VIII. APPENDICES

APPENDIX A. On-going NPS Management Actions for the Piping Plover, Northeastern Beach Tiger Beetle, and Seabeach Amaranth (from NPS 1992, USFWS 1994, 2002a, 2003a, and 2005a).

In 1992, the NPS completed a management plan for the federally-threatened piping plover (NPS 1992). The NPS consulted with the USFWS and NJDEP on the potential impacts of the reintroduction of Northeastern beach tiger beetles to Sandy Hook, and the Interim Beach Fill, Multiuse Pathway and Sand Slurry Pipeline Projects (USFWS 1994, 2002a, 2003a, 2005a). These measures are described below, sorted by species. Required biological and physical monitoring measures are also listed, organized by topic.

Existing Conservation Measures for Piping Plover

The NPS is currently managing the Sandy Hook Unit to protect the piping plover with the following management actions, as specified in consultations with the USFWS and NJDEP (USFWS 2002a, 2003a, 2005a):

- Continue to prohibit all vehicle use of the beach during full plover season, including NPS vehicles, except in emergency situations.
- Prohibit dogs and other pets, leashed and unleashed, from beaches from March 15 to August 30.
- Prohibit kite flying from March 15 to August 30, except at designated areas.
- All piping plover nesting areas will be signed and fenced with wire or string symbolic fencing.
- Use signs and fencing to discourage visitors from crossing over the South Beach seawall into the piping plover nesting area.
- Manage and enforce beach closure areas around piping plover nest sites and a 100-meter buffer, prohibiting recreational use within the closed areas. Once chicks are hatched and become mobile (approximately May 15), extend the closure area to include adjacent intertidal zones until the chicks have fledged (approximately August 15).
- Completely close the intertidal zone in front of nesting sites during critical stages of the plover breeding cycle and when heavy public use is anticipated (e.g., July 4th weekend).
- Take all reasonable steps to minimize disturbance to piping plovers from unauthorized visitor access from the multiuse path into nesting areas. Take other corrective actions as needed, based upon the extent of documented disturbances to piping plovers caused by visitor access from the multiuse path into South Beach piping plover nesting areas. Work with the USFWS to develop and implement further measures as necessary, such as modified signs or fencing, increased enforcement or penalties for unauthorized entry, or seasonal path closures.
- For all potential public use activities that may harm or harass breeding piping plovers, immediate corrective action will be taken and adaptive management will be applied and incorporated into established management practices to prevent further occurrences. An adequate number of trained personnel will be assigned to monitor, prevent, and enforce human and other disturbances at each piping plover nesting site. In particular, trained

personnel will be stationed at the ends of the protected zone at the Critical Zone to enforce protective measures.

- Implement an intensive predator monitoring and management program to reduce impacts to piping plover nests, adults, and young.
- Utilize piping plover nest exclosures where appropriate, in accordance with the USFWS's exclosure guidelines, and in cooperation with the NJ Endangered and Nongame Species Program. Triangular or circular exclosures with a perimeter of approximately 30-feet, 5-feet high (allowing 1-foot to be buried under the sand), and constructed of wire mesh (2-inch x 4-inch mesh size) should be utilized. Support stakes should not be higher than the fence to discourage perching by avian predators. Heavy-duty monofilament line should be strung across the top of the exclosure in a lattice pattern, with each grid measuring 6-inches.
- Use predator exclosures to protect piping plover nests from mammalian and avian predators such as red foxes (*Vulpes vulpes*), raccoons (*Procyon lotor*), crows (*Corvus* sp.) and gulls (*Larus* sp.). Ensure that the predator management program does not result in trap-wise "smart" predators and is adaptable to counter losses from other predator species that may become a threat to piping plovers over time. Some predators, particularly red fox, may learn that eggs are located within the predator exclosures and, subsequently, key in to other nearby exclosures. In such situations, the NPS will use electrified wire around exclosures in problem areas where the standard nonelectrified exclosures have not been sufficient.
- To prevent attracting predators, all trash cans were removed from the beach and adjacent parking areas. The park has implemented a "carry in - carry out" trash policy that requires visitors to remove any trash from items brought into the park.
- Intensify the existing trapping program of plover predators (i.e., cats, etc.) by increasing the number of live traps. Traps should be set in dense vegetation pockets at all three nesting areas (USCG, North Beach and South Gunnison). Traps, baited with fish-base cat food, should be checked every morning. All traps should be in full operation by mid-March.
- Trapping of free-roaming cats has been expanded to include year round trapping, including at beach centers and shorebird nesting areas.
- In piping plover nesting areas with a history of fox predation, foxes will be live trapped and released outside of the park in coordination with the NJDEP. Other mammalian predators will be live trapped and relocated to areas of the park outside of the nesting areas. Trapping and relocation will target problem individuals. Conduct live-trapping efforts in a manner that will avoid the need to release predatory species back into piping plover nesting areas.
- Conduct live-trapping efforts targeting foxes or other mammals during the period prior to the animals giving birth or after young are weaned to avoid capture of lactating females. OR Undertake reasonable efforts to locate the den / nest and humanely euthanize unweaned young, if lactating female mammals are trapped. If successful, relocate the lactating female. If unsuccessful, comply with NJDEP requirement that lactating females with unweaned young be released.
- Investigate measures to control vegetative encroachment.
- Continue efforts to remove invasive species of vegetation that would diminish or degrade piping plover habitat.

- If vegetation succession and / or shoreline changes diminish the amount or quality of piping plover habitat available, the NPS will implement habitat management / restoration efforts.
- Increase outreach and educational efforts to increase compliance with protective measures to reduce take of piping plovers from recreational uses at the park. Investigate the potential of giving visitors a list of rules and regulations regarding beach-nesting birds when they enter the National Park. Seek opportunities to show plover and tern videos and distribute literature where possible. Continue to utilize plover and tern wardens and to provide orientation to these and other seasonal NPS employees. Incorporate outreach and education along the South Beach portion of the multiuse path, in the Critical Zone, and at Beach Areas C, D and E to increase awareness of federally listed species and their habitat requirements.
- Develop a plan for public education regarding beach nesting birds along the South Beach portion of the multiuse path, including signs, brochures, and interpretive staff. Submit the plan to the USFWS for review, and coordinate with the USFWS regarding South Beach outreach and educational requirements.
- Schedule beach profile surveys to avoid and/or minimize disturbance to nesting piping plovers.
- Supplement NPS staff resources at South Beach nesting areas as needed based upon the extent of documented disturbances to plovers caused by visitor access from the multiuse path into piping plover nesting areas. If additional staff resources are needed to address increased disturbances, provide additional staff resources rather than diverting existing staff from other beach nesting bird management activities. Coordinate with the USFWS regarding South Beach staffing requirements.
- 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. Due to the proximity of the Critical Zone to recreational bathing beaches, 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.
- Conduct all activities associated with beach profile and shoreline surveys in a manner that will avoid or minimize loss or disturbance of piping plover adults, nests, and young.
- Provide all personnel involved in collection of beach profile and shoreline surveys with current maps of piping plover nesting areas and update maps as necessary prior to each scheduled survey.
- Ensure that any potentially affected piping plover habitat area is clearly delineated in the field with signs and / or symbolic fencing, prior to each scheduled beach profile or shoreline survey, to warn personnel of the location of sensitive habitats.
- Ensure that at least one NPS natural resource staff member routinely responsible for piping plover monitoring is present and has verified the locations of all piping plover nests and chicks when conducting beach profile or shoreline survey activities using motorized vehicles within 600 feet of piping plover nesting areas, or via foot or bicycle within 150 feet of known nests.

- Provide a natural resource staff member to walk in front of the surveyor to guide the surveyor through the piping plover nesting area and to ensure that no previously undetected nests or flightless chicks are present within the path of the surveyor when conducting beach profile or shoreline survey activities using motorized vehicles within 600 feet of piping plover nesting areas, or via foot or bicycle within 150 feet of known nests.
- Ensure that all motorized vehicles conducting beach profile surveys remain at least 300 feet from piping plover nests or chicks and that non-motorized vehicles or pedestrians remain at least 50 feet from nests or chicks when conducting beach profile or shoreline survey activities.
- Restrict speed of motorized vehicles to no more than 5 miles per hour and operation to daylight hours only when conducting beach profile or shoreline survey activities using motorized vehicles within 600 feet of piping plover nesting areas.
- Hold a pre-survey meeting, prior to each scheduled beach profile or shoreline survey, with appropriate NPS staff, contractors, and cooperators to review known piping plover nesting locations and appropriate procedures to avoid disturbance to birds and beetles.
- Continue to coordinate and consult with the USFWS on piping plover nesting at South Beach.
- 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 USFWS to determine if take is reached or exceeded and to ensure that the terms and conditions are appropriate and effective.
- Retain tidal pools and upper beach wet swales throughout Sandy Hook and especially within piping plover nesting and foraging areas, except where conditions would present a public health or safety hazard.

<u>Existing Conservation Measures for Northeastern Beach Tiger Beetle</u>

The NPS is currently managing the Sandy Hook Unit to protect the Northeastern beach tiger beetle with the following management actions, as specified in consultations with the USFWS and NJDEP (USFWS 1994b, 2003a, 2005a):

- Confine NPS foot and ORV patrol to areas outside of the upper intertidal to high drift zone to avoid the area most likely to be inhabited by Northeastern beach tiger beetle larvae.
- Maintain current or reduced levels of public access within the northern natural beach.
- Continue efforts to remove invasive species of vegetation that would diminish or degrade Northeastern beach tiger beetle habitat.
- Conduct all activities associated with beach profile and shoreline surveys in a manner that will avoid or minimize loss or disturbance of Northeastern beach tiger beetle adults and larvae.

- Provide all personnel involved in collection of beach profile and shoreline surveys with current maps of Northeastern beach tiger beetle areas and update maps as necessary prior to each scheduled survey.
- Ensure that any potentially affected Northeastern beach tiger beetle habitat area is clearly delineated in the field with signs and / or symbolic fencing, prior to each scheduled beach profile or shoreline survey, to warn personnel of the location of sensitive habitats.
- Ensure that at least one NPS natural resource staff member familiar with Northeastern beach tiger beetle areas is present and available to guide the surveyor through the beetle habitat when operating motorized vehicles within 100 feet of Northeastern beach tiger beetle areas to conduct beach profile and shoreline surveys.
- Schedule surveys through tiger beetle areas during low tide to the maximum extent possible when operating motorized vehicles within 100 feet of Northeastern beach tiger beetle areas to conduct beach profile and shoreline surveys.
- Operate vehicles in the intertidal area and away from areas where tiger beetle larvae are most likely to occur (*i.e.*, route vehicles as far as possible away from the wrack line / recent high tide line) when operating motorized vehicles within 100 feet of Northeastern beach tiger beetle areas to conduct beach profile and shoreline surveys.
- Hold a pre-survey meeting, prior to each scheduled beach profile or shoreline survey, with appropriate NPS staff, contractors, and cooperators to review known Northeastern beach tiger beetle areas and appropriate procedures to avoid disturbance to beetles.
- Exercise care in handling any specimens of dead Northeastern beach tiger beetle adults or larvae, 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 USFWS to determine if take is reached or exceeded and to ensure that the terms and conditions are appropriate and effective.
- Retain tidal pools and upper beach wet swales throughout Sandy Hook and especially within Northeastern beach tiger beetle areas, except where conditions would present a public health or safety hazard.

Existing Conservation Measures for Seabeach Amaranth

The NPS is currently managing the Sandy Hook Unit to protect the seabeach amaranth with the following management actions, as specified in consultations with the USFWS and NJDEP (USFWS 2002a, 2003a, 2005a):

- Erect symbolic fencing around seabeach amaranth plants to reduce trampling by pedestrians.
- Seabeach amaranth plants occurring outside of established protected areas will be fenced using string and post fence to prevent damage or destruction of plants from recreational users or NPS beach management operations.
- Implement a program of long-term storage of seabeach amaranth seeds, collected from various parts of Sandy Hook, as insurance against catastrophic population declines.

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

Biological Monitoring

- Provide the USFWS with an annual report, by October 1 of each year, summarizing the results of piping plover, Northeastern beach tiger beetle, and predator monitoring and management activities at Sandy Hook. The report should, at a minimum, include information outlined in other monitoring conservation measures and include maps showing the locations of federally listed species habitat areas protected, locations of individual piping plover nests and indicating type of predator exclosure used (if any), extent of areas with presence of Northeastern beach tiger adults, and areas where predator control activities were undertaken.

Monitoring Protocols for Birds

- Continue efforts to gather data on piping plover productivity and human disturbance, particularly at North Beach and South Gunnison Beach. Data should be collected from the start of the nesting season and should include all dimensions of human disturbance including, but not limited to, walking, "strolling," bathing, fishing, boat mooring, etc. Disturbances should be accounted by specific type, intensity and duration.
- Document instances of unauthorized visitor access from the multiuse path into piping plover nesting areas, recording the date, number of visitors, any observed plover response, and the NPS staff response. Submit this information to the USFWS annually, following the first three nesting seasons after completion of the South Beach portion of the multiuse path, even if no incidents were documented. After 3 years, consult with the USFWS to determine if further reporting is warranted.
- Monitor the Critical Zone for piping plover nesting activity. Implement all existing and recommended management actions at the Critical Zone on suitable piping plover habitat that may occur there.
- Monitor and continue implementation of the park's 1992 piping plover management plan.
- Monitor vegetation and other beach characteristics important to piping plovers and manage them to maintain optimum nesting and foraging conditions. Beach characteristics will be monitored via analysis of GPS shoreline profiles and aerial LIDAR surveys.
- Continue to monitor piping plover nesting and reproductive success throughout the piping plover nesting season on all park beaches, using qualified, trained biologists, to ensure the sand slurry pipeline project does not have an adverse effect on nesting piping plovers. Field data will be collected and recorded daily.
- Monitor piping plover nesting and factors affecting nesting activity or reproductive success (i.e., human disturbance, predation, flooding) at least three times per week until

May 1 and daily thereafter during the nesting season at the Critical Zone and any other sites within 300 feet of high recreational use areas. Monitor all other Sandy Hook nesting sites at least twice per week until May 1 and at least three times per week thereafter.

- Document locations of territorial or courting plovers, nest locations, and areas used by adults and chicks for foraging.
- Implement an intensive monitoring and management program of all potential public use activities that may harm or harass breeding piping plovers, including kite flying, jogging, walking, fireworks, fishing, picnicking, and other beach activities.
- Record observations of any reactions of incubating piping plovers to pedestrian or vehicular disturbance and any evidence of human disturbance or predation.
- Monitor predator activity and impacts to federally listed species at Sandy Hook and provide the USFWS with monthly summaries of management activities undertaken to reduce losses of federally listed species.
- Evaluate the piping plover monitoring and management program at least biannually, and, with USFWS and ENSP input, adapt the program and program staffing as needed to minimize disturbance from recreational and NPS activities occurring at Sandy Hook. As species distributions and / or threats may change, different levels and / or methods of species management may be necessary to maintain sufficient levels of protection.
- Provide the USFWS 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.
- Provide the USFWS with a brief monthly summary during the nesting season of piping plover nesting activity and observed threats or causes of nest or chick losses or abandonment.
- Provide at a minimum for each piping plover nesting area, a summary to include the number of nesting pairs, number of nests, number of renests, number of chicks observed hatched, number of chicks fledged, number of nests or chicks lost, and reason for losses if discernable.
- Provide the monthly piping plover nesting summary to the USFWS by the 5th day of the following calendar month.
- Include in the summary date(s) of predator management actions, predator species targeted, estimated number of problem predator individuals present in listed species area, number and type of traps deployed, number of staff hours expended, number of trapped individuals removed, and areas where trapped individuals are released (both on and off site).
- Provide the monthly predation management summary to the USFWS by the 5th day of the calendar month following trapping or predator control activities.

Monitoring Protocols for Invertebrates

- Collect at least 1 year (2 years if sand slurry project construction schedule is delayed) of baseline invertebrate data prior to pipeline operation.
- Ensure that data collected in the baseline and future invertebrate monitoring are representative of the prey base that would be present during the period when piping plovers would be foraging (March 15 through August 15).

- Provide an analysis of the results of the piping plover prey resource monitoring to the USFWS following each sampling event. If significant (greater than 10 percent) change is observed in prey species composition, size, or abundance, evaluate sand slurry pipeline operation and determine if adaptations can be made that would reduce impacts to invertebrate populations.
- Monitor and report on the status of Northeastern beach tiger beetles at Sandy Hook; take management actions as necessary to abate observed threats to the species.
- Conduct surveys for adult beetles at known Northeastern beach tiger beetle sites at Sandy Hook at least once in late June and at least twice in July each year on an annual basis and following established survey protocols.
- Conduct surveys for the presence or absence of adult Northeastern beach tiger beetles at least once every 5 years within all potentially suitable habitat at Sandy Hook. The survey period should coincide with the anticipated period of peak adult activity as determined by seasonal conditions during the survey year (usually early to mid-July).
- Monitor predator activity and impacts to federally listed species at Sandy Hook and provide the USFWS with monthly summaries of management activities undertaken to reduce losses of federally listed species.
- Provide a summary of the results of adult Northeastern beach tiger beetle surveys to the USFWS by August 15 of each year. The summary should include the areas surveyed, date and time of surveys, weather conditions, number of adult beetles found per site, and any threats to the species observed (i.e., predators, presence of oil or pollutants, erosion of previously used areas).

Monitoring Protocols for Plants

- Monitor all suitable habitats at Sandy Hook for the presence of seabeach amaranth during the core growing season (May – October).
- Conduct an annual survey of seabeach amaranth plants and record the GPS location of plants or groups of plants found. Information collected will include, but not be limited to, number of plants, plant size, reproductive state, location on beach profile (position relative to the dune or high water line), plant associates, and evidence of predation or other apparent threats.
- Monitor seabeach amaranth populations for evidence of herbivory, both insect and mammalian. Herbivores will be identified, if possible.

Physical Monitoring

- Monitor shoreline change through aerial photography, LIDAR, and beach transects. Surveys will be conducted monthly in the Critical Zone, quarterly at Gunnison Beach, and annually at the North Beach and Coast Guard beach.
- Conduct beach profile and shoreline surveys on foot, with use of a light-weight open vehicle such as a 4-wheel all-terrain vehicle (ATV), or with a non-motorized all terrain bicycle as applicable to minimize disturbance as much as possible.

APPENDIX B. NPS Non-discretionary Conservation Measures Relating to the Completed Multiuse Pathway and Interim Beach Fill Projects

The NPS consulted with the USFWS and NJDEP on the potential impacts of the Multiuse Pathway and Interim Beach Fill Projects (USFWS 2002a, 2003a). Numerous non-discretionary protection measures were identified and have been completed by the NPS when the projects were constructed. These measures are described below.

- To offset anticipated mortality of any plants within the Interim Beach Fill project 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.
- Prohibit multiuse path construction during piping plover nesting season.
- Prohibit beach access or multiuse path amenities in front of piping plover nesting areas.
- Coordinate with USFWS to develop the final design of fencing and signs to minimize visitor access from the multiuse path into South Beach nesting areas. Submit final proposed South Beach fencing and sign plans to the USFWS for review. Do not initiate construction until the USFWS has had an opportunity to review the final plans and has issued a concurrence in writing.
- Relocate the multiuse path to avoid the 2002 piping plover nest site in the "back dune" of the Critical Zone and its immediate vicinity.
- Construct a new artificial dune line between the multiuse path and the piping plover nest site at the Critical Zone to create a visual buffer.
- Place sand fencing along the new dune as a further visual buffer and to discourage visitors from leaving the multiuse path and accessing the beach through piping plover nesting areas at the Critical Zone.
- Modify the existing artificial dune to improve piping plover access from the nesting site to the oceanfront beach at the Critical Zone.
- Reconfigure dunes in the Critical Zone, and install fencing and signs throughout the South Beach area, prior to or concurrent with multiuse pathway construction, and outside the piping plover nesting season.
- Use the same borrow area for the Interim Beach Fill project as the 1997-98 fill project and use fill that conforms with the existing sand on the beach at the Critical Zone.

- The Interim Beach Fill 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.
- 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 Interim Beach Fill project.
- Coordinate with USFWS to develop the final design of the multiuse path and the reconfigured dune system in the vicinity of the "back dune" nest site at the Critical Zone. Submit final proposed project plans for the Critical Zone to the USFWS for review. Do not initiate construction until the USFWS has concurred in writing with the final plans.
- 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.
- 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.
- Schedule a pre-construction meeting among project engineers, contractors, construction staff, NPS natural resource staff, and the USFWS to review the conservation measures, reasonable and prudent measures, and terms and conditions contained in the Interim Beach Fill project Biological Opinion, including project timing.

APPENDIX C. NPS Non-discretionary Conservation Measures Relating to the Proposed Sand Slurry Pipeline Project

The NPS has consulted with the USFWS and NJDEP on the potential impacts of the proposed sand slurry pipeline project on threatened and endangered species (USFWS 2005a). Numerous non-discretionary protection measures were identified and will be implemented by the NPS if and when the project is constructed. These measures are described below.

Measures to protect the federally-threatened piping plover:

- If piping plovers nest within areas receiving fill or accreting as a result of fill activities (from the sand slurry pipeline), new nesting areas will be closed to public access and the sites will receive the same level of protection afforded existing nesting areas. The area to be closed will, at a minimum, include the nesting area and a 100-meter buffer from the nest site.
- Construct the sand slurry pipeline outside of piping plover nesting season (March 15 - August 15).
- Operate the sand slurry pipeline after October 1 and conclude before March 1 in any year.
- At Gunnison Beach, sand removal will occur outside piping plover nesting areas; specifically, sand will be removed from the approximately 1,500-foot portion of Gunnison Beach lying between the North Gunnison and South Gunnison protected areas. Only that amount of sand accreting each year in this area will be removed by the sand slurry pipeline project.
- Construct the Interim Beach Fill project outside of the piping plover nesting season.
- Use the same borrow area for the Interim Beach Fill project as the 1997-98 fill project and use fill that conforms with the existing sand on the beach at the Critical Zone.
- Evaluate the short and long-term impact to piping plover prey resources from annual deposition of sediments at the Critical Zone and, to the maximum extent possible, adapt sand slurry pipeline operation to minimize any observed impacts.
- Monitor invertebrates (sampling of transects downdrift, within, and updrift of the sand borrow and discharge areas for the first 2 to 3 years of slurry pipeline operation) to evaluate potential project-related impacts to piping plover prey resources.
- Ensure that data collected in the baseline and future invertebrate monitoring are representative of the prey base that would be present during the period when piping plovers would be foraging (March 15 through August 15).
- Repeat invertebrate sampling transects (downdrift, within, and updrift of the sand borrow and discharge areas) in years 10, 20, and 30 following sand slurry pipeline construction and evaluate any long-term changes in prey species composition, size, or abundance.
- Provide an analysis of the results of the piping plover prey resource monitoring to the USFWS following each sampling event. If significant (greater than 10 percent) change is observed in prey species composition, size, or abundance, evaluate sand slurry pipeline operation and determine if adaptations can be made that would reduce impacts to invertebrate populations.
- Evaluate any changes in the quantity and quality of available piping plover and northeastern beach tiger beetle habitat at beaches north of the Gunnison borrow area and

ensure that forestalling or reducing accretion through annual operation of the sand slurry pipeline does not diminish the quantity or degrade the quality of available habitats.

- Calculate a baseline pre-project (sand slurry pipeline) acreage of available suitable piping plover and northeastern beach tiger beetle habitat at beaches north of the Gunnison beach borrow area.
- Take action to restore or improve suitability of habitats (i.e., removal of dense or woody vegetation, creation of tidal pools to serve as alternate foraging areas), if quantity of available high to moderate quality habitat is reduced (by the sand slurry pipeline project and operation) by greater than 10 percent.
- 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 USFWS recovery plan for Atlantic Coast piping plovers and the Sandy Hook Unit Piping Plover Management Plan. The latter document includes closure of the intertidal zone in nesting areas while chicks are present.
- Seek additional methods or alternatives for effective predator control (i.e., contract trapper; assistance from U.S. Department of Agriculture, Animal & Plant Inspection Service, Wildlife Services; implement humane lethal removal), if new predator species or issues are encountered that are not addressed by the current program, or if the current predator management program is unsuccessful in countering losses to piping plover eggs, young, or adults (as measured by losses of 15 percent or more of nesting attempts or of hatched chicks to predation) immediately (within 7 days).

Measures to protect the federally-threatened Northeastern beach tiger beetle:

- Conduct annual surveys for the Northeastern beach tiger beetle in suitable habitats at Sandy Hook, including the Gunnsion Beach borrow area and Critical Zone deposition area. The presence of adult tiger beetles at the sand slurry pipeline borrow or deposition area will trigger the need to survey the affected site for the presence of beetle larvae. If larvae are found, consultation with the USFWS will be reinitiated to determine if site-specific protective measures can be developed to minimize any adverse impacts to the species from planned activities.

Measures to protect the federally-threatened seabeach amaranth:

- In the event that sand slurry pipeline construction activities cannot avoid damage or destruction of seabeach amaranth plants, the affected plants will be transplanted to a nearby suitable habitat and be protected by fencing. Prior to plants being moved, seeds, if present, will be harvested and stored. The seeds will be distributed the following season to the same area from which they were collected. The NPS will coordinate with the USFWS and other appropriate agencies / organizations prior to implementing the proposed translocation strategy.
- Survey all areas to be impacted by construction-related activities prior to initial construction and subsequent operation of the sand slurry pipeline to document the

presence or absence of seabeach amaranth, using a methodology that provides adequate coverage of potential seabeach amaranth habitat in the work area.

- Where seabeach amaranth is found within an area to be affected by construction or operation of the sand slurry pipeline, information regarding the plants will be recorded, including plant locations, numbers of plants and size of plants. The plants and a protective buffer, approximately 10 feet in diameter, will be fenced with string and post fencing to prevent disturbance to the plants. All construction activities will avoid any delineated locations of seabeach amaranth to the greatest practicable extent.

Measures to protect the multiple federally-listed species:

- Restore vegetated areas damaged by construction of the sand slurry pipeline to natural pre-project conditions where possible, using native grass species in dune areas.
- Hire two additional seasonal Biological Technicians to monitor federally-listed species populations and potential adverse impacts from the sand slurry pipeline project, and to implement conservation measures, beginning with project construction and continuing for the 30 year life of the project.
- Provide all NPS staff, contractors, cooperators, and / or permittees involved with construction and operation of the sand slurry pipeline with a written summary of all relevant conservation measures contained within the project description, RPMs, and terms and conditions of the project's Biological Opinion.
- Report on the progress of the sand slurry pipeline project and its impact on federally-listed species.
- Continue the current ongoing monitoring and reporting to the USFWS and / or ENSP by NPS natural resource staff unless otherwise notified, and begin monitoring and reporting on the progress of the sand slurry pipeline project and any project-related impacts or threat abatement activities
- Practice adaptive management of the sand slurry pipeline project and adjust protective measures as needed or as new information becomes available.

Appendix D. Existing Management Activities of the Sandy Hook Unit, Gateway National Recreation Area, to Conserve Threatened and Endangered Shoreside Species

In addition to the 131 management activities described in Appendices A, B and C, the NPS conducts a variety of management activities for protected resources at Sandy Hook, including the 1992 *Management Plan for the Threatened Piping Plover* and the 2000 *Osprey Management Plan*. The twelve Park management actions contained within the 1992 *Management Plan for the Threatened Piping Plover* are listed in Table 2. The 2000 *Osprey Management Plan* describes NPS plans to repair four osprey nesting platforms in the Park, raise the height of one platform, install four new platforms, and convert some of the utility poles into nesting platforms once utility lines are moved underground as part of the Fort Hancock Rehabilitation Project (NPS 2000). To date, two of the new platforms have been built and four platforms have been repaired. The *Osprey Management Plan* also describes the Park's monitoring program for osprey, which includes the annual documentation of mating behavior, nest site locations, productivity, factors affecting productivity such as human disturbance or predator impacts, banding of chicks, and collection of dead ospreys, infertile eggs or eggshells for analysis.

In addition to the existing piping plover and osprey management plans, the NPS has incorporated several habitat-based protection measures into the management of shoreside Park resources. First, the Park is divided into three types of management zones: Protection, Use-by-Reservation and Unstructured Recreation Zones (NPS 1979, 1990). The Protection Zones are intended to protect the Park's natural resources, including the shoreside vegetation and wildlife communities. Use-by-Reservation Zones include areas such as the forests and Fort Hancock, and human use generally is limited to permitted uses. The Unstructured Recreation Zones are those areas set aside for intensive human use and recreation. The Park's *General Management Plan* (NPS 1979) defined these zones, with approximately three-quarters of the Park set aside as Protection and Use-by-Reservation Zones with low human use, including some beachfront areas, all of the dunes and most of the bayside areas (Fig. 1). The public beaches form the bulk of the Unstructured Recreation Zone and currently contain six beach centers for Park visitors. The Park is closed after dark, except by permit (i.e., fishing).

Intensive human uses (e.g., beach grooming, kite-flying, ball playing, swimming, sunbathing, jogging) are generally allowed at Sandy Hook, but limited to the recreation zones. Recreational use of the protection zones is limited to low intensity activities like strolling along the water's edge and fishing; the intertidal zones adjacent to piping plover nests are closed once chicks are mobile, so that they may forage in the intertidal zone without human disturbance. The protection zones are separated from the recreation zones (public beaches) by symbolic fencing and signs (Fig. D-1); NPS staff are stationed at each of these roped boundaries on summer weekends, when Park visitation is highest, to further enforce the restricted human use of the protection zones and to educate visitors about the protected resources of the Park. Pets are prohibited from all oceanfront beaches from March 15 through Labor Day each year.

Figure D-1. Protection zones are separated from the Recreation zones (public beaches) by symbolic fencing and signs. Photo by Terwilliger Consulting, Inc., June 27, 2006.

On the bayside shores of the Park, the water areas and salt marshes surrounding Spermaceti Cove are closed to recreational use. The salt marsh and tidal creeks at Horseshoe Cove are also protected areas and thus closed. Visitor use in the Holly Forest, which contains northern diamondback terrapin nesting habitat, is limited to ranger-led tours or educational groups by permit. Plum Island, and its tidal ponds, are open to recreational use.

In all other areas, recreational use is allowed, including the presence of dogs (although they must be leashed), swimming, kite flying, ball playing, sunbathing, walking, jogging, and windsurfing. Fires are only permitted from October 15 to April 14 by permit, and while night fishing. Alcohol consumption is allowed throughout the Park except in parking lots and campsites. Boats may beach in non-protected bayside areas from sunrise to sunset; from sunset to sunrise they must be anchored offshore. Personal watercraft are prohibited within the Park's waters except in the navigation channel near the Highlands bridge. Fishing is allowed in accordance with NJ state fish and game laws, except in the protected areas of Spermaceti and Horseshoe Coves. Crabbing is also allowed, in accordance with state regulations. Clamming is limited to commercial clammers with a special state permit; the estuarine waters are otherwise prohibited for recreational clamming.

Public off-road vehicle use is prohibited year-round at Sandy Hook in order to minimize human disturbance to the shoreside beach communities (NPS 1992, USFWS 2005a). The only ORV use on the Park's beaches is for law enforcement patrols, which are limited to areas outside of the fenced bird nesting areas, and biological monitoring conducted by NPS Natural Resources staff. When the intertidal zones are closed once piping plover chicks have hatched, law enforcement ORV travel in protected areas is limited to only during true emergencies (i.e., incidents involving critical life saving operations). The physical shoreline monitoring surveys (beach profiles and shoreline surveys) are conducted on foot, non-motorized all terrain bicycle, or light-weight open vehicle such as a 4-wheel all-terrain vehicle (ATV).

The NPS also protects shoreside threatened and endangered species at Sandy Hook by scheduling construction and maintenance activities for outside of the beach nesting season of March 15 to August 15 and outside of beach nesting bird areas to the greatest extent possible.

The Park also has a program to remove invasive, non-native vegetation in areas managed for the protection of federally-listed species (USFWS 2005a). Natural Resources staff have identified the non-native vegetation species found within the Park and have prioritized them for removal. Asian sand sedge (*Carex kobomugi*) is the only non-native, invasive species that currently significantly threatens the shoreside threatened and endangered species community, and the Park is cooperating with a scientific study led by Dr. Louise Wooten of Georgian Court University to evaluate the most effective control measures for this species.

The Park participates in the state's Operation Clean Shores program, which utilizes inmate labor to clear debris such as large timbers, wood, and tires from the beach. Large pieces of wood is cut into manageable sizes, placed into a front end loader and removed from the beach. To the greatest extent possible, the NPS limits these annual cleaning activities to before the shorebird nesting season begins, but occasionally these activities are conducted in April. During the nesting season, NPS staff remove trash and litter from the areas surrounding bird nests by hand.

The NPS conducts a detailed biological monitoring program every year on several protected species (piping plover, Northeastern beach tiger beetle, seabeach amaranth, osprey, least tern, common tern and American oystercatcher) and the causes of nest loss for beach nesting birds (predation, flooding, abandonment, etc.). The Park contracts with Dr. Norbert Psuty at Rutgers University to conduct regular physical monitoring of the Gunnison Beach and Critical Zone areas. Most of the Park's existing monitoring program is based on requirements of consultations with the USFWS and NJDEP, which are listed in Appendix A.

The existing predation management program at Sandy Hook includes measures to remove predator attractions such as trash cans, the use of predator exclosures on piping plover nests, and the trapping and relocation of mammalian predators such as red fox, raccoon, opossum and free roaming cats. The Park adopted a carry-in/carry-out trash management policy that requires visitors to remove any trash they bring in to the Park and take it home with them. All trash cans have been removed from the beach and adjacent parking areas. Potential predation is reduced because predators are no longer attracted to trash that remained on the bathing beaches overnight.

Predator exclosures are employed on piping plover nests in accordance with the guidelines of the NJDEP Endangered and Non-game Species Program and the USFWS. Some red fox, however, learn that eggs are located in the exclosures. The fox keys in on other exclosures and digs under, jumps on top, or causes enough of a disturbance that the adults abandon the nest. To help counter this problem the NPS began electrifying the exclosures in 2004. Since nest productivity increased on nests with the electrified exclosures, the NPS expanded the use of electric exclosures to all of the piping plover nests during the 2005 and 2006 nesting seasons. The exclosures are encircled with an electrified wire approximately 8 inches above the ground and 8 inches away from the exclosure. The wire is charged with a 6 volt battery powered fence charger.

Where mammalian predators remain a problem for beach nesting piping plovers, the NPS conducts trapping and relocation activities in accordance with the conditions set forth by the USFWS Biological Opinions (see Appendix A). Live box traps are deployed near nest areas that are experiencing problems with mammalian predators. If trapped, raccoons and opossum are relocated to other areas of the Park (14 raccoon, 1 opossum and 1 crow were trapped and released in 2005). If a "smart" fox type predator problem is encountered at any of the nesting areas the Park, staff have trapped and relocated the fox to areas outside of the Park in accordance with the conditions of a NJDEP wildlife relocation permit. If the animal was injured during the trapping process it is taken to a licensed animal rehabilitator. Trapping of free roaming cats has been expanded to include year round trapping. Trapping areas include the beach centers and adjacent shorebird nesting areas. All trapped cats without identification are removed from the Park and turned over to the Middletown Animal Control, the Humane Society, or Society for the Prevention of Cruelty to Animals (SPCA).

The No Action Alternative is adaptive to changing regulatory requirements and policies of the USFWS, NJDEP and other regulatory agencies. For instance, the Park has trapped and relocated red fox out of the Park as needed in 1998, 1999, 2005 and 2006, with 8 fox relocated in 2005. The NPS had historically obtained a relocation permit from the NJDEP to conduct this management action, but the state's *Policy on the Relocation of Wildlife* (NJDEP 1996) now limits the trapping and relocation of wildlife such as raccoon, fox, feral cats and skunks. The NJDEP has informed the NPS that the Park will no longer be issued permits for trapping and relocating fox as of 2007.

The NJDEP updates the areas where beach raking is allowed on an annual basis. Beach raking activities are prohibited by the state in areas of threatened and endangered species shorebird nesting, and the NJDEP Division of Fish and Wildlife updates these prohibited areas annually based on the current extent of shorebird nesting (N.J.S.A. 7:7E-3A.1(a)3). The NJDEP Land Use Regulation Program also prohibits beach raking in areas of known seabeach amaranth occurrences, updating these areas annually based on the previous year's distribution of the plant. The NPS must obtain permission each year for each location the Park wishes to maintain with beach raking, and limits this activity to the public beaches where no shorebird nesting occurs (consistent with the state regulations) and where lifeguards are present.

APPENDIX E. Management Goals for the Preferred Alternative

The NPS considers the following management goals to be realistic, sustainable targets for shoreside threatened and endangered species at Sandy Hook. Populations of federally-listed species above these goals will continue to be protected in accordance with applicable federal and state laws and regulations. These management goals are consistent with and contribute to the goals set forth by existing conservation plans such as USFWS Recovery Plans (USFWS 1994a, 1996a, 1996b), the *U.S. Shorebird Conservation Plan* (Brown *et al*. 2001, Clark and Niles 2000), *North America Waterbird Conservation Plan* (Kushlan *et al*. 2002), Mid-Atlantic / New England Maritime Regional Working Group for Waterbirds (MANEM 2004), *Mid-Atlantic Coastal Plain Bird Conservation Plan* (Watts 1999), and the New Jersey Wildlife Action Plan (NJDEP 2005). Quantitative performance indicators (e.g., the number of nesting pairs of birds, the fledge rate of bird nests) that will allow the NPS to monitor progress and success at reaching these goals are included where applicable.

Piping plovers

- An average nesting population of 51 to 65 pair for five years
- An average productivity greater than or equal to the USFWS recovery goal of 1.5 chicks fledged per pair for five years (USFWS 1996a)
- Annual predation losses of eggs, young or adults (as measured by losses of nesting attempts or hatched chicks to predation) at or below 15% (USFWS 2005a)

The *Piping Plover Recovery Plan* recommends a target population of at least 575 breeding pair within the New York – New Jersey recovery unit (USFWS 1996a). The current NJ statewide population averages 121 pair, with a peak of 144 in 2003 (Table 8). The NJDEP drafted a statewide recovery goal of 200 to 230 pair in 1998, which would contribute 40% towards the USFWS recovery unit goal (NJDEP 1998). These draft targets were identified prior to the increase in habitat availability from widespread beach nourishment projects and changes in habitat suitability throughout the state, however. The NJDEP and USFWS currently recommend updating the target for the northern Monmouth County region to 63 to 85 pair, with Sandy Hook contributing 75 to 80% of the regional goal (T. Pover, NJDEP ENSP, personal communication). Sandy Hook has contributed, on average, 28.4% of the breeding pairs to the statewide total for NJ. Twenty-eight point four percent of a statewide target of 200 pair is 57 nesting pair for Sandy Hook's beaches (including the USCG beach), which is consistent with the recommended target of 51 to 65 pair. Since Sandy Hook supported 43 nesting pair in 1995 (Table F-1), before habitat availability increased as a result of the Park and USACE beach fill projects, this management goal is realistic.

These 51 to 65 nesting pair should be distributed amongst all of the areas of the Park that have historically supported nesting: Coast Guard, North, North Gunnison, South Gunnison, Critical Zone, Hidden, Fee and South Fee (Table F-5). Habitat conditions and availability may shift over time due to hurricanes, nor'easters, or changes in renourishment schedules or policies, federal and state management policies. As a result, piping plover nesting may shift between sites over

time within the Park, and specific target populations for individual beaches are not proposed. It is recognized, however, that Coast Guard Beach and North Beach have averaged the highest number of nesting pair, at approximately 7 and 10 respectively from 1990 to 2006; the other beaches average 1 to 3 nesting pair over the same period (Table F-5).

Red knot

- Establish baseline abundance of red knot in the Park
- Establish monitoring protocols
- Protection of migrating individuals as documented in the Park
- Protection of foraging and roosting habitat as documented in the Park

Northeastern beach tiger beetle

- Long-term average population size of at least 500 adults at the northern beaches (USFWS 1994a)
- At least one other smaller population (100 - 500 adults) on another oceanfront or bayside beach such that "sufficient protected habitat for expansion and genetic exchange" is achieved (USFWS 1994a)

The Northeastern Beach Tiger Beetle Recovery Plan (USFWS 1994a) recommends that each Geographic Recovery Unit contain at least one, self-sustaining large population of 500 or more (peak count) adult beetles, plus several smaller populations that will allow genetic exchange, migration and dispersal of populations. The entire population of this species within the New Jersey Geographic Recovery Unit currently is located within the Sandy Hook Unit. USFWS (2005a) states that maintaining tiger beetle populations at Sandy Hook and establishing similar populations at the Edwin B. Forsythe NWR and Island Beach State Park is necessary to meet the recovery objectives for this threatened species. Sustaining the Park's population at these management levels thus is essential to meeting the USFWS recovery goals for this species. Peak counts of adult beetles have reached the target level of 500 in the past, but have not been maintained long-term (Table F-6).

Seabeach amaranth

- Long-term average population size of at least 2,000 plants
- Support a 5 year average minimum population of at least 1,000 plants

Since its rediscovery at Sandy Hook in 2000, the average number of seabeach amaranth plants at the Park is 1,962 (Table F-7). The proposed action proposes a management goal that maintains this 7 year average. The plants have been distributed throughout the Park, on virtually every protected beach, but the highest populations have occurred on the southern beaches of the Critical Zone, Hidden Beach, and Fee Beach. As a fugitive, annual species, seabeach amaranth populations shift naturally over time to patches of suitable habitat; therefore the population goals for this species are for the entire Park rather than for individual beaches. USFWS (2006b) utilized the methodology of NatureServe (2006) to define a population, or element occurrence, of seabeach amaranth as one or more plants and "persistently unsuitable habitat" as extending for 1

kilometer (0.6 mi or 3,280 ft) or more. The "occurrence viability" of a population of seabeach amaranth was further ranked according to population size, with a rank of A for populations of 1,000 plants or more, B between 100 and 1,000 plants, C between 10 and 100 plants, and D for less than 10 plants (USFWS 2006b). Sandy Hook has maintained a population rank of A (greater than 1,000 plants) since 2004; as a result, one management goal is to maintain an A rank population of at least 1,000 plants within the Park.

Least terns

- At least five nesting colonies within the Park's protection zones
- An average productivity greater than or equal to the MANEM (2004) sustainability criteria of 0.59 chicks fledged per pair

Least terns have nested in five areas of Sandy Hook: Coast Guard Beach, North Beach, North Gunnison, Hidden Beach, and Fee Beach. The proposed action recommends maintaining those nesting colonies and to increase their productivity to sustainable levels as defined by the Mid-Atlantic / New England Maritime Regional Working Group for Waterbirds (MANEM).

Osprey

- Maintain at least 6 active nesting sites in any given year
- An average productivity greater than or equal to the sustainability criteria of 0.80 chicks fledged per pair (Clark and Wurst 2005)

The Sandy Hook Unit has supported 27 nesting sites for osprey since 1974, with 3 to 6 of them active in any given year (NPS 2000). This plan proposes to maintain that current level of nesting and to meet or exceed the sustainable productivity level as defined by Clark and Wurst (2005).

Seabeach knotweed and Seabeach evening primrose

- Protection of plants as discovered and documented

Black-crowned night heron, Horseshoe crab and Northern diamondback terrapin

- Protection of nesting colonies or nests as documented

American oystercatcher

- Protection of nests as documented
- Improve productivity, with adaptive management of specific productivity goals

This plan proposes to maintain those nesting sites and to increase their productivity above the current level of zero to more sustainable levels. As specific productivity goals are developed, such as through studies underway or as the American Oystercatcher Conservation Plan is implemented (Schulte et al. 2006), this plan will adaptively manage to contribute towards those goals.

Common tern

- Protection of nesting colonies as documented
- Productivity of at least 0.8-0.9 when a colony is present (MANEM 2004)

Common terns have nested in at the USCG and North Beach areas of Sandy Hook and are frequently seen loafing in other areas. The Preferred Alternative proposes to maintain those two nesting colonies and to increase their productivity to sustainable levels as defined by the Mid-Atlantic / New England Maritime Regional Working Group for Waterbirds.

Appendix F. Special Status Species Background

Federally Threatened and Endangered Species

Piping Plover

Species Description

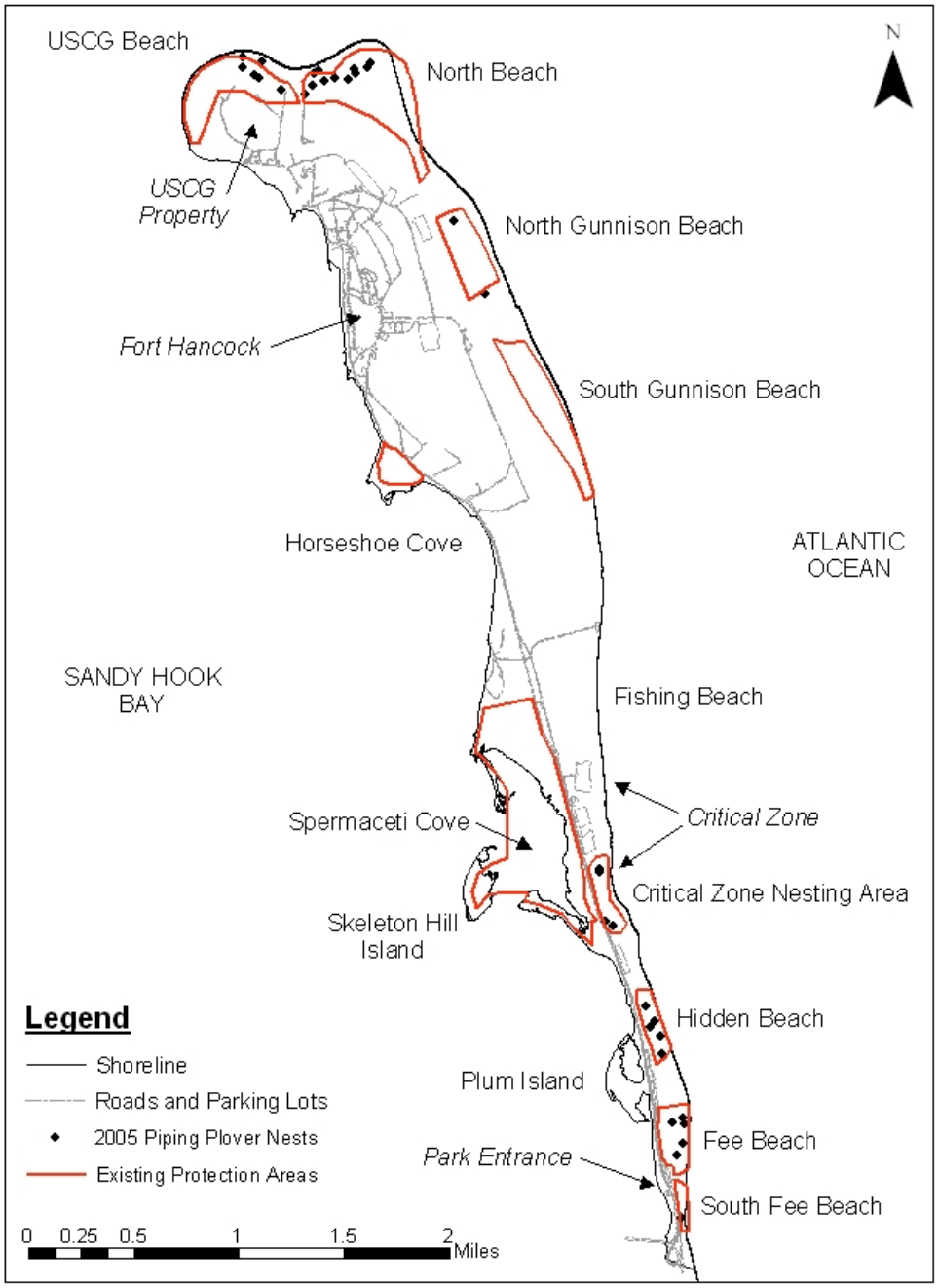
Piping plovers are small, sand-colored shorebirds, approximately 7 inches long with a wingspread of about 15 inches (Palmer 1967). On January 10, 1986, the piping plover was listed as endangered and threatened pursuant to the ESA. Three distinct populations were identified and listed separately: Atlantic Coast (threatened), Great Lakes (endangered), and Northern Great Plains (threatened). The state of New Jersey lists the piping plover as endangered. 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 (USFWS 1985). The piping plover and its life history have been fully described by USFWS (1996a) and more recently, including its status in New Jersey, in USFWS (2005a, b).

Piping plovers return to their Atlantic Coast nesting beaches, including Sandy Hook, in mid-March (Coutu *et al.* 1990, Cross 1990, Goldin 1990, MacIvor 1990, Hake 1993). Eggs may be present on the beach from early April through late July. The incubation period usually lasts 27-28 days. Chicks may move hundreds of feet from the nest site during their first week of life (USFWS 1994c), and chicks may increase their foraging range up to 3,280 ft (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). At Sandy Hook, the latest fledging observed was in late August.

Habitat Description

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 or other vegetation (Patterson 1988, Flemming *et al.* 1990, MacIvor 1990). Figure F-1 depicts piping plover nest locations within the Sandy Hook Unit for 2005.

Figure F-1. Piping plover nest locations at Sandy Hook in 2005.



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, Ellias-Gerken 1994). 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.

Overwash habitats, bayside flats, unstabilized and recently closed inlets, ephemeral pools (areas on the beach where sea and/or rain water pool 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 (*e.*g., Wilcox 1959, Strauss 1990, Massachusetts Division of Fisheries and Wildlife 1996, Jones 1997, Houghton 2000, Cohen *et al.* 2002). These characteristics are indicative of optimal or highly suitable habitats. Ellias *et al.* (2000) concluded that the retention of adequate high quality habitats is important to raising piping plover productivity rates to levels that will allow the species' recovery.

The USFWS has defined the primary constituent elements of wintering habitat to consist of intertidal flats (sand and/or mud) with little to no emergent vegetation, unvegetated or sparsely vegetated flats above mean high water adjacent to intertidal flats, surf-cast algae, sparsely vegetated backbeaches, barrier spits, salterns, and washover areas (USFWS 2001).

Status and Distribution at Sandy Hook

Breeding birds

Table F-1 and Figure F-2 summarize the breeding piping plover population status at Sandy Hook from 1990 to 2006 (NPS, unpublished data). Both abundance and productivity have varied significantly during this period. Sandy Hook has witnessed a highly variable hatching rate but a more consistent fledging rate. Aberrant predation and weather/flood events contributed to this highly variable hatch rate.

Table F-2 summarizes nest data for the same time period. Productivity at Sandy Hook exceeded the Recovery Plan goal of 1.5 chicks/pair during 7 of the last 16 years, while abundance showed an increasing trend though 1997 (severe predation event and lowest productivity recorded in 1997), then declined and remained fairly stable through 2001. In 2003 the fledging rate fell to nearly half of that of 2002, most likely due to an increase in predation by smart predators; the fledging rate fell even lower in 2004 to near a record low for Sandy Hook. In 2005 and 2006, the number of nesting pairs (22) was the lowest it has been since 1992. The 2005 and 2006 fledge rates rebounded somewhat (most likely due to the increased use of electrified exclosures) but was still below average for the Park and less than the recommended goal of 1.5 chicks per pair.

Table F-1. Piping plover abundance and productivity from 1990-2006. (Source: NPS, unpublished data)

Year	Number of nesting pairs	Number of eggs	Number of eggs hatched	Percent of eggs hatched	Number of chicks fledged	Percent of chicks fledged	FLEDGE RATE
1990	18	75	44	58	21	48	1.17
1991	20	83	53	63	23	45	1.15
1992	21	87	67	77	35	52	1.70
1993	25	100	87	87	45	52	1.80
1994	36	146	111	76	70	63	1.94
1995	43	193	108	64	57	53	1.32
1996	40	200	94	47	51	54	1.27
1997	42	195	28	14	15	54	0.36
1998	29	145	49	34	29	59	1.00
1999	27	107	79	74	50	63	1.85
2000	29	124	92	74	51	55	1.76
2001	31	140	94	67	49	52	1.58
2002	35	137	113	82	60	52	1.71
2003	38	226	62	27	31	50	0.95
2004	32	207	43	21	21	49	0.66
2005	22	116	48	41	25	52	1.13
2006	22	105	52	50	29	56	1.32
AVE	**30**	**140**	**72**	**53**	**39**	**50**	**1.33**

Figure F-2. Number of nesting pair of piping plovers (bar) and annual productivity (line) for Sandy Hook, 1990 to 2006.

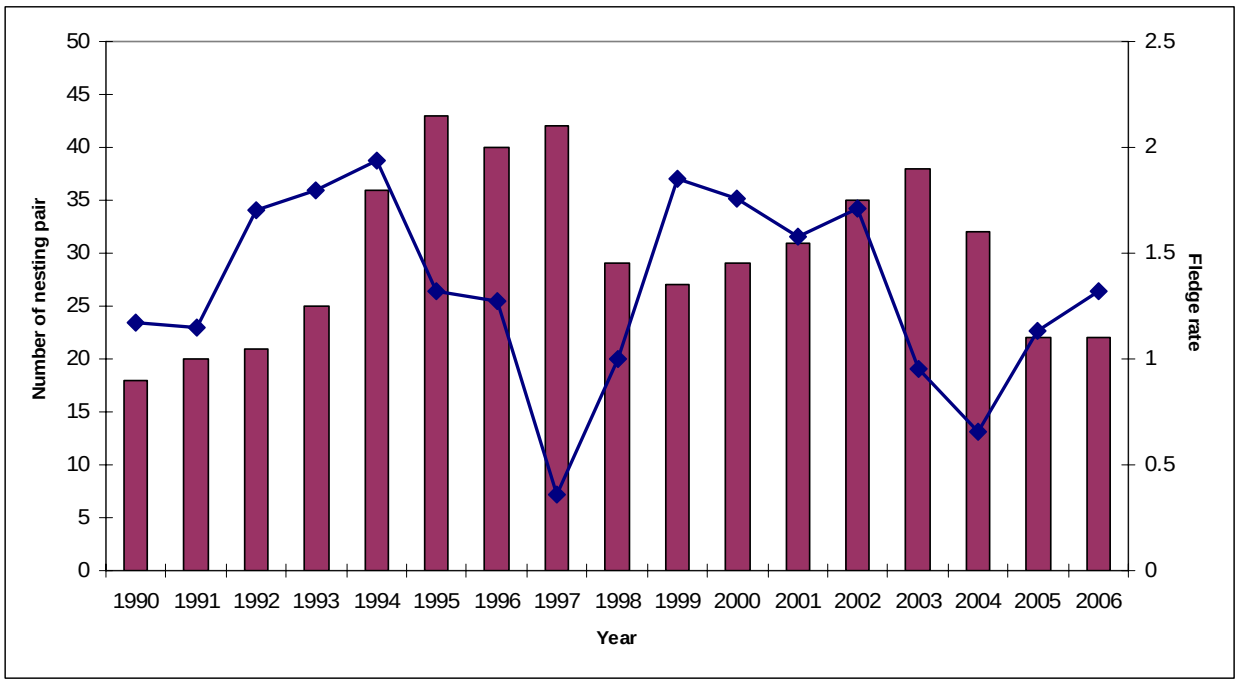


Table F-2. Sandy Hook piping plover nest data for 1990-2006. (Source: NPS, unpublished data)

Year	Number of nest attempts	Number of re-nest attempts	Number of exclosures used	Number of nests lost in laying stage	Number of eggs lost to predators	Number of eggs lost to flooding	Number of exclosed nests lost	Number of unhatched eggs
1990	21	1	14	11	12	Unknown	3	7
1991	23	2	16	8	17	Unknown	5	11
1992	25	4	18	5	13	4	0	7
1993	28	3	20	5	9	0	0	4
1994	46	10	37	11	7	6	10	25
1995	59	16	51	7	32	14	21	7
1996	57	15	37	7	64	31	21	4
1997	63	23	28	27	118	20	22	6
1998	43	16	25	11	91	0	15	5
1999	31	4	21	6	8	0	3	19
2000	33	4	28	1	8	2	2	15
2001	36	5	34	0	0	0	7	28
2002	39	4	34	3	0	1	2	24
2003	63	26	42	13	53	28	8	55
2004	61	41	31	20	133	3	23	15
2005	34	13	32	6	51	16	19	2
2006	31	10	28	4	20	3	15	30
AVE	41	12	29	9	37	9	10	16

Table F-3. 2006 Breeding piping plover abundance and productivity by nesting area. (Source: NPS, unpublished data)

	Number of nesting pairs	Number of eggs	Number of eggs hatched	Percent of eggs hatched	Number of chicks fledged	Percent of chicks fledged	FLEDGE RATE
South Fee	1	4	0	0	0	0	0.00
Fee Beach	4	19	14	74	5	36	1.25
Hidden Beach	3	13	6	46	3	50	1.00
Critical Zone	3	11	3	27	2	67	0.67
South Gunnison	0	0	0	0	0	0	0.00
North Gunnison	3	20	6	30	1	17	0.33
North Beach	4	22	11	50	9	82	2.25
USCG	4	16	12	75	9	75	2.25
Total	**22**	**105**	**52**	**50**	**29**	**56**	**1.32**

Figure F-3. Historical piping plover nesting areas (1995-2005) on Sandy Hook.

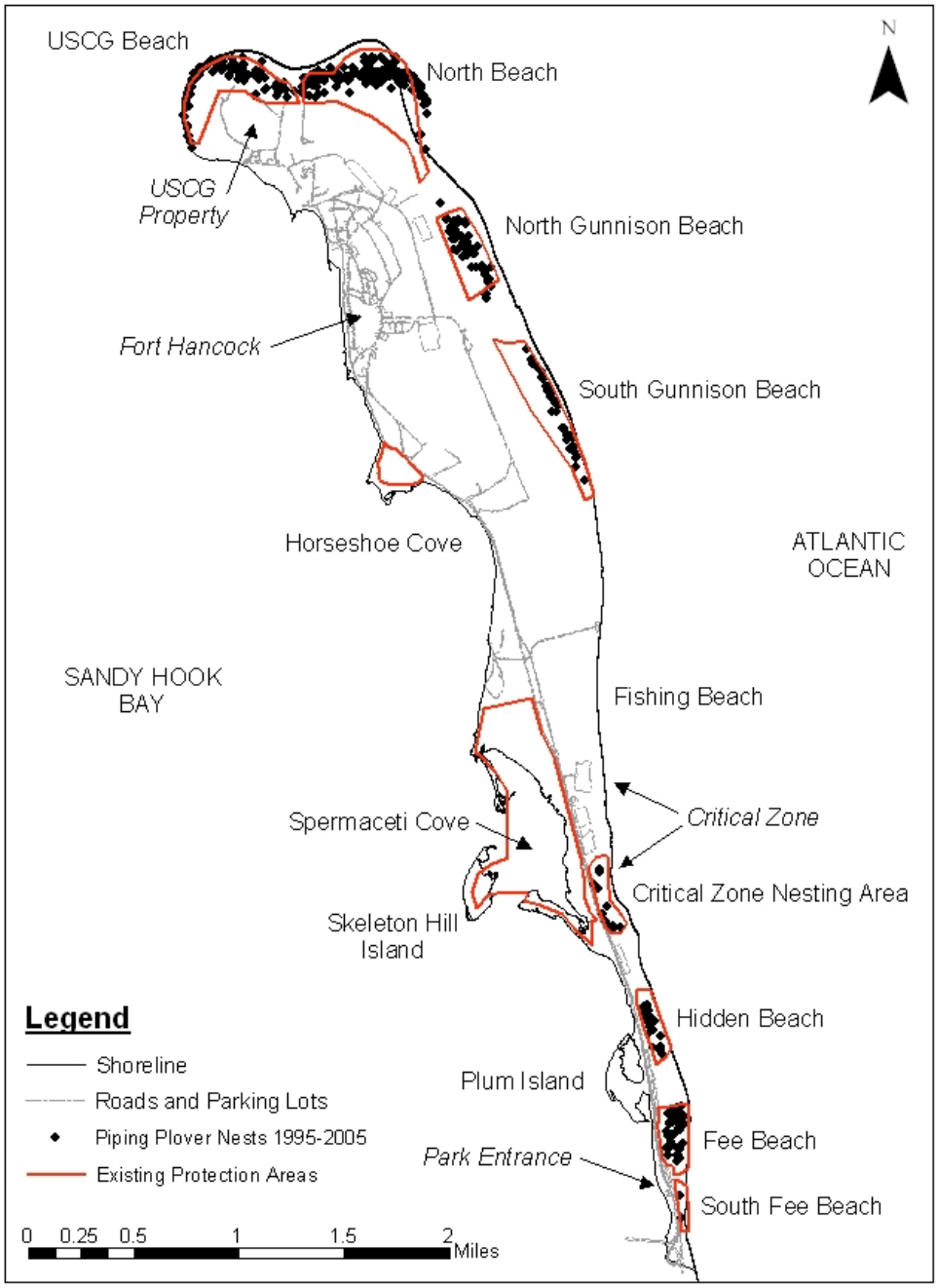


Table F-4. Causes of piping plover nest loss by site in 2006. (Source: NPS, unpublished data)

	Fox	Human	Crow	Gull	Flood	Abandoned	Unknown	Dog
South Fee	4	0	0	0	0	0	0	0
Fee Beach	4	0	0	0	0	0	3	0
Hidden Beach	4	0	0	0	0	0	3	0
Critical Zone	4	0	0	0	0	3	1	0
South Gunnison	0	0	0	0	0	0	0	0
North Gunnison	0	0	0	0	0	11	0	0
North Beach	0	0	0	0	3	8	1	0
USCG	4	0	0	0	0	0	0	0
TOTAL	**20**	**0**	**0**	**0**	**3**	**22**	**8**	**0**

* Note: Abandoned or Unknown nest loss could be associated with human disturbance and/or predation.

Most of the nests at Sandy Hook occur out on the open beach, seaward of the dunes, which later in the season become lightly to moderately vegetated. Nesting has historically occurred within six areas on Sandy Hook (Figure F-3). Table F-3 summarizes the nesting history of these sites, while Table F-4 describes the nest loss by site for 2006. Predation by fox is the leading cause of nest loss in recent years.

At Sandy Hook, plovers feed at intertidal zones, wrack lines, ephemeral pools and flats, and occasionally in primary and secondary dune areas and bayside flats (NPS, unpublished data). Sandy Hook has limited bayside foraging habitat, and plovers nesting and feeding in the Critical Zone have been observed flying back to this bayside habitat to forage. The bayside shoreline is eroding along much of the wide northern portion of the Park and only small, narrow areas of habitat occur along the narrow, southern portion of the Park. While found primarily on the beachfronts at Sandy Hook, piping plovers also utilize back dune areas as feeding and resting areas. These areas may also be used as escape cover from predators and disturbance.

NPS monitoring has documented that most of the plovers nest on the wide northern accreting beaches of the Hook. In recent years, due to the U.S. Army Corps of Engineers (USACE) large-scale NJ shoreline stabilization efforts, the southern beaches have experienced less of a sand deficit and have widened, except at the severely eroding Critical Zone. Plover distribution has responded to these changing beach conditions (Table F-5), as there has been a decline in nesting plovers at the Critical Zone and an increase at Monmouth and Sea Bright, where the replenished beaches have been supporting piping plovers since 1998. Abundance and productivity remain higher at North and Coast Guard beaches than the other Park beaches over the last 17 years. Figure F-4 depicts the rare tidal pool habitat found on these northern beaches of Sandy Hook.

Table F-5. Number of pairs of piping plover at Sandy Hook nesting sites 1990-2006. (Sources: NPS, unpublished data, and Jenkins and Pover, 2003)

	South Fee	Fee Beach	Hidden Beach	Critical Zone	South Gunnison	North Gunnison	North Beach	USCG	Total
1990	0	0	0	2	2	0	11	3	18
1991	0	0	0	3	4	0	9	4	20
1992	0	0	1	5	4	0	8	3	21
1993	0	0	0	5	4	1	9	6	25
1994	0	0	0	5	8	3	10	10	36
1995	0	0	0	6	11	4	12	10	43
1996	0	0	0	2	7	7	14	10	40
1997	0	0	6	0	4	8	13	11	42
1998	0	1	4	0	3	4	10	7	29
1999	0	2	3	0	0	3	11	8	27
2000	0	6	3	0	0	3	12	5	29
2001	0	7	3	1	0	3	11	6	31
2002	0	7	5	2	1	4	9	7	35
2003	1	6	4	4	1	5	9	8	38
2004	1	4	3	3	1	3	10	7	32
2005	1	4	3	3	0	2	6	3	22
2006	1	4	3	3	0	3	4	4	22
Ave.	**0.24**	**2.41**	**2.24**	**2.59**	**2.94**	**3.12**	**9.88**	**6.59**	**30**

Figure F-4. Tidal maintenance of ephemeral pools at high tide on North and Coast Guard Beaches. Photo by Terwilliger Consulting, Inc., July 19, 2001.

Non-breeding birds

Piping plover migration patterns are not well understood. Northward migration occurs from late February to May; southward migration extends from late July to October (Stucker and Cuthbert 2006, USFWS 1996a). Both spring and fall migration routes for Atlantic Coast population birds are believed to primarily occur within a narrow zone along the Atlantic Coast (USFWS 1996a, Stucker and Cuthbert 2006). In addition, Stucker and Cuthbert (2006) found migrating Great Lakes piping plovers as far north as New Jersey during their southward migrating to wintering grounds.

The piping plover is one of the first shorebirds to appear in spring, usually by mid-March. The earliest arrival date recorded at Sandy Hook is March 10 (NPS, unpublished data). The birds normally depart in early September; however, they have been observed as late as September 25 (NPS, unpublished data). The plover winters as far north as North Carolina (USFWS 2001, Stucker and Cuthbert 2006).

There have been a few documented sightings of non-breeding plovers in New Jersey in recent years. One migrating piping plover from the Great Lakes population was documented at Stone Harbor Point in 2003, and another was seen at North Brigantine Natural Area in the fall of 2002 and again in the fall of 2003 (Stucker and Cuthbert 2006). The NPS currently does not survey for non-breeding piping plovers at Sandy Hook, so their abundance and distribution at the Park is unknown.

Critical Habitat

On July 10, 2001, the USFWS 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 (USFWS 2001). No critical habitat has been designated or proposed in New Jersey.

Threats to Piping Plover

Piping plovers are threatened by human disturbance, habitat loss, predation, vegetation encroachment, and other threats (USFWS 1996a, Brown *et al*. 2001, Clark and Niles 2000, Watts 1999). Maintaining the integrity of barrier island beach habitat and minimizing productivity losses to human disturbance and predation are essential to recovering this threatened species (Watts 1999, USFWS 1996a). The Piping Plover Recovery Plan describes national and regional conservation measures, as does the *U.S. Shorebird Conservation Plan* and the *Mid-Atlantic Coastal Plain Bird Conservation Plan* (USFWS 1996a, Brown *et al*. 2001, Watts 1999). At Sandy Hook, these threats have shifted in dominance over time, but all must be addressed in concert to effectively improve the recent decline in piping plover productivity.

Human Disturbance

"Piping Plovers and other beach-nesting birds are sensitive to humans such that recreational use of beaches is incompatible with nesting" (Watts 1999, p. 27). Sandy Hook receives over 2.3 million visitors annually and provides employment for approximately 1,000 at several State and federal agencies, schools and private organizations located on the Park's grounds. Recreational use of the Park's beaches peaks on summer weekends, when 30,000 – 40,000 visitors typically visit throughout the day; weekday and off-season visitor use is dramatically less, with 10,000 people typically visiting throughout a summer weekday and 1,000 during the winter months (NPS 2001d, USFWS 2002a). Peak visitation is about 20,000 visitors at any one time on a summer weekend and 5,000 – 10,000 on a summer weekday.

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, Loegering 1992, Hoopes 1993, Goldin 1993), forcing them out of preferred habitats, decreasing available foraging time, and causing expenditure of energy.

Concentrations of beach-goers may deter piping plovers from using otherwise suitable habitat. On Jones Beach Island, New York, Ellias-Gerkin (1994) found less pedestrian disturbance in areas selected by nesting piping plovers than areas unoccupied by plovers. Burger (1991, 1994) found that the 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.

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, Hoopes *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. 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).

"[H]uman disturbance is a larger problem in northern areas [like New Jersey] where barrier beaches are closer to population centers and more accessible. Within these areas, closure of beaches during the breeding season and the use of wardens to educate the public have proven to be successful techniques to minimize human impacts" (Watts 1999, p. 27). NPS management for human disturbance has established eight protected areas that contain all of the nesting piping

plovers (as well as other rare beach flora and fauna). These areas were established over time and represent historic nesting sites. Prior to 1995 here were no beaches in the southern part of the Park that supported nesting piping plovers except for the beaches of the Critical Zone following beach fill projects. The protected areas comprise almost 50% of the Sandy Hook shoreline and about 90% of the wide, northern beaches. Piping plovers very rarely attempt to nest on any of the recreational use beaches, preferring the comparably undisturbed protected areas. The protected beaches of Sandy Hook (Fig. 1) currently have varying levels of human disturbance, with South Fee Beach, Fee Beach, Hidden Beach, the Critical Zone, Gunnison Beach, North Beach, and Coast Guard Beach closed to recreational use during the breeding season.

Disturbance from off-road vehicles (ORV) in the protected areas is limited to NPS monitoring and law enforcement personnel, plus USCG Homeland Security, as public ORV use is prohibited year round. In the public use beach areas, additional disturbance occurs from daily mechanical beach raking activities. Boats are prohibited from beaching on the oceanfront beaches. Dogs are prohibited on ocean beaches from March to September to protect nesting piping plovers and chicks (as endorsed by the Piping Plover Recovery Plan (USFWS 1996a)), but pet disturbance may still occur on bayside beaches and during the migratory seasons. Disturbances from kite-flying, ball-playing, Frisbee, surfing, and other recreational use activities are limited to the public use beaches and some of the bayside beaches, avoiding nesting beaches as recommended by USFWS (1996a). Bayside shorelines currently face disturbance threats from kite surfing, boat mooring and beaching, pets, fishing, and all the recreational activities allowed on the oceanfront public beaches.

Habitat loss

While loss and degradation of habitat have been major contributors to the range wide decline of the piping plover (USFWS 1996a, Brown *et al*. 2001, Clark and Niles 2000), this threat is especially prominent in the New York-New Jersey Recovery Unit. Within the New York Bight, which includes all of New Jersey and the southern Long Island shoreline, more than half the beaches are classified as “developed” (USFWS 1997, 1996a). The threat of habitat loss due to coastal development may have declined in recent years, however, as most of the remaining undeveloped areas have been protected by government agencies and non-profit organizations, including the NPS at Sandy Hook (Watts 1999).

While habitat loss can occur as a result of coastal development, vegetation encroachment, rising sea level, and erosion from downdrift shoreline stabilization structures such as the seawall at Sea Bright and the southern end of the Park, these losses are offset at Sandy Hook by accretion, or habitat gains, at the Hook (North and Coast Guard Beaches). Gunnison Beach, for example, has accreted upwards of 650 feet (200 m) since the 1980s. The Interim Beach Fill Project restored some beach habitat in 2002 by increasing the sediment supply to the Critical Zone in particular; by 2004, the beach in front of Lot D had widened by 120 to 200 feet (36 to 61 m) and the beach fronting Lot E had widened by approximately 170 feet (52 m) (Psuty and Pace 2005). As the U.S. Army Corps of Engineers (USACE) Sea Bright to Manasquan Borough beach nourishment project, which is located immediately south (downdrift) of the Park and initially constructed in 1994-96, is maintained with periodic renourishment episodes (e.g., 2002), this sediment will move along the longshore currents into the Park and offset long-term erosional losses in areas

like the Critical Zone. In fact, erosion has declined at the Critical Zone from an annual deficit of roughly 170,000 cubic meters to 20,000 cubic meters (a reduction of ~88 %) since the USACE and NPS beach erosion control projects were built in the last decade (N. Psuty, Rutgers, personal communication).

The stabilization of the eroding shoreline at the Critical Zone, through NPS and USACE beach fill projects as well as the construction and maintenance of a seawall, sheet metal bulkhead, road and artificial dunes, has led to the long-term loss of overwash habitat in this area of the Park. Overwash habitat is created periodically during storm events and is an ephemeral, bare sand habitat attractive to nesting shorebirds. Where overwash events occur elsewhere in the Park and do not threaten Park facilities, this ephemeral habitat is allowed to remain and evolve naturally as vegetation encroaches and dunes build up. Stabilization in the form of beach fills has created significant bird nesting habitat at the Critical Zone, Hidden Beach and Fee Beach.

On the bayside shoreline of the Park, foraging habitat and potential nesting habitat have been lost to shoreline stabilization (Fig. F-5). Sixty-five percent of the bayside shoreline within the Park currently is stabilized with riprap, bulkheads and similar hard structures.

Figure F-5. More than half of the bayside shoreline of Sandy Hook is stabilized with hard structures such as this riprap at Fort Hancock. Photo by Terwilliger Consulting, Inc., July 13, 2006.

Predation

Predator populations within the Mid-Atlantic Coastal Plain bird conservation region have reached "artificially high levels" with increasing human population in the region (Watts 1999, p. 27). Mammalian predators in particular have increased in both status and distribution (Watts 1999). USDA (2005) describes the threat of predators on beach nesting birds, the scientific literature on predator-prey relationships in coastal environments, and outline predator control measures to minimize or eliminate this threat.

In spite of the establishment and enforcement of protected nesting areas at Sandy Hook, major declines in piping plover productivity resulted from severe predation in 1995-1998 and more recently from 2003 through 2006. Red fox (*Vulpes vulpes*) are the dominant predator of piping plovers and their eggs at Sandy Hook, with gulls (*Larus* sp.) and crows (*Corvus* sp.) also responsible for a few losses. Feral cats have caused serious predation losses on beach nesting birds, but are not currently a problem at Sandy Hook. Predator populations naturally fluctuate, and combined with Park management actions, the proportion of nests lost to predators varies, from no egg losses attributed to predation in 2001 to 66% loss in 1998 and at least 48% in 2005.

The current population of fox at Sandy Hook is estimated at 30 to 40 individuals (NPS, unpublished data), and a female fox can have a litter of 4 to 10 pups a year (Whitaker and Hamilton 1998). In 2006, predation by smart fox at piping plover exclosures in Sea Bright are thought to be a result of fox migrating out of the Park (T. Pover, NJDEP, and L. Mack, Monmouth County Audubon Society, personal communications). The fox also could be coming onto the Sandy Hook peninsula to both the Park and to Sea Bright from the mainland, possibly as a result of development. The NPS has trapped and relocated fox on a limited basis in 1998, 1999, 2005 and 2006, but although 37 fox have been trapped and relocated in 22 years, piping plover productivity has not significantly improved over that time period and the fox appear to be expanding beyond the Park's boundaries.

Predator exclosures have been successful to increase hatching success of birds such as piping plovers (Watts 1999, USFWS 1996a), but over time predators such as fox and crow may learn to target exclosures, reducing their effectiveness. Nest exclosures have been placed around all nests at Sandy Hook that existing staff can set up and monitor according to proper protocol and guidelines (USFWS 1996c). As a result of an increase in smart predators, the NPS initiated the use of electrified nest exclosures on a trial basis in 2004 and on every nest in 2005 and 2006 (Fig. F-6). The low current of 0.25 joules delivers a mild shock (powered by 6 volt battery) is battery-powered and acts as a further deterrent to smart predators targeting nest exclosures; the risk to people is minimal as all exclosures are located within the nesting beaches, which are closed to recreational users.

NJDEP suggests that improved pair-nest success in New Jersey in recent years has resulted primarily from reducing nest losses to predation through increased use of predator exclosures and predator control efforts, but notes that "[p]redation remains a formidable problem that must be addressed if productivity is to improve" (Pover *et al*. 2006, p. 2). The New Jersey Division of Fish and Wildlife "believes that continued use of predator exclosures and electric fence, are still the most prudent measures, but an increased focus on localized predator removal and reduction is

Figure F-6. The NPS initiated the use of electrified exclosures on piping plover nests in 2004 to deter predators. The electrified fence is powered by a 6 volt battery (seen on the left). An incubating piping plover is visible in the lower center portion of the photo, within the wire exclosure. Photo by Terwilliger Consulting, Inc., June 27, 2006.

also necessary" (Jenkins and Pover 2004b). Watts (1999) also recommend the localized removal of predators as a means to increase productivity and USFWS (2002a) has specifically recommended its use at Sandy Hook.

Vegetative encroachment

Since piping plovers, and other shorebirds and colonial waterbirds, nest on bare ground habitats, the encroachment of vegetation over time threatens the availability of suitable nesting habitat. Vegetation encroachment may also threaten the availability of foraging habitat on bayside shorelines, by covering tidal flats and intertidal areas with wetland vegetation like *Phragmites* sp. and *Spartina* sp. While thin vegetation may provide shelter for piping plovers and other birds during harsh weather conditions, thick vegetation may also provide cover for predators.

Vegetation can also encroach on piping plover habitat through the manual planting of plants on artificially constructed dunes or beaches. At Sandy Hook, the manual landscaping of the beach habitat has only rarely occurred, most recently during the re-contouring of dunes along the Multiuse Pathway along the Critical Zone in 2003. Plantings are limited to areas where necessary to protect buildings, roads or infrastructure, or to replace invasive non-native plants. Invasive species can also threaten the natural equilibrium of the coastal ecosystem. The invasive Asian sand sedge is found throughout the Park but is most prevalent on North Beach and Gunnison Beach.

Other Threats

Weather and flooding events have also contributed to nest failure. Flooding was the most notable cause of the abandonment rate in 2003. In 2006, 7 % of the nests lost at Sandy Hook were due to flooding (Table F-4). Flooding has been the dominant cause of nest loss from 2001 to 2003 and again in 2005 at ENSP monitored sites throughout the state (Pover *et al*. 2006).

Oil spills also threatened piping plovers, at any stage in their life cycle (USFWS 1996a, Brown *et al*. 2001, Clark and Niles 1999). Piping plovers have been oiled at Sandy Hook in the past, most recently in the BT Nautilus spill in 1990, when five piping plover were oiled. In October 2005, the USS Detroit spill at Naval Weapons Station Earle pier was quickly contained and did not result in any impacts to threatened or endangered species at the Park. The NPS maintains an oil spill response plan to respond to the threat of oil spills on Park resources, including threatened species such as the piping plover.

Red knot

Species Description

The red knot (*Calidris canutus rufa*) is a medium-sized shorebird that can be found along the New Jersey shore during migration seasons (May, August), when it is traveling between its Arctic breeding grounds and South American wintering grounds. Red knots generally fly in groups, sometimes with other shorebird species. Characterized by a distinctive rusty red breast that extends up the neck and around the eyes, red knots have whitish rumps and a patterned brown, black, gray and white coloration on the back and wings. The bill is short, straight and black. Some adults arrive in New Jersey showing varying amounts of non-breeding plumage as they molt into or out of breeding plumage; non-breeding plumage is characterized by a washed out gray look with greenish legs, scaly white feather edgings, and whitish flanks with dark barring. Juveniles are typically gray with a scaly pattern on the wings and dull, yellow-olive legs (NJDEP 2002b).

The average lifespan of the red knot is estimated as 7 years (British Trust for Ornithology 2005), although banded adults along Delaware Bay have been seen with estimated ages of 10 to 13 years (Harrington 1996, 2001). Red knots stop at Delaware Bay to gain weight on their northward, spring migration by feeding primarily on horseshoe crab (*Limulus polyphemus*) eggs (Tsipoura and Burger 1999, Baker *et al*. 2004). The birds also forage on other small

invertebrates, including mollusks, crustaceans, marine worms, small snails, amphipods, and polychaete worms (Zwarts and Blomert 1992, Dekinga and Piersma 1993, Gonzalez *et al*. 1996, Harrington *et al*. 1986, Prater 1972, Piersma *et al*. 1993).

Habitat Description

Red knot breeding habitat is the tundra and wetlands of the Canadian Arctic (Cramp and Simmons 1983, Harrington 1996, 2001). Wintering habitat consists of intertidal areas, typically along open coastlines and large bays, in Argentina, Chile and Brazil (Harrington 1996, 2001). The Atlantic coast of the United States provides migratory habitat for the red knots as they travel the immense distance between their breeding and wintering grounds. The coastal habitats at the mouths of bays and estuaries are the preferred migratory habitat, as they provide sandy beaches for foraging (Harrington 1996, 2001). Although these habitats are generally high wave energy (Harrington *et al*. 1986, Vooren *et al*. 1990, Blanco *et al*. 1992), red knots also use tidal flats in more low energy, sheltered bays or lagoons (Harrington *et al*. 1986; Harrington 1996, 2001; Tsipoura and Burger 1999). Sandy beaches and spits in New Jersey provide roosting habitat for migratory red knot (NJDEP 2002b). Studies at Delaware Bay indicate that migratory red knots stop in New Jersey – Delaware for 1 to 35 days, averaging 17 ± 8 days (USFWS 2003b). An estimated 80% or more of the New World population of red knot migrates through the North Atlantic region annually (Clark and Niles 2000).

Status and Distribution at Sandy Hook

Approximately 30 to 50 migratory red knots use Spermaceti Cove and Plum Island during spring migration (S. Barnes, NJ Audubon, personal communication). The NPS currently does not monitor for red knot at Sandy Hook, so their precise abundance and distribution are unknown.

Threats to Red knot

Red knots are threatened by a decline in the availability of horseshoe crab eggs, particularly in Delaware Bay (NJDEP 2002b; USFWS 2003b, 2006c). Horseshoe crabs are harvested for bait for the conch and eel fisheries and medical use. Red knot may also be threatened by human disturbance; disease; shoreline changes in Delaware Bay; sea level rise causing shifts and declines in preferred habitats; predation and climate change induced changes in habitat on their breeding grounds; and pollution, human disturbance and development on their wintering grounds (USFWS 2003b, 2006c; Clark and Niles 2000).

Northeastern Beach Tiger Beetle

Species Description

The Northeastern beach tiger beetle has white to light tan wing covers on it's back that are often marked with fine dark lines. The head and thorax (chest area) are bronze-green. Overall length varies from 1/2 to 3/5 inch. Larvae and adults are predatory (New York Department of Environmental Conservation (NYDEC) 2003). The Northeastern beach tiger beetle and its life

history have been described by USFWS (1994a, b) and more recently, including their status in New Jersey, in USFWS (2005a).

Northeastern beach tiger beetles have a full, two-year life cycle. Adults emerge in late June, reach peak abundance by mid-July, and decline through early September. Foraging occurs in the damp sand of the intertidal zone; prey species include lice, fleas, flies, dead crabs and fish (USFWS 1990, NYDEC 2003). Mating and egg-laying occur from late-June through August. Females deposit their eggs in the sand after mating, higher up the beach in the dunes. Eggs hatch and larvae appear in late July and August. Larvae experience three developmental stages or "instars." Most larvae reach the second instar by September and a few reach the third instar well into November, when larvae are still active (USFWS 1990, NYDEC 2003).

Larvae live in vertical burrows located in the upper intertidal to high drift zone, where prey is most abundant. Larvae forage from their burrows, preying on passing insects. Their primary food sources are beach fleas, lice, flies and ants. Larvae are regularly covered during high tide; sand moisture is important. Larvae lack a hard shell and are subject to desiccation. During the summer months they are inactive, going through a period of aestivation. With each successive stage of development, larvae grow in size and burrow deeper in the sand (USFWS 1990, NYDEC 2003).

Populations of tiger beetles normally experience very high larval mortality and dramatic year-to year, two to three fold fluctuations in abundance, sometimes resulting in local extinction (USFWS 1994a, 2005a). Weather factors such as flood tides, hurricanes, erosion and winter storms, mortality due to predators and parasites, and recreational beach use all contribute to the population declines.

Habitat Description

Early records indicate that the Northeastern beach tiger beetle occurred in "great swarms in July" along coastal beaches from Martha's Vineyard south to New Jersey and on both sides of Chesapeake Bay in Virginia and Maryland. Ideal habitat for the adult beetles and their larvae are wide, undisturbed, dynamic, fine sand beaches. The most important consideration, though, is limited use and disturbance by vehicles and humans (USFWS 1990, NYDEC 2003).

Ideal habitat for adult tiger beetles is a beach wider than 16 to 26 ft (5 to 8 m), although larvae may not survive at sites that are otherwise suitable for adults. Narrow beach widths are frequently the cause of lack of larvae (USFWS 2005a). Beach slope does not appear to influence the density of larvae, but sand particle size does with larvae rare at locations with greater than 60 percent coarse sand (defined as the percentage of sand grains larger than a 100-size mesh sieve) (Knisley 1997a). Longer stretches of beach (greater than 1,312 ft or 400 m) have a higher probability of supporting the species because these beaches are better able to provide patches of favorable habitat over time (Hill and Knisley 1994).

Studies have found that adult tiger beetles may travel 5 to 12 miles (Knisley and Hill 1989), with some individuals dispersing up to 15 miles (Knisley 1997b). Hill and Knisley (1994) concluded that large tiger beetle sites appear to function as recruitment areas and small sites as migratory stopovers that provide feeding or resting areas; the migration between large sites may require the smaller migratory stopover sites (Hill and Knisley 1994). Tiger beetle migration allows the

dispersal of genetic material, the colonization of new locations, and movement away from eroding sites to more favorable habitat (Hill and Knisley 1994).

Status and Distribution at Sandy Hook

NPS monitors this species at Sandy Hook in coordination with USFWS through annual surveys. Adult populations were estimated to be around 500 individuals according to annual surveys in the early years after reintroduction of the species (Knisley and Hill 2000), but the observed population has declined in more recent years. Table F-6 shows the results of NPS surveys for the larvae and adult beach tiger beetles conducted annually from 1994-2006. The population occurs within the North and Coast Guard Beach protected areas. These beaches are accreting and receive low human use. No tiger beetle adults or larvae have been reported from other areas of Sandy Hook except the reintroduction area on North Beach and occasional individuals at the Gunnison Beach reintroduction site.

Recent trends in survey results are puzzling and highly variable. Marked low numbers were reported both in 2001 and since 2003. Reasons for these variable survey results are not known, however, survey effort and timing might be a factor to consider. Large numbers of loafing/roosting gulls have also been recorded during a tiger beetle survey when low beetle numbers were recorded (USFWS 2003a).

Table F-6. Abundance and distribution of Northeastern beach tiger beetles at Sandy Hook since its reintroduction in 1994. (Sources: NPS, unpublished data)

Year	Location	Larvae Released	Adults Observed
1994	North Beach	400	N/A
1994	Gunnison	298	N/A
1995	North Beach	171	48
1995	Gunnison	124	7
1996	North Beach	0	18
1996	Gunnison	0	1
1997	North Beach	484	178
1998	North Beach	0	48
1999	North Beach	585	260
2000	North Beach	554	720
2001	North Beach	0	749
2002	North Beach	0	142
2003	North Beach	0	50
2004	North Beach	0	6
2005	North Beach	0	2
2006	North Beach	480	28

Critical Habitat

No critical habitat has been designated by the USFWS for Northeastern beach tiger beetle as of this time.

Threats to Northeastern Beach Tiger Beetle

Northeastern beach tiger beetles are naturally limited by beach erosion, winter storms, hurricanes, flood tides and natural enemies (Stamatov 1972, USFWS 2005a). The species is also threatened by human disturbance, habitat loss and fragmentation, habitat degradation, predation, and other threats (USFWS 1994a, 2005a).

Human disturbance

The extirpation of the tiger beetle from most of its range has been attributed primarily to destruction and disturbance of natural beach habitat, off-road vehicular traffic, and high levels of recreational use, shoreline development and beach stabilization (Knisley *et al.*, 1987; Knisley and Hill 1989, 1990; Hill and Knisley 1994a; USFWS 1994a; NYDEC 2003). Human disturbance can disrupt adult foraging, mating and ovipositioing (Knisley *et al.,* 1987). Larvae are thought to be more affected by human activities, however, because they spend the majority of their time at the tops of their burrows waiting for prey; as a result, the slightest vibrations, movement or shadows can disturb the larvae (Knisley *et al*., 1987)

Knisley and Hill (1990) found that as human use continued to increase at a public beach in Maryland, the number of newly emerged adults appeared to diminish. Larval survival was significantly lower on the beach area with the greatest amount of human use. The study found a 50 to 100 percent reduction in numbers of active larvae in areas that were firmly stomped to simulate increased foot traffic (Knisley and Hill 1989). Negative effects of foot traffic appear to involve compaction, disruption of burrows, or direct injury to larvae. Because larvae occur in the intertidal zone, burrows can easily be compacted or dislodged either by vehicles or by high levels of human activity (Knisley *et al.* 1987, USFWS 2005a).

Habitat loss and fragmentation

Although there are many populations of Northeastern beach tiger beetles in the Chesapeake Bay area, most are threatened by activity associated with increases in human population. Developmental pressure with concurrent beach alteration, beach stabilization structures, and recreational activities, has greatly altered and eliminated the beetle's habitat along the Atlantic Coast. The decrease in habitat availability and a reduced number of populations make it difficult for beetles to recover from population declines. Long-term survival of this species is probably dependent upon its ability to disperse for considerable distances to colonize transient or well separated habitats, something which becomes more difficult as more habitat is lost and fragmented. While mark recapture study results have shown the beetles capable of traveling 5-12 miles from their original capture site, it might not be enough to reach the nearest suitable habitat (USFWS 1990, NYDEC 2003).

Habitat may also be lost to beach erosion, which can result from natural processes or anthropogenic beach modifications. Beach stabilization structures such as jetties, groins, riprap revetments, bulkheads and seawalls are all intended to reduce erosion but usually increase erosion on adjacent beaches. Beach profiles can be steepened by the wave reflection off of hard structures like seawalls and revetments, possibly making the intertidal zone unsuitable as tiger beetle habitat (Knisley and Hill 1994). Hard stabilization structures also block access and natural sediment movement between the back, dry portions of the beach and dune system, and the intertidal and underwater portions of the beach; this generates habitat loss by narrowing the beach, and fragments the lower and upper portions of the beach from one another. While narrow beaches may support small populations of adult beetles, larval beetles appear to be limited to beaches with at least 8 m within and above the intertidal zone (Knisley *et al.* 1987, USFWS 1994a). The long-term (50 years or more) impacts of anthropogenic shoreline modifications may eventually lead to the collapse of the natural beach habitat on which Northeastern beach tiger beetles depend (Hill and Knisley 1995),

Habitat degradation

Northeastern beach tiger beetle habitat can be degraded by vegetation encroachment, invasive species, ORV use, heavy human foot traffic, pesticides and oil spills (Stamatov 1972; USFWS 1994a, 2005a). Stamatov (1972) found that the use of pesticides to control mosquitoes and oil spills may have contributed to the decline of the species. The threats of encroaching vegetation, invasive plant species, and oil spills that were described previously for piping plovers also apply to Northeastern beach tiger beetles, as the two species share the same shoreside habitats.

Predation

The natural balance between the beetles and their primary predators has been altered by habitat degradation and other factors. In some cases, these natural enemies may now pose a significant threat to the beetles. Wolf spiders (*Arctosa littoralis*), asilid flies (*Dasypogon diadema*), and birds are the primary natural enemies of adult tiger beetles (USFWS 1994a). The primary natural larval enemy is a small, parasitic wasp (*Methocha* sp.) that enters the larval burrow, paralyzes the larvae with a sting, and lays an egg on the larvae. The egg hatches, and as it develops, the larval wasp consumes the larval tiger beetle. Mites have also been found on larvae at Martha's Vineyard, but their effect, if any, is unknown (USFWS 1994a, 2005a). At Sandy Hook, high numbers of gulls have been observed at known tiger beetle areas during periods of low surveyed populations, and could be a predator of the species. Natural predation, when combined with habitat disturbance and loss, could reduce the species' population to the point of extinction (Knisley *et al*. 1987, Knisley 1987, USFWS 2005a).

Seabeach Amaranth

Species Description

Seabeach amaranth is an annual plant 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 0.5 to 1 inch 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 12 inches in diameter, but occasionally reach 35 inches in diameter, with 100 or more branches. Flowers and fruits are inconspicuous. Seabeach amaranth and its life history have been described by Weakley and Bucher (1992), USFWS (1996b) and more recently in USFWS (2002a, b; 2005a, b; 2006b), which include its status since its reappearance in New Jersey.

Individual plants live only one season with only a single opportunity to produce seed. The species overwinters 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. 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 (USFWS 1996b, 2002a and 2003a). While seabeach amaranth seems capable of essentially indeterminate growth (Weakley and Bucher 1992), 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 (USFWS 1993).

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. Island-end sand flats generally have higher densities than oceanfront beaches (Weakley and Bucher 1992). Seabeach amaranth has been found to have a strongly clumped distribution (Hancock 1995). On Long Island, New York, however, dense assemblages and high abundances have been recorded on central barrier island locations (Young 2002).

Habitat Description

Seabeach amaranth is "an annual species with a fugitive lifestyle," shifting its distribution between patches of suitable habitat in any given year (USFWS 1996b). The USFWS Recovery Plan for the species describes the essential components to its habitat as consisting of a sandy substrate, a coastal environment with a nutrient supply from salt spray, minimal competition from other beach plants, and unstabilized dunes, upper beach and overwash flats (USFWS 1996b).

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 is intolerant of even occasional flooding during the growing season. 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 does not occur on well-vegetated sites, particularly where perennials have become strongly established (Weakley and Bucher 1992). Seabeach amaranth seems to be incapable of competing with other plants and is typically found in areas with little or no vegetation. 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.

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.

Within its primary habitats, seabeach amaranth concentrations can be found in the wrackline (Mangels 1991, Weakley and Bucher 1992, Hancock 1995, McAvoy 2002). In 2001, a study by Pauley *et al.* (1999) suggested that organic litter may be an advantageous microhabitat for seabeach amaranth when it contains higher levels of organic material and moisture than bare sand.

Status and Distribution at Sandy Hook

Seabeach amaranth is a rare plant at Sandy Hook. The plant had been absent in the Park for nearly 100 years and recently reappeared in 2000, primarily in areas receiving beach fill (Table F-7). Seabeach amaranth may have been decimated over much of its former range by the increasing impacts of beach development and usage in recent decades (USFWS 1993). At Gateway NRA, fencing that protected piping plovers and other shorebird nesting areas has favored seabeach amaranth by reducing access by off road vehicles and pedestrians (Stalter *et al.* 1995). Numbers have increased presumably due to the accreting beach and neighboring sand and seed source immediately to the south. In 2003, 325 plants were planted at the Critical Zone by the USFWS. The population of seabeach amaranth has been increasing in the Park since then, with a record high of 6,338 plants documented in 2006 (Table F-7, Fig. F-7). The Critical Zone supports the highest average density of seabeach amaranth in the Park, with Hidden Beach, Fee Beach and South Fee Beach also hosting significant populations in recent years (Fig. F-8).

Figure F-7. Seabeach amaranth abundance at Sandy Hook since its discovery in 2000.

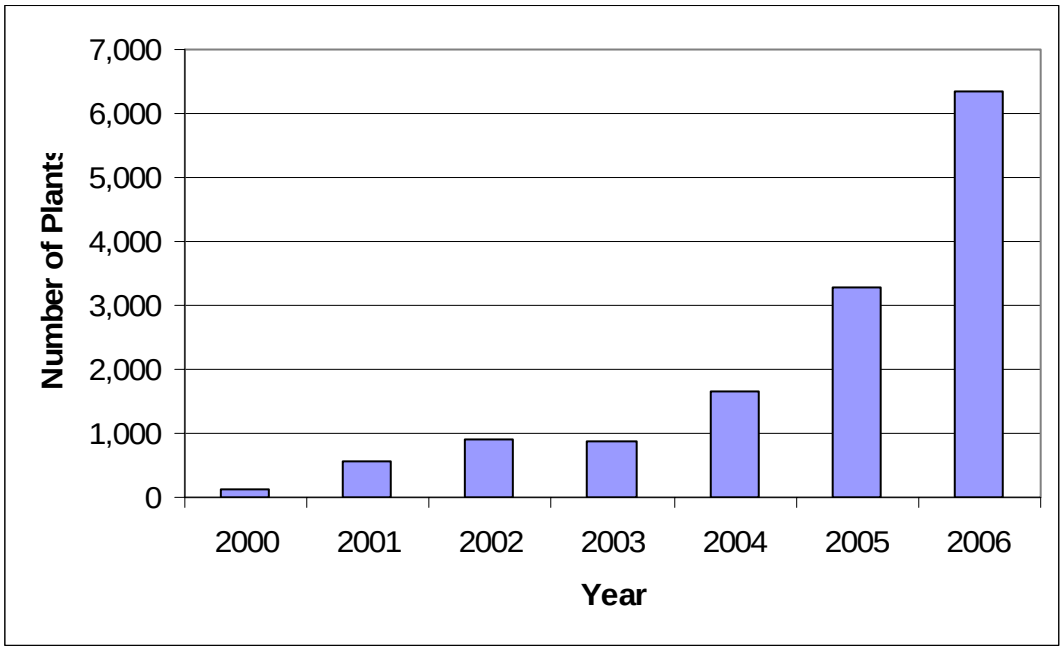
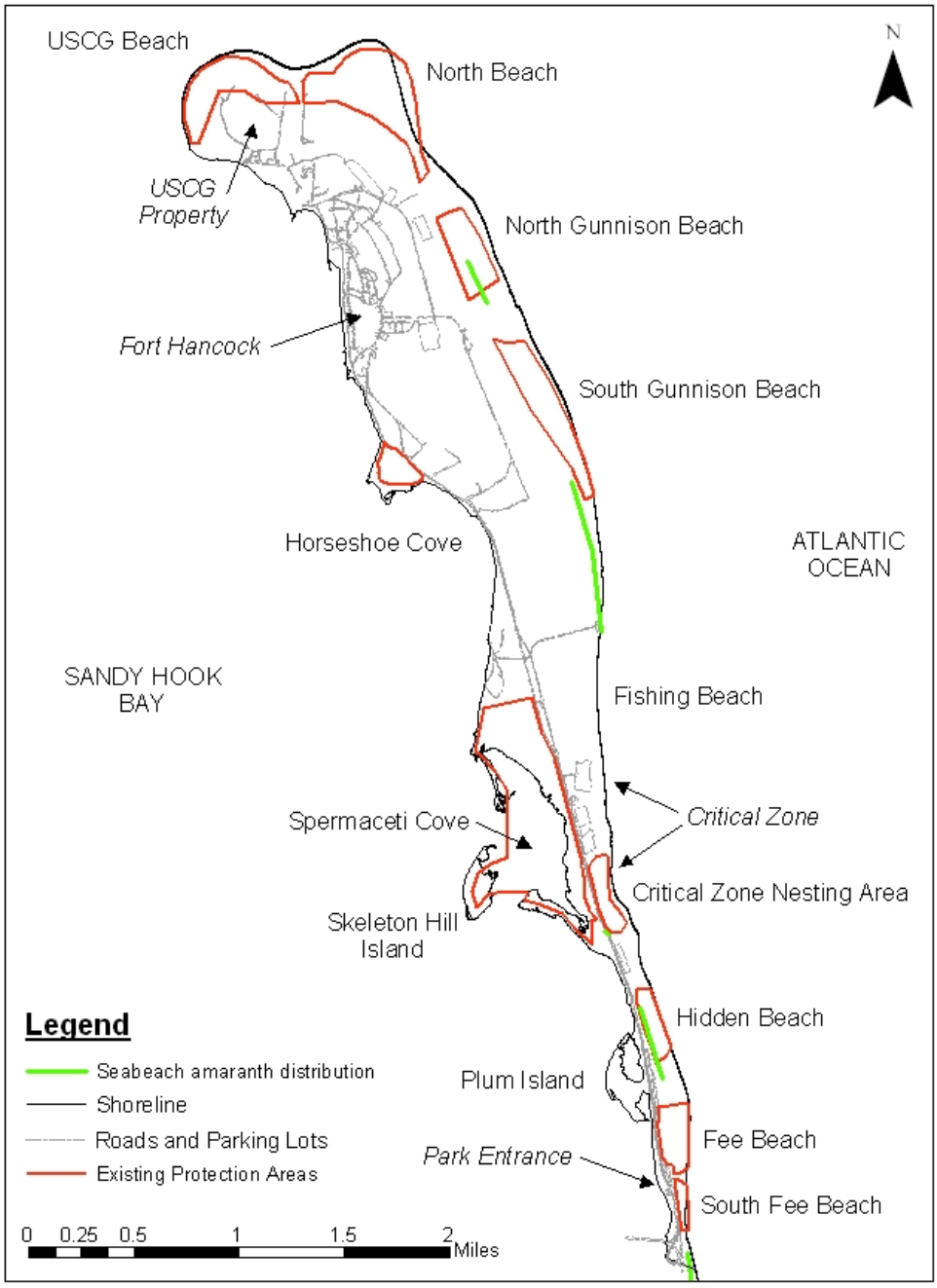


Table F-7. Seabeach amaranth abundance and distribution at Sandy Hook since its discovery in 2000.

Site	Number of Plants							Average since Discovery
	2000	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	
USCG	0	1	5	1	0	2	0	1
North Beach	0	0	2	0	2	0	0	1
North Gunnison	6	0	11	2	0	0	6	4
South Gunnison	1	5	15	2	2	13	2	6
North of F Lot	8	25	12	0	8	13	6	10
Lot E	0	0	0	0	1	7	15	3
Lot D	0	0	0	0	181	72	0	36
Critical Zone	7	53	98	370*	872	2,430	1,645	782
Hidden Beach	57	285	536	139	104	234	141	214
Fee Beach	41	192	225	128	77	452	2,420	505
South Fee Beach	0	0	0	225	420	57	2,103	401
Sandy Hook Total	**120**	**561**	**904**	**642***	**1,667**	**3,280**	**6,338**	**1,962**

* The USFWS planted 325 seabeach amaranth at the Critical Zone in 2003

Figure F-8. Distribution of seabeach amaranth plants at Sandy Hook.



Critical Habitat

No critical habitat has been designated by the USFWS for seabeach amaranth as of this time.

Threats to Seabeach Amaranth

Historically, seabeach amaranth occurred in nine states from Massachusetts to South Carolina. The populations which have been extirpated are believed to have succumbed as a result of hard shoreline stabilization structures, erosion, tidal inundation, and possibly as a result of herbivory by webworms (USFWS 1996b). The continued existence of the plant is threatened by these activities (Ellias-Gerken 1994; Van Schoik and Antenen 1993) as well as the adverse alteration of essential habitat primarily as a result of "soft" shoreline stabilization (beach nourishment, artificial dune creation, and beach grass plantings), but also from beach grooming and other causes (USFWS 1993).

Habitat loss and fragmentation

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 as habitat is lost and fragmented. 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 (USFWS 2002a).

The primary source of habitat loss for 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.

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 (USFWS 1993, 2002a). 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 (USFWS 1996b, 2002a). While seabeach amaranth is threatened by severe erosion caused by coastal storms, as it was in 1989 and 1990 in the Carolinas, it was the subsequent bulldozing and dune reconstruction that generated significant habitat loss and fragmentation (Weakley and Bucher 1992, USFWS 2002a).

Attempts to halt beach erosion through hard structures (*i.e.*, sea walls, jetties, groins, bulkheads) appear invariably to destroy habitat 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 (USFWS 1996b, 2002a).

Seabeach amaranth is vulnerable to habitat fragmentation and isolation of small populations (USFWS 1993, 2002a). 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, USFWS 2002a).

New York and New Jersey beaches have been especially affected by past and ongoing habitat loss and fragmentation. New Jersey has the highest degree of shoreline stabilization of any state. New Jersey, America's oldest developed shoreline, was documented to be 43 percent hard-stabilized in the mid-1980s, nearly 20 years ago (Pilkey and Wright 1988). Much of New York and New Jersey oceanfront is included in current or proposed long-term beach nourishment programs. Cumulatively, these nourishment projects contribute significantly to the stabilization of the NY-NJ shoreline and the loss of seabeach amaranth's preferred unstable, unvegetated habitat.

Habitat degradation

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 (USFWS 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.

In addition, beach nourishment and dredged material disposal 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 (USFWS 1996a). 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.

Beach grooming and the maintenance of constructed dunes with sand fencing and planted vegetation such as American beach grass (*Ammophila breviligulata*), can degrade the unstable, unvegetated habitat of seabeach amaranth. The landscaping of artificially constructed dunes prevents the colonization of new, bare sand habitat with pioneer species such as seabeach amaranth. Beach grooming, more common on northern beaches, may 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 (USFWS 1996a). In New Jersey, plants were found along a nearly continuous length of beach, noticeably interrupted by stretches that are routinely raked (USFWS 2002a).

Predation

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 (USFWS 1993, 2002a). Herbivory damage to seabeach amaranth has ranged from 3.2% to 12.2% from 2003 to 2005 in the Sea Bright to Monmouth Beach region, including predation by the beet armyworm (*Spodoptera exigua*), a newly documented herbivore species (USFWS 2006b). Overall, webworm herbivory is probably a contributing, rather than a leading factor, in the decline of seabeach amaranth. In combination with extensive habitat alteration, severe herbivory could threaten the existence of the species (Weakley and Bucher 1992, USFWS 2002a).

Several additional herbivores of seabeach amaranth have been observed including deer (*Odocoileus virginianus*), rabbits (*Sylvilagus floridanus*), migratory song birds, and feral horses (Van Schoik and Antenen 1993, USFWS 2002a). Minor insect damage was noted on a few New Jersey plants in 2000, and larval insects were observed feeding on seabeach amaranth in 2001. 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 (USFWS 2002a). As with webworms, the abundance of these newly documented predators on barrier islands is increased by human activities.

At Sandy Hook, predation has not been observed to be a significant threat to seabeach amaranth, although deer tracks were observed in piping plover and seabeach amaranth protected areas in 2005 and 2006 (J. McArthur-Heuser, NPS, personal communication). Webworm predation was observed on plants in the Critical Zone in 2006.

Vegetative encroachment

Seabeach amaranth is threatened by the encroachment of perennial and woody vegetation, as well as invasive species. As shorelines are stabilized with beach nourishment projects, sand fencing and dune construction, vegetation on the dunes and back beach is often planted to stabilize the newly constructed beach and dune system. The plant species used in this landscaping may or may not be native species, and they prevent the bare sand habitat from evolving naturally through vegetative succession, enhancing competition and incompatible vegetative encroachment into seabeach amaranth habitat. USFWS (2006b) found that the encroachment of dense stands of seaside goldenrod (*Solidago sempervirens*) and purple sand grass (*Triplasis purpurea*) has displaced seabeach amaranth at Shark River Inlet in Belmar, in southern Monmouth County.

The exotic, invasive Asian sand sedge (*Carex kobomugi*) may be a potential threat to seabeach amaranth (USFWS 2002a). This sedge is strongly rhizomatous and forms dunes (National Park

Service and Maryland Natural Heritage Program 2000). The plant was introduced from east Asia to the east coast (New Jersey to Virginia) during the 1930s for erosion control and to stabilize sand. Asian sand sedge is known to crowd out native dune species (Virginia Department of Conservation and Recreation and Virginia Native Plant Society, undated), and it may be detrimental to seabeach amaranth by direct competition, and by reducing habitat suitability through sand stabilization and dune building (USFWS 2002a). At Sandy Hook, the abundance and distribution of Asian sand sedge is under study by Dr. Louise Wooten of Georgia Court College.

Other Threats

Seabeach amaranth is also threatened by disease and human disturbance. In 2000, the first known disease of seabeach amaranth was documented in South Carolina (USFWS 2002a). Intensive recreational use of beaches can threaten seabeach amaranth populations, both through direct damage and mortality of plants, and by impacting habitat (USFWS 2002a). Light pedestrian traffic, even during the growing season, usually has little effect on seabeach amaranth (USFWS 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 (USFWS 1996b).

Off-road vehicle use on the beach during the growing season can have detrimental effects on the species, as the fleshy stems of this plant are brittle and easily broken (USFWS 2002a). 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).

Other Federally Threatened & Endangered Species

The roseate tern (*Sterna dougallii*), a migratory colonial waterbird, is listed as an endangered species by both the USFWS and the state of New Jersey. USFWS (1998) describes the species, its habitat and life history. Roseate terns breeds on islands along the northeastern coast of the United States from New York to Maine (and northward into coastal Canada) and overwinter in South America, passing through New Jersey as they migrate from one to the other. This species historically nested in New Jersey and as far south as Virginia, but the majority of nesting roseate terns are currently limited to New York and Massachusetts (USFWS 1998). At Sandy Hook, between one and ten migrating individuals are observed in the latter part of May every year (S. Barnes, NJ Audubon, personal communication). Roseate terns are threatened by habitat loss, competition with common terns (*Sterna hirundo*) for prey, predation, an imbalanced sex ratio, oil

spills, and potentially by wind farm development in the northeastern U.S. (MANEM 2004, USFWS 1998). Since roseate terns are only found in the Park in low numbers during migration, their conservation is codependent with that of the common tern (MANEM 2004), and conservation measures to protect the beach bird community are likely to provide benefits to roseate terns as well, no specific management actions are proposed for this species.

The bald eagle (*Haliaeetus leucocephalus*) is considered threatened at the federal level, and its breeding population is classified as endangered in NJ and its non-breeding population classified as threatened. Large raptors with a wingspan of 7 to 8 feet, bald eagles are noted for their white heads and tails and dark brown to black bodies (NJDEP 2002a). Bald eagle habitat consists of forests near bodies of water, where they nest in trees taller than its surrounding forest canopy. The species breeds and overwinters in New Jersey. By 2005, bald eagles had recovered to 53 pairs statewide (from only one nest in 1982; Smith et al. 2005). Bald eagles do not currently nest at Sandy Hook but have been observed during migration surveys. Since bald eagle foraging and perching habitats exist within the Park boundaries, conservation measures to protect osprey should benefit any future expansion of the population into the Park.

Numerous whales, sea turtles and the shortnose sturgeon (*Acipenser brevirostrum*) that are listed as federally threatened or endangered are occasional visitors to the ocean and estuarine waters surrounding Sandy Hook (Table 1). The NPS Sandy Hook boundaries extend one quarter of a mile seaward from the shoreline, and as a result these aquatic species may be found within the Park. Typically the whales and sea turtles are only found stranded on the beaches within the Park, and all strandings are reported to the Marine Mammal Stranding Center in Brigantine. Because these aquatic species are only occasional visitors to the Park, no specific conservation measures are proposed for them other than to continue reporting strandings to the Marine Mammal Stranding Center. The NPS will continue to coordinate management activities relating to marine species in accordance with the Endangered Species Act, Marine Mammal Protection Act, the Magnuson-Stevens Fishery Conservation and Management Act, and all appropriate management and recovery plans (NMFS 1991a, 1991b, 1998a, 1998b, 1998c, 2003; NMFS and USFWS 1991a, 1991b, 1992, 1993; NOAA 1999).

New Jersey Threatened and Endangered Species

Least tern

Species Description

The least tern (*Sterna antillarum*) is a colonial waterbird with a black cap, white belly and gray upper body, forked tail and wings. At about 9 inches in length, the least tern is the smallest of the terns. The bird has a distinctive yellow bill with a black tip that turns dusky to black in the fall. The legs are yellow during the breeding season but also turn dusky to black in the fall. The black cap on its head retreats in the fall to cover only the back of the head and the eye lines (NJDEP 2002a).

Least terns are monogamous, nest in colonies (sometimes of mixed species), and typically lay one to three eggs in a nest. Males court females by carrying fish around in their bills. Birds feed on fish, aquatic invertebrates and insects (Ehrlich *et al*. 1988). The Mid-Atlantic/New England Maritime Regional Working Group for Waterbirds has defined population sustainability as producing 0.59 fledged chicks per breeding adult (MANEM 2004).

Habitat Description

Least terns utilize seacoasts, beaches, bays, estuaries, lagoons, lakes and rivers. Breeding habitat is sandy or gravelly beaches and the banks of lakes or rivers (MANEM 2004, Watts 1999). On barrier islands, least tern nesting habitat is virtually indistinguishable from that of the piping plover (Watts 1999). In New Jersey, least terns nest on bare sandy areas or areas sparsely vegetated with sea rocket (*Cakile endentula*), American beach grass (*Ammophila breviligulata*), beach clotbur (*Xanthium echniatum*), and seaside spurge (*Euphorbia polygonifolia*), just beyond the reach of normal spring tides (NJDEP 2002a). Nesting colonies have also occurred on sandy dredged material disposal sites (particularly shortly after deposition before vegetation encroaches), near sand and gravel pits with sand piles from mining operations, and although not in NJ, on gravel rooftops (NJDEP 2002a). Colonies may contain anywhere from a few nesting pair to several hundred pair.

Birds may forage from 1.9 to 7.5 miles from a nesting colony, foraging on a variety of shallow water habitats including (in coastal areas) bays, lagoons, river and creek mouths, estuaries, tidal marshes and lakes, and occasionally offshore (MANEM 2004).

Status and Distribution at Sandy Hook

Least terns arrive at Sandy Hook in early to mid-May and nest from mid-May through July. Chicks fledge from July to August before migrating south in September. Least terns have attempted to nest at every beach except South Gunnison at Sandy Hook in recent years. No chicks have successfully fledged from these colonies for the last three years (Table F-8). Productivity has consistently been well below the sustainability goal of 0.59 chicks per pair, with every nest lost to fox predation in 2005.

Threats to Least tern

Least terns have historically been threatened by egg collecting and hunting for their feathers. More recently, coastal development, increased recreational use of beaches, predation, and increased losses to coastal flooding have threatened least tern populations (NJDEP 2002a). Mechanical beach raking threatens the survival of least tern chicks and degrades foraging habitat (NJDEP 2005). Colonies can be deserted if threatened by cat, rat or human predation (Ehrlich *et al*. 1988). Regionally, least terns are threatened by habitat loss and degradation resulting from development, off-road vehicles and other human use of nesting areas; encroaching vegetation; removal of shell substrates; and predation by mammals and other bird species, especially dogs and foxes (MANEM 2004). Nests are vulnerable to heavy rains and flooding from spring tides. Research and/or banding efforts may also lead to nest abandonment and chick mortality

Table F-8. Least tern nesting productivity at Sandy Hook from 1996 to 2006. (Source: NPS and NJDEP unpublished data)

	Number of adults	Number of chicks fledged	Productivity
1996	160	8	0.10
1997	315	28	0.18
1998	152	28	0.37
1999	258	124	0.96
2000	318	57	0.36
2001	388	74	0.38
2002	444	52	0.23
2003	144	9	0.12
2004	138	0	0
2005	96	0	0
2006	462	0	0

(MANEM 2004). At Sandy Hook, least tern colonies are threatened by human disturbance, flooding, and predation by fox, gull, and crows, all of which have led to nest failures.

Osprey

Species Description

Osprey (*Pandion haliaetus*) is a large raptor with a 4.5 to 6 ft wingspan. When in flight, the osprey's long, narrow wings resemble the letter "M" and the flight pattern consists of stiff and shallow wing beats. Adult osprey are dark brown above and white below, with contrasting dark carpal patches. The head is white with a broad, black eye stripe extending to the back of the neck. Tail and flight feathers are barred consisting of a dark brown color with faint white bands. The bill of the osprey is black with a prominent hook with a sharp tip to pierce the skin of fish. Nestlings have blood red eye color, which becomes orange-yellow in juveniles and yellow in adults (NJDEP 2002b).

Habitat Description

Osprey feed almost entirely on fish, and as such their habitat is associated with bodies of water supporting fish populations. Habitat includes coastal rivers, marshes, bays, inlets, inland rivers, lakes and reservoirs. Large stick nests are built on live or dead trees, light poles, man-made nesting platforms, abandoned duck blinds, channel markers, and other artificial structures that offer unobstructed views of the surrounding areas and are close to foraging areas (NJDEP 2002b, Ehrlich *et al*. 1988). Osprey are monogamous and will return to the same nest each year, increasing the size of the nest over time; nests contain 2 to 4 eggs (Ehrlich *et al*. 1988). An osprey's territory usually contains snags, poles or other structures near the nest where the bird can perch (NJDEP 2002b, NPS 2000).

Status and Distribution at Sandy Hook

The NPS has maintained an Osprey Management Program since 1974 and has provided a total of 15 artificial nesting platforms since that time. The birds typically arrive at Sandy Hook during the third week in March, and by mid-April the nests have been established. The fourth week of April is the peak egg laying period, and chicks are fledged by August. The birds begin to migrate to their wintering grounds in September (NPS 2000). Osprey have constructed nests at 21 locations at Sandy Hook since 1974; seventeen of these locations have produced young. An additional six nesting platforms were never used for nesting during that same time period. Three to six nests generally active in any given year; the number of active nests and the number of birds fledged has increased at the Park since 1974 (NPS 2000). Six pair of osprey nested at Sandy Hook in 2006; two non-nesting pairs were also documented. The nests produced 11 young, with a productivity of 1.57 (NPS, unpublished data). Historic nest sites include Spermaceti Cove, Horseshoe Cove, the Holly Forest, North Pond, the USCG property, the chimney of Houses 13 and 14, the chimney of the Officer's Club, the South Maintenance Area, and along the South Beach Dune Trail.

Threats to Osprey

Osprey were historically threatened by the pesticide DDT, which contaminated its prey fish and bioaccumulated in the birds; the pesticide led to thinning of osprey eggs and dramatically reduced reproductive success (NJDEP 2002b, Ehrlich *et al*. 1988). Osprey populations in NJ declined significantly following the use of DDT in coastal areas, plummeting from an estimated 500 pairs in the 1950s to only 68 in 1975. Use of DDT was banned in NJ in 1968, but contamination related threats persisted well into the 1970s (NJDEP 2002b).

Habitat loss, including the removal of nest trees, has also threatened osprey. Once an abundant breeding species in coastal NJ, the state's osprey population declined from the late 19th century through the 1970s (NJDEP 2002b). Collection of eggs and shooting have also contributed to early population declines in NJ (NJDEP 2002b, Ehrlich *et al*. 1988). Current threats to osprey include pesticide contamination (including PCBs), a potential reduction in prey species, and occasionally predators (NJDEP 2002b).

Seabeach knotweed

Species Description

Seabeach knotweed is an annual plant visible on the New Jersey shore between May and November. Part of the buckwheat family, seabeach knotweed is characterized by a silvery color, stems branching outward and upward from the base of the plant, and a height between 8 and 27.5 inches. The flowers of seabeach knotweed are white with white or pink margins and bloom from May to November (USFWS 2006b). The species produces a small reddish brown to dark brown seed fruit, commonly in the late season.

Habitat Description

Most seabeach knotweed occurrences in New Jersey are on sandy beaches, dunes and dune-hollows where the plants generally occur above the limit of the tide. Similar to seabeach amaranth, seabeach knotweed is a pioneer species that prefers unstable habitats created by active sand deposition and overwash. The species can also be found along the margins of salt marshes and coastal ponds (USFWS 2006b).

Status and Distribution

Seabeach knotweed ranges along the Atlantic coast from Maine to Florida. New York and Massachusetts have the only remaining locally abundant populations. In New Jersey, seabeach knotweed plants have been documented in Monmouth and Ocean Counties (NatureServe 2006). In 2003, 249 seabeach knotweed plants were documented by the USFWS and ENSP in the Sea Bright to Monmouth Beach region; in 2004, 1,064 plants were observed but in 2005 only 62 were found (USFWS 2006b). Seabeach knotweed is considered endangered by the state of New Jersey. The NPS incidentally observed 151 seabeach knotweed plants in 2005 during the annual seabeach amaranth survey, but its abundance and distribution within the Park is otherwise unknown.

Threats to Seabeach knotweed

Coastal development, dune building and stabilization projects, and recreational use of otherwise protected beaches all threaten seabeach knotweed. Habitat loss has contributed to the decline of the species, as many of its former sites have been lost to development and dune stabilization. Off-road vehicle use and beach grooming activities also threaten seabeach knotweed, degrading its beach habitat (NatureServe 2006, USFWS 2006b).

Seabeach evening primrose

Species Description

Seabeach evening primrose is a perennial plant of the primrose family; its stems are whitish, hairy and often flattened on the ground (Kraus 1988, USDA 2006). The plants typically reach 8 to 18 inches in height (USDA 2006). The leaves of the seabeach evening primrose are alternate in arrangement and elliptical to oblanceolate in shape with wavy margins (Kraus 1988). The species produces large yellow flowers tinged with pink and hairy, cylindric fruit capsules from May to October (USDA 2006, Kraus 1988).

Habitat Description

Seabeach evening primrose grows in beach and dune habitats, generally on foredunes above the limit of most storm tides. The species often occurs with American beachgrass (*Ammophila breviligulata*), seaside goldenrod (*Solidago sempervirens*), and silver bunch grass (*Panicum*

amarum var. amarulum) (NatureServe 2006). *Oenothera humifosa* hybridizes with the evening primrose *Oenothera laciniata* (Kraus 1988).

Status and Distribution

Seabeach evening primrose can be found along the Atlantic coast of the U.S. from New Jersey and Pennsylvania south to Florida, and along the Gulf coast from Louisiana to Florida. In New Jersey, the plant has been observed in Atlantic and Cape May Counties (NatureServe 2006). The species is classified as endangered by the state of New Jersey. The NPS does not currently monitor for seabeach evening primrose, so its abundance and distribution at Sandy Hook are unknown.

Threats to Seabeach Evening Primrose

The species is threatened by trampling, off-road vehicle use, dune stabilization projects and coastal development that degrade or eliminate its habitat.

Other State-listed Threatened and Endangered Species

The American bittern (*Botaurus lentiginosos*) breeding population is considered endangered in New Jersey. Non-breeding American bittern are listed as a state Species of Special Concern. This species is a cryptic and elusive wading bird that lives in densely vegetated marshes (saltwater, brackish and freshwater). With long, yellowish-green legs, brown back and buffy-white neck and body with brown vertical streaks, the American bittern resemble young black-crowned and yellow-crowned night herons (*Nycticorax nycticorax* and *Nyctanassa violacea* respectively). American bittern are threatened by wetland habitat loss, and the species has shown population declines in New Jersey of 68% from the early 1970s to the mid-1980s (NJDEP 2002c). The species has been identified as a Migratory Nongame Species of Management Concern by the USFWS and a Northeast Species of Conservation Concern by the Northeastern Association of Fish and Wildlife Administrators (NEES & WDTC, in press). At Sandy Hook, the abundance and distribution of American bittern is unknown; a recent NPS inventory and monitoring project to document secretive birds at Sandy Hook may fill this data gap.

The black skimmer (*Rynchops niger*) is a black and white colonial waterbird with a long, reddish-orange and black beak; its legs and feet are also reddish-orange. The species' foraging behavior, flying low over shallow water estuarine areas while its open beak sluices through the water, is distinctive. Nesting habitat includes open sandy beaches, inlets, offshore islands, sandbars, dredge spoil islands with sparse vegetation and containing shell fragments, and on wrack mats on marsh islands (NJDEP 2002d). The black skimmer population has declined 75% in the region since the 1970s, to about 2,000 to 3,000 nesting pairs (Watts 1999). Currently, the black skimmer regional population is considered stable, but it has shown recent declines in New York, New Jersey and Virginia (MANEM 2004). The New Jersey population of black skimmers totaled 2,186 adults on 12 colonies in 2002 (NJDEP, unpublished data). Sustainability is considered 2.77 young produced per nesting pair. Threats include sea level rise, predation, flooding of nests, human disturbance, coastal development, ORV use, and the concentrated

nature of the remaining nesting colonies (MANEM 2004). The black skimmer is endangered in New Jersey. At Sandy Hook, black skimmers historically arrive in mid May, nest in June, and fledge from late July to mid-August. No black skimmers have nested in the Park in nearly twenty years (T. Pover, NJDEP ENSP, personal communication). Conservation measures to protect least terns and other beach nesting birds will benefit the black skimmer, but no measures specific to black skimmers are proposed.

The yellow-crowned night heron (*Nyctanassa violacea*), a colonial waterbird that nests in trees in wooded areas near water, is classified as threatened in New Jersey. A medium-sized, short-legged wading bird, adult birds have a blue gray body and black and white patterned head with a yellow-white crown (NJDEP 2002e). The habitats of the yellow-crowned night heron include marshes, swamps, lakes, lagoons and mangroves. Regionally, the population of yellow-crowned night heron has increased 199% from the 1970s to the 1990s. The species is threatened by degradation and loss of its wetland nesting and foraging habitat, human disturbance, and environmental contaminants (MANEM 2004). Yellow-crowned night herons are considered rare migrants at Sandy Hook, and as such no specific conservation measures are proposed for the species.

The black-crowned night heron (*Nycticorax nycticorax*) both breeds and winters in the region, nesting in trees in wooded areas near water and more recently on dredged material islands (MANEM 2004). Black-crowned night herons are similar in appearance to American bittern and yellow-crowned night herons, differing from the latter in that their backs are black instead of gray and has a black cap and white cheeks instead of white streaking (NJDEP 2002f). Birds may fly up to 15 miles to forage along marshes, mudflats, tidal creeks, pilings, boat riggings, and shallow, weedy pond margins. The regional population has declined 49.2% from the 1970s to the 1990s, and is threatened by loss and degradation of habitat, human disturbance, mammalian predators, and environmental contaminants (MANEM 2004). At Sandy Hook, a heron rookery is suspected to exist in an impenetrable area of the holly forest; black-crowned night herons have historically been observed at the Nike Pond (S. Barnes, NJ Audubon, personal communication).

The black rail (*Laterallus jamaicensis*) is a secretive, nocturnal bird that lives in coastal salt and brackish marshes. Roughly the size of a sparrow, adult birds are dark gray to nearly black with a varying amount of white spots scattered across their back and wings. The black rail typically nests in marshes dominated by salt hay (*Spartina patens*). Threats include wetland filling, ditching and draining, pollution, and increased human recreational activities within its estuarine habitat (NJDEP 2002g). The black rail is classified as threatened in New Jersey, is a bird of management concern and a NAWCA Priority Species for the New England/Mid-Atlantic coast for the USFWS, and is on the red Audubon WatchList. The abundance and distribution of black rail at Sandy Hook is unknown; a recent secretive marsh survey by NJ Audubon did not observe any black rail in the Park (S. Barnes, NJ Audubon, personal communication). Due to its presumed absence from the Park, no conservation measures are proposed specifically for black rail.

Sea-milkwort (*Glaux maritima*), an endangered species in NJ, is a perennial herb in the primrose family, characterized by green foliage that grows less than one foot tall. White flowers are produced in late spring and brown seeds in the summer. Along the coast, sea milkwort grows

along beaches and in high salt marshes; in inland areas, the species also grows in wetlands such as wet meadows and streambanks. Sea milkwort is distributed along the northern Atlantic coast and in most of the western states, but is currently presumed extirpated from New Jersey (NatureServe 2006). Due to its presumed absence from the state, no conservation measures are proposed for sea-milkwort.

Other Significant Species of Management Concern

American oystercatcher (*Haematopus palliates*). A solitary nesting shorebird, the oystercatcher is a tall (18.5 inches long) bird that shares the same beach nesting habitat (and threats) as the piping plover, least tern, black skimmer and common tern. The species is characterized by a black head, dark brown back, large red-orange bill, white belly, wing and tail patches (National Geographic 1999). Between 300 and 500 pairs of oystercatchers nest in the Mid-Atlantic Coastal Plain region, with 75% of them found on the Virginia barrier islands; the regional population has declined by 40% in recent decades (Watts 1999). The *U.S. Shorebird Conservation Plan* prioritized the American oystercatcher as a Species of High Concern (Brown *et al*. 2001), with an estimated population of only 11,000 birds (Schulte et al. 2006). American oystercatchers along the Atlantic and Gulf coasts of the U.S. are threatened by habitat loss from coastal development, human disturbance, predation, contamination of primary food sources, and global climate change with rising sea levels (Schulte et al. 2006). This species can be found during both the breeding and wintering seasons in New Jersey (Schulte et al. 2006). Six pairs of oystercatchers attempted to nest at Sandy Hook in 2005 and four in 2006, but no chicks fledged and productivity was zero in both years, most likely due to predation. Up to 8 pairs of oystercatchers have nested in the Park in the past, but productivity has always been poor. Conservation measures to protect the beach nesting bird community (e.g., piping plover) will also benefit the American oystercatcher (Schulte et al. 2006).

The common tern (*Sterna hirundo*) is a colonial waterbird that often shares shoreside habitat with other terns and shorebirds described in this management plan. Breeding common terns are listed as a state Species of Special Concern and are classified as Low Concern by the *North America Waterbird Conservation Plan* (Kushlan *et al*. 2002). The species has been identified as a Northeast Species of Conservation Concern by the Northeastern Association of Fish and Wildlife Administrators. The common tern has a white body and black cap on its head. Up to 90% of the bird's diet consists of fish, with its foraging habitat extending 3.1 to 12.4 miles from the nesting colony and consisting of shallow, inshore waters, estuaries, bays, salt marsh creeks and lakes (Ehrlich *et al*. 1988, MANEM 2004). Nesting colonies may number from tens to thousands of birds and are threatened by mammalian and avian predators, habitat loss to large gulls, flooding, and human disturbance (Ehrlich *et al*. 1988, MANEM 2004). Sustainable productivity rates for common terns are estimated at 0.8 to 0.9 chicks per nesting pair (MANEM 2004). No common terns successfully nested at Sandy Hook in 2005 or 2006, but in previous years they have nested at USCG and North Beaches; this species is frequently observed loafing at other areas of the Park. Conservation measures to protect the beach nesting bird community (e.g., least tern) will also benefit the common tern.

The horseshoe crab (*Limulus polyphemus*) is a marine arthropod (not a real crab) that can be found in marine and estuarine waters up to 75 feet deep, emerging to estuarine sandy beaches to lay and bury thousands of eggs in the sand during new and full moon high tides during May and June. These eggs are a crucial food source for migrating shorebirds like red knot, dunlin (*Calidris alpina*), sanderling, ruddy turnstone, semipalmated sandpiper and others. Crabs, fish and other animals also feed on horseshoe crab eggs. The beaches of Delaware Bay support the highest number of spawning horseshoe crab in the U.S. (Western Hemisphere Shorebird Reserve Network 2003) and are famous for their resulting shorebird migration, but populations of horseshoe crabs have declined significantly in recent years and are threatened by commercial harvest and loss of nesting habitat. The species shows site fidelity to specific beaches, returning to the same beach year after year to spawn (USFWS 2003b). The blood of the horseshoe crab is a valuable pharmaceutical and medical tool, as it contains copper instead of iron and its blood cells can be used to screen for bacterial infections. The Atlantic States Marine Fisheries Commission (ASMFC) adopted a Fishery Management Plan for the horseshoe crab in 1998 (ASMFC 1998). Horseshoe crabs have been observed spawning on the north end of Plum Island at Sandy Hook (S. Barnes, NJ Audubon, personal communication), but no surveys have been conducted to determine their abundance and distribution within the Sandy Hook Unit (although a survey study is underway at Plum Beach in the New York portion of Gateway NRA).

Northern diamondback terrapin (*Malaclemys terrapin terrapin*) is a New Jersey Species of Special Concern that bury nests in the sandy borders of coastal salt marshes or in dunes from June to July. Hatchlings emerge from late August to early October, and some may overwinter and emerge in the following spring. Northern diamondback terrapins feed on fish, mollusks, marine snails, carrion, clams, and worms and live from 25 to 40 years (CTDEP 2000, Ner and Burke 2005). This small (4 to 9 inches long) turtle species frequents salt marshes and estuarine waters and is threatened by predation, commercial harvest, unintentional entrapment in crab and lobster pots, boat propeller injury, coastal development, and road mortality. Habitat loss and fragmentation through the installation of bulkheads and riprap, and habitat degradation resulting from pollution and dune grass encroachment into nesting habitat, also threaten the Northern diamondback terrapin (NEES & WDTC in press, CTDEP 2000). The Northern diamondback terrapin is restricted to the coastal zone of the northeastern U.S., ranging from Massachusetts to northern North Carolina, and hibernates during the winter months (CTDEP 2000).

At Sandy Hook, over 150 Northern diamondback terrapins have been observed using the sandbar in Spermaceti Cove during the summer (S. Barnes, NJ Audubon, personal communication), and Ner and Burke (2005) found 203 terrapin nests at Sandy Hook in 2002. Ner and Burke (2005) estimate a minimum population of 200 to 300 Northern diamondback terrapins in Sandy Hook Bay. The most important terrapin nesting beaches at Sandy Hook are the Battery Zone (near the Kingman and Mills gun batteries), the bayside across from the Seagull's Nest Restaurant, Holly Forest, Plum Island, Skeleton Hill Island, Horseshoe Cove, and the two sandy spits enclosing Spermaceti Cove (Ner and Burke 2005). Of the 203 nests observed in the Ner and Burke (2005) survey, 170 (84%) of the nests and at least five adults were predated almost exclusively by raccoons; wire mesh exclosures were placed on 11 nests, successfully protecting them from raccoons during incubation. One nest was predated by roots from the dune grass *Ammophila breviligulata*, which penetrated the nest cavity and surrounded the eggs, resulting in the loss of the entire nest. Ner and Burke (2005, p. 19) recommend that human disturbance in nesting areas

be reduced via outreach and education and that the raccoon population be reduced because “it is possible that in the coming decades the terrapin population at Sandy Hook could be greatly reduced or even eliminated as a result of predation on eggs and adults.”

Appendix G. Potential Impacts to Each Special Status Species from Alternatives A, B and C.

Table G-1. Potential effects of the No Action Alternative on Special Status Species in the Sandy Hook Unit of Gateway NRA.

Common Name (Scientific Name)	Status*	Potential Effect
American bittern *(Botaurus lentiginosos)*	SE	Not likely to adversely affect; potential to have minor to moderate positive or negative impacts if species is present depending on whether it occurs within existing protected areas or not.
Red knot *(Calidris canutus rufa)*	FC, ST	
Bald eagle *(Haliaeetus leucocephalus)*	FT, SE[3], ST[4]	
Black rail *(Laterallus jamaicensis)*	ST	
Black-crowned night heron *(Nycticorax nycticorax)*	ST	
Yellow-crowned night heron *(Nyctanassa violacea)*	ST	
Black skimmer *(Rynchops niger)*	SE[3], ST[4]	
Roseate tern *(Sterna dougallii)*	FE, SE	
Piping plover *(Charadrius melodus)*	FE[1], FT[2], SE	Not likely to adversely affect; potential to have minor to moderate negative impacts if predation losses continue at current levels.
American oystercatcher (*Haematopus palliates*)		Likely to adversely affect productivity assuming that predation losses continue at current levels.
Osprey *(Pandion haliaetus)*	ST	Not likely to adversely affect; potential to have minor to moderate positive impacts with the implementation of the 2000 *Osprey Management Plan.*
Least tern *(Sterna antillarum)*	SE	Likely to adversely affect productivity assuming that predation losses continue at current levels.
Common tern (*Sterna hirundo*)	SC	Likely to adversely affect productivity assuming that predation losses continue at current levels.

Northeastern beach tiger beetle *(Cincindela dorsalis dorsalis)*	FT, SE	Not likely to adversely affect; potential to have minor to moderate positive impacts with continuation of the reintroduction program but potential minor to moderate negative impacts with unidentified limiting factors. Overall impacts most likely negative.
Horseshoe crab (*Limulus polyphemus*)		Not likely to adversely affect; potential to have minor to moderate positive or negative impacts if species is present depending on whether it occurs within existing protected areas or not. Overall impacts most likely negative.
Northern diamondback terrapin (*Malaclemys terrapin terrapin*)	SC	Likely to adversely affect productivity assuming that predation losses continue at current levels.
Seabeach amaranth *(Amaranthus pumilus)*	FT, SE	Not likely to adversely affect; potential to have minor to moderate positive or negative impacts depending on whether new plants occur within existing protected areas or not. Overall impacts most likely negative.
Sea-milkwort *(Glaux maritime)* Seabeach evening primrose *(Oenothera humifusa)* Seabeach knotweed *(Polygonum laucum)*	SE SE SE	Not likely to adversely affect; potential to have minor to moderate positive or negative impacts if species is present depending on whether it occurs within existing protected areas or not. Overall impacts most likely negative.

*FE = federally endangered, FT = federally threatened, FC = federal Candidate species, SE = State endangered, ST = State threatened, SC = Special concern

[1] Great Lakes breeding population
[2] Atlantic coast breeding population
[3] breeding population
[4] non-breeding population

Table G-2. Potential effects of the Preferred Alternative on Special Status Species in the Sandy Hook Unit of Gateway NRA.

Common Name (Scientific Name)	Status*	Potential Effect
American bittern *(Botaurus lentiginosos)*	SE	Not likely to adversely affect; potential to have minor to moderate overall positive impacts if species is present, it occurs within existing protected areas, and habitat improvements are conducted.
Red knot *(Calidris canutus rufa)*	FC, ST	
Bald eagle *(Haliaeetus leucocephalus)*	FT, SE[3], ST[4]	
Black rail *(Laterallus jamaicensis)*	ST	
Black-crowned night heron *(Nycticorax nycticorax)*	ST	
Yellow-crowned night heron *(Nyctanassa violacea)*	ST	
Roseate tern *(Sterna dougallii)*	FE, SE	
Piping plover *(Charadrius melodus)*	FE[1], FT[2], SE	Not likely to adversely affect; potential to have minor to moderate positive impacts depending on the number of predators removed, reduced human disturbance and if habitat improvements are conducted.
American oystercatcher (*Haematopus palliates*)		Not likely to adversely affect; potential to have minor to moderate positive impacts depending on the number of predators removed and reduced human disturbance.
Osprey *(Pandion haliaetus)*	ST	Not likely to adversely affect; potential to have minor to moderate positive impacts with the implementation of the 2000 *Osprey Management Plan*.
Black skimmer *(Rynchops niger)*	SE[3], ST[4]	Not likely to adversely affect; potential to have minor to moderate positive impacts if species is present and it occurs within existing protected areas, and depending on the number of predators removed and reduced human disturbance.

Least tern *(Sterna antillarum)*	SE	Not likely to adversely affect; potential to have minor to moderate positive impacts depending on the number of predators removed from nesting areas and reduced human disturbance.
Common tern (*Sterna hirundo*)	SC	Not likely to adversely affect; potential to have minor to moderate positive impacts depending on the number of predators removed from nesting areas, reduced human disturbance and if habitat improvements are conducted.
Northeastern beach tiger beetle *(Cincindela dorsalis dorsalis)*	FT, SE	Not likely to adversely affect; potential to have minor to moderate positive impacts with continuation of the reintroduction program, reduced ORV disturbance, and if habitat improvements are conducted.
Horseshoe crab (*Limulus polyphemus*)		Not likely to adversely affect; potential to have minor to moderate overall positive impacts if species is present, it occurs within existing protected areas, and habitat improvements are conducted.
Northern diamondback terrapin (*Malaclemys terrapin terrapin*)	SC	Not likely to adversely affect; potential to have minor to moderate positive impacts depending on the number of predators removed from nesting areas and if habitat improvements are conducted.
Seabeach amaranth *(Amaranthus pumilus)*	FT, SE	Not likely to adversely affect; potential to have minor to moderate positive impacts depending on reduced human disturbance and if habitat improvements are conducted.
Sea-milkwort *(Glaux maritime)*	SE	Not likely to adversely affect; potential to have minor to moderate positive impacts if species is present and habitat improvements are conducted.
Seabeach evening primrose *(Oenothera humifusa)* Seabeach knotweed *(Polygonum laucum)*	SE SE	Not likely to adversely affect; potential to have minor to moderate positive impacts depending on if species is present, reduced human disturbance and if habitat improvements are conducted.

*FE = federally endangered, FT = federally threatened, FC = federal Candidate species, SE = State endangered, ST = State threatened, SC = Special concern

[1] Great Lakes breeding population
[2] Atlantic coast breeding population
[3] breeding population
[4] non-breeding population

Table G-3. Potential effects of Alternative C on Special Status Species in the Sandy Hook Unit of Gateway NRA.

Common Name (Scientific Name)	Status*	Potential Effect
American bittern *(Botaurus lentiginosos)*	SE	Not likely to adversely affect; potential to have minor to moderate positive impacts if species is present and if habitat improvements are conducted.
Red knot *(Calidris canutus rufa)*	FC, ST	
Bald eagle *(Haliaeetus leucocephalus)*	FT, SE[3], ST[4]	
Black rail *(Laterallus jamaicensis)*	ST	
Black-crowned night heron *(Nycticorax nycticorax)*	ST	
Yellow-crowned night heron *(Nyctanassa violacea)*	ST	
Roseate tern *(Sterna dougallii)*	FE, SE	
Piping plover *(Charadrius melodus)*	FE[1], FT[2], SE	Not likely to adversely affect; potential to have moderate to major positive impacts depending on the number of predators removed, reduced human disturbance and if habitat improvements are conducted.
American oystercatcher (*Haematopus palliates*)		
Least tern *(Sterna antillarum)*	SE	
Common tern (*Sterna hirundo*)	SC	
Osprey *(Pandion haliaetus)*	ST	Not likely to adversely affect; potential to have minor to moderate positive impacts with the expansion of closed bayside areas and if habitat improvements are conducted.
Black skimmer *(Rynchops niger)*	SE[3], ST[4]	Not likely to adversely affect; potential to have moderate positive impacts depending on if the species returns to the Park, the number of predators removed, reduced human disturbance and if habitat improvements are conducted.

Northeastern beach tiger beetle *(Cincindela dorsalis dorsalis)*	FT, SE	Not likely to adversely affect; potential to have minor to moderate positive impacts with continuation of the reintroduction program, reduced ORV disturbance, and if habitat improvements are conducted; potential to have minor negative impacts from off-season human disturbance.
Horseshoe crab (*Limulus polyphemus*)		Not likely to adversely affect; potential to have minor to moderate positive impacts if species is present and if habitat improvements are conducted.
Northern diamondback terrapin (*Malaclemys terrapin terrapin*)	SC	Not likely to adversely affect; potential to have moderate to major positive impacts depending on the number of predators removed, reduced human disturbance and if habitat improvements are conducted; potential to have minor negative impacts from off-season human disturbance.
Seabeach amaranth *(Amaranthus pumilus)*	FT, SE	Not likely to adversely affect; potential to have minor to moderate positive impacts depending on reduced human disturbance and if habitat improvements are conducted.
Sea-milkwort *(Glaux maritime)*	SE	Not likely to adversely affect; potential to have minor to moderate positive impacts if species is present and if habitat improvements are conducted.
Seabeach evening primrose *(Oenothera humifusa)*	SE	Not likely to adversely affect; potential to have minor to moderate positive impacts if species is present and depending on off-season human disturbance levels.
Seabeach knotweed *(Polygonum laucum)*	SE	Not likely to adversely affect; potential to have minor to moderate positive impacts depending on off-season human disturbance levels.

*FE = federally endangered, FT = federally threatened, FC = federal Candidate species, SE = State endangered, ST = State threatened, SC = Special concern

[1] Great Lakes breeding population
[2] Atlantic coast breeding population
[3] breeding population
[4] non-breeding population