	285	192	561

2. Factors Affecting Species Environment Within the Action Area

a. <u>Habitat</u>

The suitability of Sandy Hook's southern beaches as piping plover and seabeach amaranth habitat is strongly affected by hard stabilization structures, and the pattern of beach nourishment activities in the Critical Zone, and south of the park. No piping plover nesting occurred at Hidden Beach or Fee Beach prior to 1997, due to the groin field, sea wall, and hard structures south of Sandy Hook. These areas were eroded back to the seawall, except for small sand fillets updrift of the groins (Lane, pers. comm., 2002). Colonization of these beaches by piping plovers in 1997 and seabeach amaranth in 2000 was made possible in part by the increased transport of sand into the area from a 1995-96 Corps beach fill in Sea Bright and Monmouth Beach Boroughs. Hidden Beach and Fee Beach have since accreted to a width of about 150 m (Lane, pers. comm., 2002).

Hard structures, combined with a natural deflection point in the northbound littoral drift of sediments, result in continually eroding conditions at the Critical Zone. Barring a breach or overwash of the peninsula, this area is unlikely to provide any habitat for piping plovers or seabeach amaranth without periodic beach fills. The pattern of piping plover nesting at the Critical Zone during the 1990s clearly relates to the pattern of beach nourishment. After two years absence, piping plovers returned to the Critical Zone in 1990 (Jenkins, 1990), following a large beach fill during the winter of 1989-90, which utilized sand from Sandy Hook Channel (Eddings *et al.*, 1990; National Park Service, 2001a). Nesting continued in the Critical Zone until 1996, but ceased from 1997 to 2000 in response to narrowed, eroding beach conditions. The re-colonization of the Critical Zone by piping plovers in 2001 was due to beach fills in 1996-97 and 1997-98, followed by several years of significantly reduced erosion rates which allowed wider beach conditions to persist.

Continually narrowing, eroding conditions in the Critical Zone likely provide less suitable nesting habitat for piping plovers than other Sandy Hook nesting areas. Two pairs of piping plovers nested in the area in 1990, following the 1989-90 beach fill. Feeding behaviors in the Critical Zone were observed at approximately 0.25 the frequency of the other three Sandy Hook nesting areas occupied that year. No piping plovers were observed in the intertidal zone or in a small amount of fresh wrack located a short distance from the nests. A 0.5 to 1.0-m-high sand scarp present in the Critical Zone throughout the nesting season made wrack and intertidal habitats inaccessible to chicks. Adult and fledgling plovers were suspected to forage on the bay-side of Sandy Hook, across from the Critical Zone. Bay-side foraging areas were inaccessible to unfledged chicks due to dense back-beach vegetation and Hartshorne Drive. The failure of all seven chicks to fledge was most likely attributable to the lack of accessible foraging habitat (Eddings *et al.*, 1990). Since 1990, stabilized dunes have been established in the Critical Zone, further limiting the availability of suitable foraging habitat.

In addition to accessible foraging habitats, the suitability of the Critical Zone for piping plovers also depends on the availability of nesting habitat. Given the presence of the stabilized dune and the road, suitable nesting habitat in the Critical Zone is limited to unflooded, upper beach areas between mean high water and the base of the dune. This zone also constitutes the only suitable seabeach amaranth habitat in the area. Such habitat is most likely present immediately following a beach fill, subsequently diminishing each year due to loss of upper beach width and elevation, the latter resulting in greater flooding frequency. At least temporary extirpation of both species from the Critical Zone would be expected once the upper beach becomes extensively scarped, or once the mean high water line meets the base of the dune.

Accreting conditions at Sandy Hook's northern beaches provide substantial, high-quality habitat for piping plovers and seabeach amaranth at the Gunnison Beaches, North Beach, and the U.S. Coast Guard beach. (The NPS manages endangered species on the U.S. Coast Guard beach.) Except for harbor channel dredging that prevents northern expansion of the spit, and stabilized dunes in some areas, relatively natural conditions persist at Sandy Hook's northern beaches (National Park Service, 2000b).

b. <u>Predation</u>

In 1990, 16 percent of the total piping plover eggs laid on Sandy Hook were lost to predation (National Park Service, 2000b). Based on data collected that year, Eddings *et al.* (1990) concluded that reducing predation would be an important component of efforts to raise productivity, and suggested that trapping and removal of foxes may be necessary to reduce predation of shorebird nests. Predation increased to 20 percent of eggs in 1991, but steadily dropped from 1992 through 1994. From 1995 to 1998, piping plover reproductive success on Sandy Hook was severely limited by predation, primarily by foxes. In 1998, 66 percent of piping plover eggs were lost to predation. Egg losses from predation were sharply reduced in 1999 (7 percent) and 2000 (6 percent) due to a natural reduction in predator populations combined with limited NPS trapping efforts and other management practices. In 2001, no egg losses were attributed to predation (National Park Service, 2001d).

Since 1990, productivity on Sandy Hook has been above the recovery goal of 1.50 in 1992, 1993, 1994, 1999, 2000, and 2001, corresponding with years of low losses of eggs to predation (National Park Service 2000b; 2001d). The extent to which chicks are lost to predation on Sandy Hook, both directly and through stress and harassment, has not been well established. Reproductive data from the 1990s, however, clearly show that controlling predation of piping plover nests is central to maintaining strong productivity on Sandy Hook.

No evidence of herbivory of seabeach amaranth has been reported from Sandy Hook to date. However, evidence of minor insect herbivory has been observed in Sea Bright and Monmouth Beach, where isolated occurrences of chewed leaves, insect webs, and a few feeding larval insects have been noted. To date, these insect species have not been identified, and damage has appeared minimal. Low-level herbivory most likely occurs on Sandy Hook as well, and may increase in coming years. As plant populations expand, insect and mammalian herbivores may increasingly exploit this new food source.

c. Recreational Use

Sandy Hook beaches are intensively used for recreation. The park receives approximately 2.3 million visitors per year, with 30 to 40 thousand guests *per day* on a typical summer weekend (National Park Service, 2001a; 2000b). Most recreational activity is clustered at six developed, staffed beach centers (National Park Service, 2000b). The beach centers are separated by natural areas, where almost all of the piping plover nesting areas and seabeach amaranth occurrences are located (see Figures 1 and 6). To minimize disturbance of piping plovers from recreational activities, the NPS manages the birds in accordance with the Service (1996a) recovery plan and the NPS (1992) Sandy Hook Unit Piping Plover Management Plan (National Park Service, 2001a). Seabeach amaranth receives incidental protection from beach closures enacted to protect piping plovers and other beach-nesting birds.

Current visitor use restrictions to protect endangered species include closure of fenced piping plover nesting areas from March 15 through Labor Day. The closure extends to include the intertidal zone while chicks are present. Kite flying within 500 feet of posted nesting areas is prohibited. High-impact recreational activities are prohibited in the intertidal zones adjacent to nesting areas. These activities include: ball playing, jogging, picnicking, beaching of boats/jet skis, campfires, and sunbathing. Low-impact activities such as walking, fishing, birding, and surfing are permitted until intertidal zones are closed. Off-road vehicle use is prohibited on Sandy Hook, and use of vehicles by NPS staff during the nesting season is limited to recreational beach centers, and one resource management vehicle to transport fencing supplies to nest sites. Park interpretation regarding beach-nesting birds includes Visitor Center displays and video, signs and waysides, brochures provided at information areas and by shorebird wardens, offsite programs to school and other groups, and orientation for park employees. Permanent and seasonal NPS staff and volunteers patrol and monitor nesting areas (National Park Service, 2000b).

No nest losses were attributed to human disturbance in 2000 or 2001 (National Park Service 2000b; 2001d). Due to the strong protective measures described above, the overall level of disturbance of nesting piping plovers on Sandy Hook is low, especially relative to other New Jersey nesting areas. To date, no evidence of trampling or other recreational impacts to seabeach amaranth has been reported from Sandy Hook. The level of damage to seabeach amaranth will increase considerably if the species colonizes any of the recreational beach centers.

Recreational disturbance of nesting birds in the Critical Zone is likely higher than within other Sandy Hook nesting areas. Piping plovers nested unsuccessfully in the Critical Zone in 1990, following the large 1989-90 beach fill. In that year, Eddings *et al.* (1990) noted that public beaches immediately beyond the northern and southern boundaries of the Critical Zone produced a “steady daytime flow of pedestrian traffic throughout the week.” The rate of human disturbance, and the percent of the piping plover activity budget spent responding to disturbance, were lowest in the Critical Zone, compared to Gunnison Beach, North Beach, and the U.S. Coast Guard beach. However, the authors attributed this finding to the fact that almost of all behavioral observations at the Critical Zone were made within the area closed to public use. The study employed a randomized method to select focal birds and, by chance, nearly all focal birds in the Critical Zone were within fenced areas. The high potential for disturbance of nesting birds in the Critical Zone in 1990 was indicated by numbers of people counted in each nesting area. For its size (only about 15 percent of the total length of shoreline used by piping plovers in 1990), the Critical Zone accounted for a disproportionate percent of mean total people counted within piping plover nesting areas in four out of six survey periods (morning, afternoon, and evening during both weekdays and weekends/holidays). On weekday afternoons, for example, the Critical Zone accounted for 57 percent of the mean number of people counted in all nesting areas, with a mean of 104 people (Eddings *et al.*,1990).

Events during the most recent nesting season suggest that piping plovers in the Critical Zone continue to receive higher levels of recreational disturbance than in other nesting areas. A greater-than-average visitor use conflict arose at the Critical Zone in 2001 due to the proximity of the piping plover nest to Beach Area C. After 4 years without any nesting at the Critical Zone, park visitors were particularly uncooperative regarding the closure of this nesting area in 2001. Responding to frequent conflicts at the Critical Zone often diverted NPS staff from other nesting areas (MacArthur, pers. comm., 2001).

d. Other Beach-Nesting Birds

Piping plovers often nest in association with least tern colonies, benefitting from the aggressive behaviors of terns in driving away predators. Burger (1987) found that piping plovers in New Jersey derived anti-predator benefits from nesting near terns, and plovers nesting in tern colonies often had higher success than those nesting out of tern colonies. Seabeach amaranth also benefits from the presence of least tern colonies, since restrictions on public access in the nesting areas provide protected areas where plants can become established (Weakley and Bucher, 1992). Least terns are listed as endangered by the State of New Jersey. The locations of least tern colonies on Sandy Hook in 2001 are shown in Figure 6. Total least terns on Sandy Hook for 1990 to 2001 are given in Table 10. Least tern numbers by nesting area for 2000 and 2001 are given in Table 11. Since 1984, least terns have nested in the Critical Zone every year except 1997, 1999, 2000, and 2001 (Canale, 2000; Lane, pers. comm., 2002).

Common terns also nest on Sandy Hook, primarily on northern beaches. Twenty pairs of common terns (*Sterna hirundo*) produced 9 fledged chicks in 2001. Oystercatchers (*Haematopus palliatus*) nest throughout the park; 12 pairs produced 7 fledged chicks in 2001. Fencing to protect these species benefits seabeach amaranth, and common terns lend additional predator defense to piping plovers on the northern beaches (National Park Service, 2001d).

Table 10. Least Tern Total Numbers on Sandy Hook, 1990-2001
(National Park Service, 2000b; 2001d)

Year	Number of Pairs	Number of Young
1990	258	30
1991	161	48
1992	99	13
1993	172	19
1994	233	31
1995	305	5
1996	80	8
1997	158	28
1998	76	28
1999	129	124
2000	188	57
2001	194	74

Table 11. Least Tern Numbers by Nesting Area, 2000-2001 (National Park Service, 2000b; 2001d)

	2000		2001	
	adults	**young**	**adults**	**young**
U.S. Coast Guard	20	0	36	5
North Beach	46	10	51	10
North Gunnison	22	0	14	2
South Gunnison	0	0	0	0
Critical Zone	0	0	0	0
Hidden Beach	35	0	109	12
Fee Beach	195	47	178	45
Total	318	57	388	74

D. EFFECTS OF THE ACTION

In evaluating the effects of the federal action under consideration in this consultation, 50 CFR 402.2 and 402.14(g)(3) require the Service to evaluate both the direct and indirect effects of the action on the species, together with the effects of other activities that are interrelated or interdependent with the action that will be added to the environmental baseline. Indirect effects are those that are caused by the proposed action and are later in time, but are still reasonably certain to occur. Interrelated actions are those that are part of a larger action and depend on the larger action for project justification. Interdependent actions are those that have no independent utility apart from the action under consideration. The Interim Beach Fill will provide temporary, marginal benefits to federally listed species in the action area; however, the project will also cause adverse effects to piping plovers and seabeach amaranth. Both beneficial and adverse effects are discussed below.

1. Beneficial Effects

a. Maintenance of Habitat Within the Project Area

As the pattern of piping plover nesting at the Critical Zone in the 1990s demonstrates, utilization of this area by this species has been made possible by previous beach fills. In the absence of the Interim Beach Fill project, erosion of the Critical Zone beach would be expected to continue at a rate of at least 43,000 cubic yards per year. Barring other interventions (*i.e.*, implementation of the Sand Slurry Pipeline[1]), beaches in the project area would eventually become too narrow and scarped to support nesting piping plovers or seabeach amaranth. Such unsuitable habitat conditions would persist until overwashing or breaching of the peninsula occurred. More likely, once the area eroded, unsuitable habitat conditions may persist indefinitely since the NPS may act to prevent or repair overwash or breaching.[1] Therefore, the proposed project benefits piping plovers and seabeach amaranth by maintaining habitat that supported one pair of plovers and 53 plants in 2001. Given the current sand deficit of 43,000 cubic yards per year and a proposed fill volume of 253,000 cubic yards, the benefits of maintaining suitable habitat in the Critical Zone are expected to last up to 6 years.

As discussed below, however, the benefits to piping plovers of maintained habitat at the Critical Zone are negated by reproductive data suggesting that this nesting area constitutes a population sink, probably due to less suitable habitat and higher levels of recreational disturbance than are found in other Sandy Hook nesting areas. Conversely, maintenance of sandy beach habitat in the Critical Zone is expected actually to benefit seabeach amaranth. With favorable growing conditions and the NPS proposed conservation measure to restore plants following project implementation, the Critical Zone population of seabeach amaranth can be expected to continue increasing over the next 6 years, due to the perpetuation of wider beach conditions that the Interim Beach Fill project would provide.

[1] NPS actions not considered in this Biological Opinion that would likely adversely affect federally listed species would require separate formal consultation.

b. Increased Sand Transport to Northern Beaches

Due to littoral drift, much of the sand placed in the project area during the Interim Beach Fill will eventually be transported through the Gunnison Beaches (Psuty, 2001), and deposited on the North Beach and U.S. Coast Guard beaches. By contributing to slightly wider northern beaches, the proposed project will benefit piping plovers and seabeach amaranth because the project will enhance habitat that supported 20 pairs of plovers and 31 plants in 2001.[1] These benefits are expected to accrue over approximately 6 years. Considering the ample existing width of Sandy Hook's northern beaches, with North Beach and the U.S. Coast Guard beach already actively accreting, the anticipated benefits to federally listed species from slightly increased sand transport into these areas is marginal.

2. Direct Adverse Effects

a. Disturbance of Nesting Piping Plovers

The Interim Beach Fill project as proposed by the NPS will occur completely outside of the piping plover nesting season, thereby avoiding all potential direct adverse effects to this species from harm or harassment of nesting birds.

b. Destruction of Seabeach Amaranth Plants

From 2000 to 2001, the population of seabeach amaranth in the Critical Zone increased 757 percent. Of 53 plants in the Critical Zone in 2001, 28 plants, or 53 percent, were located in the fill template that was proposed at the time (National Park Service, 2001a). Extrapolating this limited data set, approximately 212 plants may be expected to occur in the fill template in early fall 2002, out of a projected Critical Zone population of 401 plants. These calculations must be interpreted as the best available estimates, rather than reliable projections.

The Service anticipates that all plants located within the fill template, roughly 200, will be destroyed by burial. The NPS has proposed to mark plants outside the fill template with string line to prevent disturbance by vehicles and construction crews. This conservation measure is expected to reduce plant mortality, but the Service anticipates that up to half of the plants outside the fill template, roughly 100, will still be damaged or destroyed by drifting sand and accidental intrusions into marked areas. Thus total expected mortality based on the projected population numbers given above is approximately 300 plants.

The above estimate is based on data collected by the NPS relative to the original fill template, which extended further south than the current, revised template. The NPS did not provide information

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[1] Northeastern beach tiger beetles will also benefit. This species is not included in this Biological Opinion because it is not likely to be adversely affected by the Interim Beach Fill.

regarding the proportion of the 2001 Critical Zone seabeach amaranth population that would have been located within the new fill template or Contractors Work Area.
However, most plants in the Critical Zone in 2000 and 2001 occurred at the southern end. Therefore, the Service expects somewhat less plant mortality than indicated by the above estimate of 300 plants, due to the change in fill template.

The mortality estimate of 300 plants also assumes that the Interim Beach Fill will take place from late August through late September, the season corresponding to the time of peak plant numbers. Fewer plants will be damaged or killed if work begins later in the proposed construction period (August 28 through March 1). Based on studies from New York (Young, 2001) and Maryland (Lea and King, 2001), only 10 to 15 percent of the peak population is expected to survive through November, and would therefore be subject to mortality from construction. Assuming 300 plants would be destroyed by construction during September, mortality of roughly 30 to 45 plants would be expected if construction occurs after November 1. No direct plant mortality is expected if work begins after December 1. Project implementation early in the proposed construction period would have the additional adverse effect of causing plant mortality prior to the period of peak seed production, thereby reducing the 2002 seed crop.

Given the change in fill template and uncertain construction start date, fewer than 300 plants are expected to be damaged or destroyed by the Interim Beach Fill. From 2000 to 2001, seabeach amaranth populations increased 468 percent on Sandy Hook and 559 percent State-wide. Projecting these increases, mortality of 300 plants in 2002 would represent approximately 11 percent of the total population on Sandy Hook, and 0.9 percent of the total population in New Jersey. In 2000, the only year for which data are available, New Jersey's population of seabeach amaranth constituted approximately 7 percent of the range-wide total number of plants. With favorable growing conditions, this number is expected to increase over the next few years, based upon the large population increase documented in New Jersey from 2000 to 2001.

The population increases used in the above analysis, while extraordinary, are based on documented 2000-2001 increases in New Jersey, and are consistent with observations from other States. New York populations have shown 1-year increases in excess of 600 and even 700 percent (Young, 2001). Extreme population fluctuations are a normal condition for this species. It should be noted that equally extreme declines may also occur due to random events or unfavorable growing conditions. One-year declines in excess of 80 percent have been recorded. Therefore, far fewer plants, if any, may be located in the project area in 2002. However, even a few plants in the Critical Zone project area may represent a much greater percent of the total 2002 seabeach amaranth population on Sandy Hook and in New Jersey, depending on conditions.

For an annual plant, the effects of direct plant mortality are less important than the effects of reduced seed production, which impairs the species ability to persist into successive growing seasons. The NPS proposes to offset anticipated destruction of plants and seed by returning propagated plants to the project area in the early summer of 2003. Restoration programs in Maryland and South Carolina, and experiments in North Carolina, have shown that seabeach amaranth can be propagated in a laboratory or greenhouse, and cultivated plants can be successfully restored back into the wild (Lea and King, 2001; Hamilton, 2000b; Jolls and Sellars, 2000). The facility retained by the NPS to conduct the propagation and restoration of plants, the CMPMC, has extensive experience with beach and dune plant propagation, including specific experience with seabeach amaranth. Based upon the likely success of this conservation measure, as well as the proximity of the project area to outside seed sources, the Service anticipates that post-project numbers of seabeach amaranth in the Critical Zone in 2003 will be equal to or greater than those of August 2002. Therefore, the anticipated mortality of less than 300 plants is not expected to have population-level adverse effects in subsequent growing seasons.

Although the Service expects numbers of plants to recover by 2003, the possibility exists that plant mortality from the Interim Beach Fill may reduce genetic diversity of the Critical Zone seabeach amaranth population. Preliminary studies suggest that genetic diversity between seabeach amaranth populations is low, even between populations from different States (Hunter, pers. comm., 2001; Strand, pers. comm., 2000). Based on these studies, it may be expected that intra-population genetic variation is also low. However, sufficient information regarding the genetic diversity of this species is not available to conclude that no genetic variants will be lost from the mortality of less than 300 plants, probably prior to seed set. Therefore, loss of genetic diversity is another potential adverse effect to seabeach amaranth from the Interim Beach Fill project.

c. Burial of Seabeach Amaranth Seed Bank

As this Opinion previously noted, seabeach amaranth cannot germinate from depths of more than a few (1-2) centimeters (Hancock, 1995; Jolls, pers. comm., 2000). Burial at depths of only 6 cm suppresses germination and delays emergence (Jolls *et al.*, 2001). Basing its estimate upon the distribution of plants in the fill template as of September 2001, the Service anticipates that at least 50 percent of the seabeach amaranth seed bank in the Critical Zone will be buried at depths sufficient to significantly reduce or completely prevent germination for one or more growing seasons following renourishment. A reduction in germination of at least 50 percent is expected in the Critical Zone in 2003.

In some areas, seabeach amaranth populations have persisted and even thrived following beach nourishment (U.S. Fish and Wildlife Service, 1996b). Given the shallow burial depths required for germination, persistence of the plant at such sites is most likely due to re-colonization of project sites from outside seed sources. While suppressing germination by at least half could have significant effects on the seabeach amaranth population in the Critical Zone, the Service anticipates these effects would be short-lived, as the species would quickly re-colonize the area with seed from populations outside the project area. Due to the NPS conservation measure to mark plants outside the fill template, approximately 25 percent of plants in the Critical Zone are expected to survive the Interim Beach Fill and produce seed. Other potential seed sources include significant seabeach amaranth populations at Hidden Beach, Fee Beach, and North of F Lot, as well as very large populations in Sea Bright

Borough and Long Island. Due to the proximity of the project area to these external seed sources, population-level effects of seed bank burial and subsequent depression of germination would be expected to last no more than 2 to 4 years, depending on the occurrence of random events and the suitability of growing conditions.

Although prompt re-colonization of the project area from outside seed sources is expected, even a few seasons of depressed populations in the project area could have a potentially severe impact on seabeach amaranth, given the extreme variability of this species and its vulnerability to random catastrophic events. The conservation measure proposed by the NPS to restore propagated plants to the project area following the Interim Beach Fill is designed to avoid even short-term population-level effects. As discussed above, the Service has reason to expect successful implementation of this conservation measure, and therefore anticipates that the 2003 seabeach amaranth population in the Critical Zone will be returned to at least 2002 levels.

Although a potential reduction in plant numbers will be offset by the NPS conservation measure, reduction of germination of the natural seed bank of at least 50 percent in 2003 represents a potential loss of additional genetic diversity. The NPS restoration effort will use plants propagated from only a few source plants, which may have contained only a small proportion of the total genetic variation present in the Critical Zone seabeach amaranth population. Therefore, potential exists to lose further genetic diversity from burial of the seed bank.

Species experts believe that seabeach amaranth seeds are long-lived. Buried seeds in the project area may remain viable long enough after renourishment to germinate eventually, after being exposed by erosion. Although the Service cannot assume that viable seeds will remain, or that habitat or growing conditions will be suitable when seeds are finally exposed, delayed germination may further offset any adverse effects of seed bank burial from the Interim Beach Fill, including lost genetic diversity.

3. Indirect Adverse Effects

a. Preclusion of Natural Habitat Formation

Any activity that artificially stabilizes dynamic beach strand habitats is detrimental to piping plovers and seabeach amaranth. The most highly productive habitats for these species are found in areas of overwash or recent inlet formation. Such habitats are prevented from forming by shoreline stabilization projects. Due to erosion, establishment of predators and competitors, and lower prey densities, stabilized beach strands are generally less productive habitats for piping plovers and seabeach amaranth than more dynamic, unstabilized beaches, particularly inlets and overwash areas. The NPS recognizes that overwash and eventual breaching of the Sandy Hook peninsula at the Critical Zone are the likely outcome of the No Action alternative to the Interim Beach Fill, barring any separate interventions [1] (National Park Service, 2001a). By forestalling these events, the Interim Beach Fill adversely affects piping plovers and seabeach amaranth because it postpones the formation of highly favorable habitats for up to 6 years.

[1] NPS actions not considered in this Biological Opinion that would likely adversely affect federally listed species would require separate formal consultation.

Attempts to quantify the anticipated effects to piping plovers and seabeach amaranth that would result from overwash or breaching at the Critical Zone are speculative. Available information strongly suggests that significant population increases would be likely for both species. Piping plover populations and productivity have increased in other areas where inlets have formed. Along 27.4 km of barrier beach in Long Island, New York, piping plover populations increased from 3-4 pairs in 1929 to 64 pairs in 1941, following the natural opening of Moriches and Shinnecock Inlets (Wilcox, 1959). In the Village of West Hampton Dunes on Long Island, New York, no piping plover nesting occurred between 1983 and 1992. Following a breach of the island in November 1992, the number of nesting pairs has steadily increased, from 5 pairs in 1993 to 39 pairs in 2000, with an average of 23 nesting pairs per year and average productivity of 1.34 (Houghton *et al.*, 2000). Although the Corps filled the breach in late 1993, piping plover populations continued to expand due to the continued accessability of bay-side habitat. Following a 1996 Corps project that widened the ocean-front beach, re-built the dune, and increased beach elevations, the distribution of piping plover nests has subsequently shifted to generally less productive ocean-front habitats (Houghton *et al.*, 2000; Papa, pers. comm., 2002).

A third example comes from Maryland. From 1986 to 1992, an average of 20 pairs of piping plovers per year nested in Assateague Island National Seashore, with an average productivity of 0.84. In January 1992, a storm surge altered the primary dune line along the entire island, removing a large area of vegetation on the northern 8 km (5 miles) of the island. An average of 50 piping plover pairs have nested in Assateague Island National Seashore in each of the 9 years following this overwash event, with an average productivity of 1.38 fledged chicks per pair. Comparing the 5-year periods before and after the overwash, the nesting population tripled and productivity more than doubled. Although significant changes in NPS management and protection of piping plovers coincided with these population and productivity increases, the change in habitat is the primary cause of the increases. Highly suitable habitat conditions were maintained by a later overwash event caused by two nor'easters within a 2-week period in January and February 1998. However, reduced prey availability caused by drought and increased predation have subsequently reduced reproductive success (National Park Service, 2001e; National Park Service and Maryland Department of Natural Resources, 2001; Kumer, pers. comm., 2002).

The greatest densities of nesting piping plovers in New Jersey tend to occur in areas of wide, accreting island ends (*i.e.*, northern Sandy Hook, Barnegat Light, Holgate and Little Beach in the Edwin B. Forsythe National Wildlife Refuge, North Brigantine Natural Area, Stone Harbor Point). Although nest site distribution is also influenced by other factors, this spatial pattern demonstrates the suitability of habitats adjacent to inlets. Scientific literature contains numerous studies showing preferential piping plover utilization of nesting areas with access to bay-side feeding habitats, and increased reproductive success in such areas. Bay-side foraging habitat would be a feature of the Critical Zone nesting area, should overwash or breaching occur in this location. Likewise, seabeach amaranth has been shown to occur on accreting barrier island ends at densities 10 times greater than those found on typical linear beach strand habitats (Weakley and Bucher, 1992). Based on the above information and the response of piping plovers to similar events in other areas, doubling or tripling of piping plover and seabeach amaranth populations in the Critical Zone, and increased piping plover productivity, would be conservative estimates of the likely response of these species to overwash or breaching in this area. Such benefits are postponed up to 6 years by the Interim Beach Fill project.

b. Burial of Piping Plover Prey Base

Piping plovers feed on invertebrates such as marine worms, fly larvae, beetles, crustaceans, and mollusks (Bent, 1929; Cairns, 1977; Nicholls, 1989). Prey can generally be divided into two categories: terrestrial invertebrates (chiefly flies and other insects, but also diurnally burrowing Talitrid amphipods (Gibbs, 1986)), and benthic intertidal infaunal invertebrates. Beach nourishment projects can affect both types of piping plover prey. Burial of these organisms temporarily reduces their abundance and, in some cases, permanently alters the composition of invertebrate communities.

On ocean-front habitats, terrestrial invertebrates, mainly flying insects, tend to be concentrated in the wrack line (Loegering and Fraser, 1995; Hoopes *et al.*, 1992; Eddings *et al.*, 1990), a favored piping plover foraging area (Eddings *et al.*, 1990), particularly for chicks (Goldin, 1993; Hoopes, 1993; Hoopes *et al.*, 1992), and especially at sites where ephemeral pool and bay-side foraging areas are not available. The Interim Beach Fill will completely remove or bury the wrack line in the project area. Recovery rates of the terrestrial insect prey resource associated with the wrack line are unknown; however, the Service expects that the wrack line prey resource will not be depressed for more than one nesting season. This assumption is based upon the close proximity of the project area to areas unaffected by the proposed beach fill, and the presumably high dispersal capabilities of flying insects. Therefore, adverse effects in the form of a depressed wrack line prey base for up to one nesting season are anticipated.

The nature of the benthic intertidal infaunal prey resource in the Critical Zone is unknown. Eddings *et al.* (1990) sampled infaunal macroinvertebrates on Sandy Hook's northern beaches; however, South Beach areas including the Critical Zone were not sampled, and cores from northern Sandy Hook beaches were not analyzed by prey type. More information is available for southern Monmouth County beaches. As part of its Biological Monitoring Program (BMP) for an ongoing beach nourishment program, the Corps studied benthic communities along a 5-km stretch from Asbury Park City to Manasquan Borough, an area approximately 18 km south of Sandy Hook. The intertidal infaunal assemblage in this area is dominated by ribbon worms (Nemertea or Rhynchocoela), polychaetes (especially *Scolelepis squamata*), oligochaetes, the mole crab (*Emerita talpoida*), and a number of haustoriid amphipods (U.S. Army Corps of Engineers, 2001c).

Likewise, the composition of the piping plover diet in the Critical Zone is not known, but has been studied in other areas. On three southern New Jersey beaches, Staine and Burger (1994) found that polycheate abundance is highest in piping plover foraging areas. These authors concluded that, during the breeding season on outer beaches where intertidal polychaetes are present, polychaetes are the major food source for piping plovers. Hoopes *et al.* (1992), Gibbs (1986), and Cairns (1977) also documented that piping plovers feed on polychaetes. Based on a positive, though weak, correlation between density of foraging birds and density of amphipods, and a preponderance of amphipod remains in plover droppings, Gibbs (1986) concluded that piping plovers on Seawall Beach, Maine were feeding primarily on amphipods (both terrestrial and intertidal infaunal species). Loegering (1992) found amphipods and mole crabs abundant in the saturated intertidal zone of the ocean beach on Assateague Island National Seashore in Maryland, with amphipods comprising approximately 95 percent of samples from these areas. Loegering (1992) and Loegering and Fraser (1995) observed that older chicks and adults often feed in this saturated zone, suggesting that amphipods constitute a prey resource at this site.

Based upon the known intertidal infaunal assemblage in nearby southern Monmouth County and known piping plover prey items, plovers foraging in the intertidal zone of the Critical Zone most likely feed on polychaetes (especially *S. squamata*) and amphipods. Ribbon worms and oligochaetes are probably not important food resources, due to their small size (Ray, pers. comm., 2001). Despite their abundance, it is unclear whether mole crabs serve as piping plover prey due to their relatively large size (25 mm long and 19 mm wide), although juvenile mole crabs are smaller (less than 10 mm) (Ray, pers. comm., 2001).

The Service expects that 100 percent of the intertidal infaunal prey base in the project area will be covered by sand placement. In its BMP, the Corps found that, following initial beach nourishment from Asbury Park to Manasquan in 1997 and 1999, complete recovery of the infaunal assemblage in the intertidal zone took between 2.0 and 6.5 months. Recovery times in this range are dependent on a good match between the sediments on the existing beach and the fill material. Recovery can take considerably longer, up to a year, when fill material contains substantial amounts of silts and clays (U.S. Army Corps of Engineers, 2001c).

The surf zone macrofaunal community after re-colonization of a nourished beach may differ considerably from the original community. Once established, it may be difficult for species of the original community to displace the new colonizers (Hurme and Pullen, 1988). However, this did not appear to be the case in Corps' southern Monmouth County project area, with biomass composition and species composition returning to reference conditions within 5 months. The Corps calculated recovery times for the following parameters (U.S. Army Corps of Engineers, 2001c):

abundance	49 days (1997), 189 days (1999)
biomass	38 days (1997), 176 days (1999)
taxa richness:	178 days
biomass composition	145 days
species composition	approximately 5 months

The BMP found that intertidal abundance varies seasonally; with highest abundance in the summer and lowest in mid-winter. These observations are consistent with other studies of Atlantic Coast intertidal infauna. The longer recovery time observed after the 1999 renourishment was attributed to the time of year during which construction took place. The 1997 renourishment was completed by early October, while the 1999 renourishment was not finished until mid-December. Infaunal populations decline precipitously between November and January, suggesting that in 1997 sufficient time was available for colonization to be completed before the onset of the decline. In 1999, nourishment was not completed until the natural seasonal decline was well underway; few invertebrates were available to colonize the disturbed sediments. Sites where filling did not conclude until the low point in the seasonal cycle took the longest to recover (U.S. Army Corps of Engineers, 2001c).

The applicability of the above recovery times to the Interim Beach Fill project area depends on several factors. The Interim Beach Fill will be conducted in conjunction with a regularly-scheduled renourishment of northern Monmouth County (Sea Bright and Monmouth Beach Boroughs), part of the above-mentioned ongoing Corps beach nourishment program. Thus, construction methods will be employed in the Interim Beach Fill that are similar to those used from Asbury Park to Manasquan in 1997 and 1999.

Available studies are insufficient, however, to determine the degree of similarity between the benthic intertidal invertebrate communities of the Critical Zone and of southern Monmouth County. Benthic invertebrate abundance has been reported from Gunnison and North Beaches on Sandy Hook (Eddings *et al.*, 1990) and from the Asbury Park to Manasquan project area (U.S. Army Corps of Engineers, 2001c). Differences in methodology, sample sizes, and time of year, however, do not permit a direct comparison of invertebrate abundances reported in these two studies (Ray, pers. comm., 2001). In addition, the Sandy Hook study by Eddings *et al.* (1990) did not include invertebrate sampling of the Critical Zone. Although no data are available from the Critical Zone, the composition, abundance, and patterns of seasonal variation of the benthic infaunal community from Asbury Park to Manasquan are probably sufficiently similar to permit a generalized extrapolation of the above recovery times to the Interim Beach Fill project area. This supposition is based on the proximity of the two areas, as well as physical similarities (*i.e.*, stabilized, generally eroding beaches with similar sediments).

The Interim Beach Fill, however, will utilize sand obtained from a different borrow area than the 1997 and 1999 fills of southern Monmouth County, which used sand from the Belmar borrow areas (see Figure 5). This difference is significant, as several studies have shown that the nature of the fill material is a critical factor in recovery rates (U.S. Army Corps of Engineers, 2001c). Invertebrate recovery rates following beach fills using sand from the 1989 Sea Bright borrow area have not been studied. Both the Belmar and 1989 Sandy Hook borrow areas are located offshore, only about 25 km (15 miles) apart. In addition, the NPS and the Corps have concluded that sand from the 1989 Sea Bright borrow area is "clean" (*i.e.*, 90 percent or greater sand, thereby meeting applicable criteria for environmental contaminants), and represents a good match with existing beach sediments (U.S. Army

Corps of Engineers, 1990; National Park Service, 2001a). The 1989 Sea Bright borrow area was used in the 1995-96 initial nourishment of Sea Bright and Monmouth Beach, and for the 1997-98 fill at the Critical Zone. Piping plovers did nest in both areas following these fills, but not immediately. In Sea Bright and Monmouth Beach, nesting attempts did not occur until 1997, and successful nesting did not take place until 1998, a delay of 3 years after initial beach nourishment. Following the 1997-98 fill, piping plovers did not return to the Critical Zone until 2001, a lag of 4 years. The degree to which a depressed prey base contributed to delayed piping plover colonization of these areas is unknown.[1]

In the absence of specific information about the benthic invertebrate community of the Critical Zone, or regarding benthic recovery times following placement of sand from the 1989 Sea Bright borrow area, the Service must rely on the BMP and other studies to estimate the effects to piping plovers of prey resource burial from the Interim Beach Fill. Since both the NPS and the Corps certify that sand from the 1989 Sea Bright borrow area is suitable for the Interim Beach Fill, and since in the past piping plovers have nested in areas nourished with sand from this borrow area, the Service expects that the intertidal benthic invertebrate community will eventually recover to an abundance and composition sufficient to support nesting birds.

The anticipated recovery time will be highly dependent on the time of year in which the project takes place. The NPS expects construction to take place during September (Lane, pers. comm., 2002). The intertidal infaunal community may recover within 2.0 months following beach nourishment carried out at this time, with little or no adverse effects to piping plovers during the 2003 nesting season due to reduced benthic prey availability. However, the Interim Beach Fill project may be carried out any time between August 28, 2002 and March 1, 2003. Renourishment in the late fall or early winter would coincide with the period of sharp natural, seasonal decline in benthic invertebrate abundance, and the infaunal community would not be expected to recover for at least 6.5 months. Therefore, project implementation later in the proposed construction period would likely result in reduced productivity in, or abandonment of, the Critical Zone nesting area for 1 year.

[1] Piping plovers returned to the Critical Zone in the season immediately following the 1989-90 beach fill, demonstrating that the area is not necessarily abandoned for some period following sand placement. This fill, however, utilized sand from a different source (Sandy Hook Channel dredging). The failure of any of the 7 chicks to fledge that year was strongly influenced by the inaccessibility of foraging habitats to unfledged chicks, caused by unfavorable beach configuration (*i.e.*, a steep scarp); no information is available regarding the availability of prey within those foraging habitats (Eddings et al., 1990).

c. Perpetuation of a Piping Plover Population Sink

The maintenance of existing habitat is not necessarily a purely beneficial effect of beach nourishment for piping plovers. Continued plover use of an area may actually be detrimental if indirect adverse effects are sufficient to result in reproductive rates below those needed for stable or recovering populations. Habitat that is physically suitable may create a "population sink" by recruiting individuals to the area each season, only to yield reproduction below replacement levels. This may particularly affect piping plovers on sites close to more productive habitats. Potential exists for the Interim Beach Fill to lure piping plovers into the Critical Zone, although the birds would have nested more successfully elsewhere on Sandy Hook.

A comparison of piping plover productivity for the Critical Zone with Sandy Hook as a whole suggests that past fills of this area may have created a population sink in this area (see Table 12). Situated between South Beach Areas C and D, and subject to constant erosion, the Critical Zone may offer the least suitable habitat, and the highest levels of disturbance, of any Sandy Hook nesting area. Piping plovers nested unsuccessfully in the Critical Zone in 1990, following the large 1989-90 beach fill. In that year, Eddings *et al*. (1990) noted that public beaches immediately beyond the northern and southern boundaries of the Critical Zone produced a "steady daytime flow of pedestrian traffic throughout the week," and found that mean numbers of people counted in the Critical Zone were higher than in other Sandy Hook nesting areas during afternoon and evening survey periods. These authors also observed a 0.5 to 1.0-m-high sand scarp in the berm of the Critical Zone that interfered with the access of unfledged chicks to intertidal and wrack foraging habitats. Higher-than-average recreational conflicts were also reported in 2001, when plovers re-colonized the Critical Zone following the 1997-98 fill (MacArthur, pers. comm., 2001).

Piping plover productivity in the Critical Zone over the last decade has consistently lagged behind the average productivity for all Sandy Hook nesting areas, despite high levels of protection and management provided by the NPS. This low reproductive success is probably due to the combined effects of human disturbance and erosion [1] (*i.e.*, scarping, flooding, and narrowed beaches, which provide less intertidal feeding area and greater exposure to human disturbance). Productivity in the Critical Zone was below the level needed for a stable population (1.245 chicks fledged per pair) in 7 of the 8 years the area has been occupied since 1990. These data suggest that the area may, in fact, be a piping plover population sink. The Interim Beach Fill will adversely affect this species by perpetuating this situation for up to 6 years.

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[1] Maintenance of habitat at the Critical Zone will also continue exposure of piping plovers and seabeach amaranth to current levels of predation. However, there is no evidence to suggest that predation levels at the Critical Zone are any higher than elsewhere on Sandy Hook.

Table 12. Comparison of Piping Plover Productivity in the Critical Zone versus all of Sandy Hook, 1990-2001 (Jenkins, 1990; Jenkins and Pover, 2001; Jenkins *et al*., 1995; 1996; National Park Service, 2000b; 2001d)

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
Sandy Hook	1.17	1.15	1.70	1.80	1.94	1.32	1.27	0.36	1.00	1.85	1.76	1.58
Critical Zone	0.00	0.50	1.20	0.60	1.60	0.50	0.00	n/a	n/a	n/a	n/a	1.00

d. Perpetuation of Sub-Optimal Habitat

Following the 1997-98 beach fill of the Critical Zone (287,000 cubic yards of sand from 1989 Sea Bright borrow area), seabeach amaranth colonized the area in 2000, and piping plovers colonized in 2001. Given that a similar volume of sand (253,000 cubic yards) from the same borrow area is proposed for the Interim Beach Fill, the Service anticipates that suitable habitat for these species will return to the project area within 3-4 years. However, suitable habitat may not be immediately available, due to the configuration of the selected construction template. Piping plovers and seabeach amaranth both favor beaches with gentle slopes from the foredune to the water, a configuration that dissipates wave energy and provides a wide inter-tidal plover feeding area. The slope of the intertidal zone is generally steeper after nourishment, until the beach reaches a more stable profile (National Research Council, 1995).

The construction template for the Interim Beach Fill calls for a completely flat berm (0 upper beach slope) and an inter-tidal beach at a slope of 1:20 (landward) and 1:10 (seaward), or 5 and 10 percent, respectively. Although these proposed slopes are consistent with areas preferentially used by piping plovers in Massachusetts (Jones, 1997; Strauss, 1989), important differences exist between a natural beach profile and the proposed construction template. The construction template creates a sharp discontinuity of slopes between the upper beach (0 percent) and the intertidal zone (10 percent) that may inhibit the movement of piping plovers, especially chicks, into intertidal foraging areas. The Service anticipates that the physical configuration of the construction template will hinder the ability of unfledged piping plover chicks to forage in the intertidal zone for 1 to 3 years following construction. The configuration of the construction template is not likely to affect seabeach amaranth adversely, as the wide, flat berm should provide ample habitat following the Interim Beach Fill.

In addition to this temporary adverse effect from the design of the selected construction template, the Interim Beach Fill will also adversely affect piping plovers and seabeach amaranth by creating habitat that will eventually become suitable but will remain sub-optimal throughout its projected 6-year duration. Unfavorable features of habitat in the Critical Zone include stabilized dunes and perpetually eroding and narrowing beaches with likely scarping.

Heavily vegetated, stabilized dunes provide essentially no habitat for piping plovers or seabeach amaranth (Weakley and Bucher, 1992; Jones, 1997). Stabilized dunes do, however, provide cover for plover predators, and promote vegetation, especially beach grass, that reduces habitat suitability for both species. The stabilized dune system will also hasten the elimination of piping plovers and seabeach amaranth from the Critical Zone, as the project area erodes until the high water line reaches the toe of the dune. Under such conditions, piping plovers and seabeach amaranth might be able to persist in an unstabilized dune system, on more gently-sloping foredunes or in blowouts. These habitats are not currently present in the Critical Zone due to existing sand fencing and planted vegetation, which steepen and stabilize the dune. The dune is likely to be maintained in its current condition over the life of the project.

Narrow, eroding, ocean-front beaches, with no alternate feeding areas, generally provide the least productive habitat for both piping plovers and seabeach amaranth. Narrow beach widths increase the exposure of these species to flooding, and to disturbance from recreational beach users (Weakley and Bucher, 1992). In addition, a distinct scarp often forms in the intertidal zone following beach nourishment, as the fill adjusts (National Research Council, 1995). By steepening the intertidal slope, scarping may reduce the size of the intertidal piping plover foraging area, further inhibit the movement of plover adults and chicks into the intertidal zone, and possibly delay the formation of an upper beach wrack line, an important habitat component for both piping plovers and seabeach amaranth. Following the 1989-90 fill of the Critical Zone, scarping was observed by Eddings *et al.* (1990). These authors observed that the 0.5 to 1.0-m-high scarp prevented unfledged chicks from reaching intertidal or wrack foraging habitats, and considered this inaccessibility of foraging habitat to be a major factor in the failure of any of the seven hatched chicks to fledge that year (Eddings *et al.*, 1990).

Thus, the Interim Beach Fill will perpetuate habitat that will continue to expose piping plovers and seabeach amaranth to adverse effects from stabilized dunes and a narrow, eroding beach with no alternate piping plover feeding areas. As previously discussed, the maintenance of sub-optimal habitat, combined with continued exposure to higher recreational impacts than is seen in other Sandy Hook nesting areas, is likely to perpetuate a piping plover population sink at the Critical Zone.

e. <u>Recreational Impacts</u>

By maintaining habitat at the Critical Zone, the Interim Beach Fill will continue, for up to 6 years, the current exposure of piping plovers to possibly the highest levels of disturbance of any nesting area on Sandy Hook. Combined with perhaps the least suitable habitat conditions in the park, this level of disturbance is likely to perpetuate a piping plover population sink in the Critical Zone. Recreational impacts to seabeach amaranth in the Critical Zone over the 6-year life of the fill are expected to be minor, given the plant's confinement to habitats above the high-water line, areas that are not favored by recreational users. Impacts to seabeach amaranth in the Critical Zone will be further minimized by fencing and beach closures to protect piping plovers.

Slightly increased recreational impacts to piping plovers elsewhere on Sandy Hook are also expected as a result of the proposed project. Due to the proximity of the Critical Zone to recreational bathing beaches, additional NPS staff will be assigned to the area as necessary to enforce shorebird area closures (National Park Service, 2001a). This increased enforcement may unintentionally divert NPS staff from other piping plover nesting areas, as it did in 2001 (MacArthur, pers. comm., 2001). Thus, the Service anticipates marginally increased levels of disturbance to nesting birds outside the Critical Zone for up to 6 years following project implementation due to NPS staff constraints. This staff diversion is likely to have at least a small impact on piping plover productivity due to the high level of monitoring and management necessary to protect nesting birds, especially in nesting areas adjacent to recreational centers, such as Gunnison Beach. Expected increases in damage to seabeach amaranth are minimal.

By forestalling a breach and preserving vehicle access onto the Sandy Hook peninsula, the Interim Beach Fill will permit the continuation of existing levels of disturbance to federally listed species throughout the park.[1] Current levels of disturbance to piping plovers and seabeach amaranth on Sandy Hook are considered low, due to the strong protections and intense management efforts provided by the NPS. Recreational disturbance of federally listed species throughout the park is expected to increase marginally each year over the duration of the proposed beach fill. However, the Interim Beach Fill will merely perpetuate, not increase, recreational impacts relative to baseline conditions. Even with slight annual increases, continuation of these impacts is not expected to result in incidental take of piping plovers.

E. CUMULATIVE EFFECTS

Cumulative effects include those of future State, 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 addressed here because they require separate consultation pursuant to Section 7 of the ESA. Although the Service has concerns regarding other relevant effects to piping plovers and seabeach amaranth, none meet the regulatory definition of "cumulative effects," and therefore were not considered in this Biological Opinion. These other factors affecting piping plovers and seabeach amaranth do, however, merit at least cursory mention.

The tenuous status of piping plovers in the New York-New Jersey Recovery Unit is exacerbated by the extreme degree of stabilization of New Jersey's coastline. Although currently expanding, the long-term recovery potential of seabeach amaranth in New Jersey is also severely limited by the minimal opportunities for formation of highly productive, self-maintaining, early successional habitats. New Jersey has the highest degree of shoreline stabilization of any State. As measured by the amount of

[1] Information obtained in the course of previous consultations indicates that northeastern beach tiger beetles are not likely to be adversely affected by the continuation of existing levels of recreational use in those areas of Sandy Hook where the species occurs.

shoreline in the totally stabilized category (90 to 100 percent "walled"), New Jersey, America's oldest developed shoreline, is 43 percent hard-stabilized (Pilkey and Wright, undated *in* U.S. Fish and Wildlife Service, 1996b). Although construction of new hard stabilization structures has slowed, the Shore Protection Master Plan documents the State's intent to maintain existing functional structures in many parts of New Jersey. Sandy Hook represents one of the few relatively natural beach ecosystems in New Jersey, and the only one in Monmouth County. By maintaining existing hard structures, and through implementation of short-term (*i.e.*, Interim Beach Fill) and long-term (*i.e.*, Sand Slurry Pipeline) beach nourishment projects, the NPS is opting to forego the return of Sandy Hook's southern beaches to the natural coastal processes that sustain federally listed and other rare beach strand species. Very few locations along the New Jersey shoreline offer similar restoration opportunities due to the presence of far more extensive commercial and residential development than that which occurs in the vicinity of the Critical Zone.

In addition, almost the entire ocean-front coastline of New Jersey is scheduled for beach nourishment through federal, State, or local programs over the next 5 to 10 years, further contributing to shoreline stabilization, and further exposing beach strand species to the kinds of direct and indirect effects discussed above. Together, these proposed beach nourishment programs may also increase the risk of species declines or extirpation in New Jersey by rendering significant proportions of habitat temporarily unsuitable at any given time (*i.e.*, through construction effects on both species and their habitats). These widespread, simultaneous habitat disturbances limit the ability of these species to disperse and recover from declines in productivity or catastrophic events.

F. CONCLUSION

After reviewing the current status of the piping plover and seabeach amaranth, the environmental baseline for the action area, the effects of the proposed project, and cumulative effects, the Service's Biological Opinion is that the Interim Beach Fill of the Critical Zone, Sandy Hook, Monmouth County, New Jersey, is not likely to jeopardize the continued existence of the piping plover or seabeach amaranth. Important factors in the Service's evaluation of the effects of the proposed project on federally listed species include the low numbers of piping plovers and seabeach amaranth present in the project area, the low levels of adverse effects anticipated outside the project area, the temporary nature of the proposed project, and conservation measures proposed by the NPS that are expected almost entirely to avoid or offset direct adverse effects. The NPS proposes to include these conservation measures as part of its agency action; therefore, they were considered as an integral part of the proposed project and are nondiscretionary.

The environmental baseline on Sandy Hook was also central to the formulation of the Service's Biological Opinion regarding the Interim Beach Fill. The Service's analysis assumes continuation of the long-standing NPS commitment on Sandy Hook to strong policies to protect federally listed species, intensive management of public use to minimize recreational disturbance of listed species, and high levels of species monitoring and management. Baseline conditions also include strong piping plover productivity from 1999 to 2001, due in large part to sharply reduced predation. Similar NPS actions in the future may produce more severe adverse effects to piping plovers and seabeach amaranth if baseline conditions deteriorate, in both the Critical Zone and the park as a whole.

The Interim Beach Fill temporarily precludes the formation of highly productive piping plover and seabeach amaranth habitats by postponing overwash or breaching of the Sandy Hook peninsula at the Critical Zone for up to 6 years. The proposed project will temporarily maintain suitable, but sub-optimal, habitat for these species. No critical habitat has been designated for these species; therefore, no critical habitat will be affected.

IV. INCIDENTAL TAKE STATEMENT

A. DEFINITION OF INCIDENTAL TAKE

Section 9 of the ESA and federal regulations pursuant to section 4(d) of the ESA prohibit the take of endangered and threatened wildlife species, respectively, without special exemption. *Take* is defined as "to harass, harm, pursue, hunt, shoot, wound, kill, trap, capture, or collect, or attempt to engage in any such conduct." *Harm* is further defined by the Service to include significant habitat modification or degradation that results in the 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, 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 a prohibited taking under the ESA provided that such taking is in compliance with the terms and conditions of this Incidental Take Statement.

B. EXTENT OF ANTICIPATED TAKE

The NPS proposes to conduct all project activities for the Interim Beach Fill outside of the piping plover nesting season. Therefore, no take due to the direct effects of project construction are anticipated. However, the Service anticipates that incidental take of piping plovers in the Critical Zone will occur in the form of reduced prey availability; postponed creation of highly productive habitat; and continued exposure of birds to sub-optimal habitat and recreational disturbance sufficient to perpetuate a population sink. Since 1990, an average of 2.5 pairs of piping plovers per year have nested in the Critical Zone. In the 8 years the area was occupied by nesting birds since 1990, productivity has averaged 0.68. The average piping plover productivity for Sandy Hook from 1990 to 2001 was 1.41.

The Service anticipates that the Critical Zone nesting area may be abandoned in 2003 due to reduced prey availability and an unfavorable beach configuration. Abandonment of this nesting area will result in take (in the form of harm) of up to 3 pairs of piping plovers that may have otherwise nested in the area. These pairs are expected to re-locate to other nearby nesting areas, with productivity at least equal to what would have occurred in the Critical Zone.

Alternatively, if piping plovers nest in the Critical Zone in 2003, the Service expects incidental take in the form of reduced productivity. No chicks are expected to fledge due to unsuitable conditions caused by the Interim Beach Fill. These conditions include reduced prey availability, and reduced accessibility of foraging areas resulting from an unfavorable beach configuration. Based on the 1990-2001 averages given above, unsuccessful nesting attempts by 3 pairs of plovers (0 chicks fledged) will represent a loss of 2 chicks relative to an average nesting season in the Critical Zone, or a loss of the 4 chicks that would have been produced if these pairs nested elsewhere on Sandy Hook.

Over the remaining duration of the fill, up to 5 years starting in 2004, the Service expects an average of 2.5 pairs of birds per year, up to 13 total, to nest in the Critical Zone. The Service assumes that these birds would have otherwise nested elsewhere within the park, where they would have been exposed to more suitable habitat conditions and less recreational disturbance. Thus the Interim Beach Fill will result in take (in the form of harm) of up to 13 pairs of birds through 2008. Additional take in the form of lost productivity is expected as a result of attracting these pairs to the Critical Zone. Using the average productivity rates given above, only 9 chicks are expected from these 13 pairs, compared to 18 chicks if these birds nested elsewhere on Sandy Hook, a loss of 9 chicks over 5 years.

The Interim Beach Fill will cause additional incidental take of piping plovers by postponing the formation of highly productive overwash or inlet habitat. Based on the response of piping plover populations to similar events in other areas, the Service expects that the creation of such habitat would permit the average population at the Critical Zone at least to triple, from 2.5 to 8 pairs per year. This increase would represent an overall expansion of Sandy Hook's piping plover population, rather than a mere re-distribution of nesting birds. The Service would also expect the creation of such habitat to result in productivity increasing from the present Critical Zone average of 0.68 to at least the park-wide average of 1.41. The Interim Beach Fill will delay these benefits by curtailing habitat formation through natural coastal processes for up to 6 years. Any attempt to quantify the number of birds that will be taken through this lost opportunity for population and productivity increases is speculative, as this number would depend on exactly when, where, and how overwash or breaching would occur, and the condition of Sandy Hook's piping plover population at the time. However, preventing anticipated increases in numbers and productivity meets the definition of harm, and therefore constitutes incidental take.

Additional incidental take of piping plovers is expected park-wide from 2003 to 2008 from recreational impacts stemming from diversion of NPS staff to the Critical Zone, resulting in lost productivity of 1 chick per year, or 6 chicks total.

C. EFFECT OF THE TAKE

The Service has determined that the level of take anticipated, as described above, from the proposed action is not likely to result in jeopardy to the species or destruction or adverse modification of critical habitat.

D. REASONABLE AND PRUDENT MEASURES

The measures described below are non-discretionary, and must be undertaken by the NPS for the exemption in section 7(o)(2) to apply. The NPS has a continuing duty to implement the activity covered by this Incidental Take Statement. If the NPS: (1) fails to implement the terms and conditions or (2) fails to require all contractors to adhere to the terms and conditions of the Incidental Take Statement, the protective coverage of section 7(o)(2) may lapse. In order to monitor the impact of incidental take, the NPS must report the progress of the action and its impact on the species to the Service as specified in the Incidental Take Statement. The Service concludes that the following reasonable and prudent measures are necessary and appropriate to minimize take of piping plovers:

1. Ensure that all project engineers, contractors, and construction staff are fully informed of and compliant with all conservation measures, reasonable and prudent measures, and terms and conditions.

2. Ensure that the demands of enforcing park protections for endangered species at the Critical Zone do not adversely affect piping plovers in other nesting areas through diversion of NPS staff.

3. Increase outreach and educational efforts at the Critical Zone regarding federally listed species.

E. TERMS AND CONDITIONS

In order to be exempt from the prohibitions of Section 9 of the ESA, the NPS must comply with the following terms and conditions, which implement the reasonable and prudent measures described above. These terms and conditions are nondiscretionary.

1. Provide all project engineers, contractors, and construction staff with a written summary of this Biological Opinion (including all conservation measures and terms and conditions), a written statement that all conservation measures, reasonable and prudent measures, and terms and conditions contained herein are non-discretionary, including project timing.

2. Schedule a pre-construction meeting among project engineers, contractors, construction staff, NPS natural resource staff, and the Service to review the conservation measures, reasonable and prudent measures, and terms and conditions contained in this Biological Opinion, including project timing.

3. Dedicate an additional seasonal staff person to the Critical Zone, at least part time during peak use periods, in any years piping plovers occupy the area. This staff time must represent an addition to park natural resource staff, not a reallocation. In addition, allocate sufficient NPS law enforcement personnel to the Critical Zone to ensure that measures to protect piping plovers are enforced effectively and consistently.

4. Increase public outreach and educational efforts regarding federally listed species at Beach Areas C, D, and E. Increased efforts may include signs, displays, brochures, and interpretive staff. Provide the Service with a summary of these efforts.

5. Provide the Service with an annual summary of piping plover nesting activity in the Critical Zone, quantifying the extent of incidental take from exposure to unsuitable habitat and recreational disturbance.

6. Exercise care in handling any specimens of dead piping plover adults, young, or non-viable eggs to preserve biological material in the best possible state. In conjunction with the preservation of any specimens, the finder is responsible for ensuring that evidence intrinsic to determining the cause of death of the specimen is not unnecessarily disturbed. Finding dead or non-viable specimens does not imply enforcement proceedings pursuant to the ESA. Reporting dead specimens is required for 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 piping plover, initial notification must be made to the following Service Law Enforcement office:

Senior Resident Agent
U.S. Fish and Wildlife Service
Division of Law Enforcement
Sea Land Building, 2nd Floor
1210 Corbin Street
Elizabeth, New Jersey 07201
(973) 645-5910

Upon locating an abandoned nest or non-viable egg specimen, initial notification must be made to the following Service office:

Supervisor
U.S. Fish and Wildlife Service
New Jersey Field Office
927 N. Main Street, Bldg. D
Pleasantville, New Jersey 08232
(609) 646-9310

The reasonable and prudent measures, with their implementing terms and conditions, are designed to minimize incidental take that might otherwise result from the proposed action. If, during the course of the action, the aforementioned level of incidental take is exceeded, such incidental take would represent new information requiring reinitiation of consultation and review of the reasonable and prudent measures provided. The NPS must immediately provide an explanation of the causes of the taking and review with the Service the need for possible modification of the reasonable and prudent measures. 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. §§ 703-712) if such take is in compliance with the terms and conditions specified herein.

V. 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 minimize or avoid adverse effects of a proposed action on listed species or critical habitat, to help implement recovery plans, or to develop information. The Service recommends the NPS carry out the following actions to further piping plover and seabeach amaranth recovery. Several of these recommendations are offered in anticipation of a proposed NPS long-term beach nourishment program at the Critical Zone.

1. Meet on-site with contractors and construction crews prior to initiation of the Interim Beach Fill to observe the locations of seabeach amaranth, and to review the NPS conservation measure for avoidance of marked plants.

2. Monitor the response of the wrack line and intertidal infaunal invertebrate communities in the project area during and after sand placement. Place special emphasis on species likely to be piping plover prey items (*i.e.*, flying insects, polycheates, amphipods, juvenile mole crabs), and produce estimates of total recovery time, as well as recovery rates of abundance, biomass, and composition of piping plover prey items.

3. Initiate research into the diet and foraging habits of piping plovers in the project area.

4. Conduct research to determine where pre-nesting and non-incubating piping plover adults forage and stage on southern Sandy Hook throughout the nesting season, starting in mid-March. Such a study would involve using two observers with phones or radios to locate birds and observe their movements. Protect habitats identified through this research from disturbance and degradation.

5. Institute and implement a policy to actively control piping plover predators on Sandy Hook if, when, and where predation begins to significantly reduce reproductive success.

6. Conduct a statistically defensible experiment of various methods for restoring seabeach amaranth seed and cultivated seedlings to the project area to determine which treatments are most efficient and effective.

7. Conduct a genetic analysis of seabeach amaranth from the Critical Zone, other sites on Sandy Hook and in New Jersey, and other States to investigate if differences exist between populations. Genetic studies will contribute to future species recovery activities, and may lead to lower-cost restoration programs, both in the project area and elsewhere.

8. Design seabeach amaranth restoration methods to retain maximum genetic diversity, based on results of the genetic analysis recommended in #7. Techniques that incorporate

genetic factors would improve seabeach amaranth restoration following future beach fills on Sandy Hook, and would contribute to species recovery.

9. Terminate the planting of beach-stabilizing vegetation throughout Sandy Hook in the vicinity of known seabeach amaranth populations. Particularly avoid non-native species such as Asiatic sand sedge.

10. Monitor seabeach amaranth populations for evidence of herbivory, both insect and mammalian. Identify herbivores when possible. Report the results to this office.

11. Implement a program of long-term storage of seabeach amaranth seeds collected from various parts of Sandy Hook as insurance against catastrophic population declines.

12. Begin working with the Corps, the Service, and Sandy Hook natural resource staff to maximize habitat suitability at the Critical Zone for federally listed species. Possible enhancements include gradual beach slopes, de-stabilized dunes, and non-ocean feeding areas, such as tidal pools.

VI. REINITIATION - CLOSING STATEMENT

This concludes formal consultation on the Interim Beach Fill of the Critical Zone, Sandy Hook, Monmouth County, New Jersey. 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 agency 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 is 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.

Any change to timing of the project's schedule as stated in the project description would constitute relevant new information, and would require reinitiation of consultation prior to the start of any project-related work or activities.

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