



III. Environmental Assessment

Terminal groin structures are frequently located within estuarine and coastal systems; however, only a limited amount of information exists on the biological effects of such structures [Coastal Engineering Research Center (CERC) 1981]. Coastal structures may result in changes in wave and current patterns, sedimentation patterns, and habitat types although the Physical Assessment Section does conclude that terminal groins do not have a big impact on regional sand transport when looked at in conjunction with the other major natural and anthropogenic effects on the inlet, but can anchor an inlet shoreline at least temporarily. These factors in turn affect coastal and marine biological communities (CERC 1984).

As noted in the Physical Assessment Section, the primary geomorphological consequence of the presence of a terminal groin structure and its physical consequences on habitat is the stabilization of the inlet channel and shoreline inhibiting natural physical processes of sand flat formation, overwash to some degree, and creation of new unvegetated nesting and resting habitat for many species. The prevention of inlet migration and reduction in overwash events affects those resources dependent on dynamic inlet shorelines. The Physical Assessment data indicate the selected inlet's tidal dynamics, storm impacts, dredging, beach nourishment, and day-to-day wave processes are the chief factors affecting the sedimentation patterns and sand distribution at the selected study sites.

Coastal protection projects, whether they include hard or soft structures, have proved to be of particular environmental concern due to their magnitude, timing, and the sensitivity of high value resources within the vicinity of an inlet. A scientific literature review and discussion of the environmental considerations and the significant resources dependent upon natural dynamic barrier islands is provided in the General Environmental Effects Section. A review of primary and secondary natural resource data with respect to the selected five terminal groin locations is provided in the Environmental Assessment of the Five Study Sites Section.

1. Technical Approach of Analysis

The CRC Science Panel discussed during the 29 September 2009 meeting that in the event data was limited for the five sites chosen for full evaluation; alternative sites may need to be considered (NCDCM 2009). Based on limited data, representative projects at adjacent inlets were evaluated via regulatory documentation and scientific literature to provide additional natural resource data in order to comprehensively analyze the effects of terminal groins. In order to conduct an interdisciplinary analysis, summary of findings from the Physical Assessment Section was integrated into the Environmental Section in order to analyze coastal habitats and organism responses based upon the dynamics of sediment transport changes and geomorphological changes potentially occurring within the selected study sites.



A review of past scientific, engineering, and publicly accessible information and data related to the five terminal groin projects chosen in North Carolina and Florida was conducted. Environmental natural resources evaluated include benthic resources, shorebirds and waterbirds, fisheries, coastal habitats and associated biota, and federally protected species, such as sea turtles and piping plovers. Readily available data from each selected site was identified from web-based literature searches and over 140 contacts and interviews were made with applicable state/local and federal agencies, coastal engineering firms, non-profit organizations, and libraries (Appendix E). Table III-1 provides a breakdown of representatives contacted for environmental data. Information identified was reviewed for its usefulness in assessing natural resource effects from construction and maintenance of the selected terminal groin locations.

Table III-1. Enumerated list of representatives contacted for environmental data and/or information as it relates to terminal groins

Representatives	North Carolina	Florida
State/Local Agency	17	33
Federal Agency	26	21
Non-profit Organization ^a	8	11
For-profit Organization ^b	23	13
Individual ^c	2	0
Total	76	78

^a Non-profit organization (501c3) category includes Audubon Chapters, Conservation organizations, etc.

^b For-profit organization category includes universities, consulting firms, etc.

^c Individual category includes persons that have retired from state and federal agencies, experts in their field and conducting their own research, etc.

In general, the historical nature of the selected study sites resulted in limited availability of pre- and post-construction resource population and natural ecosystem data. Local population data from each selected study site were utilized in order to most efficiently detect a trend or change over a spatial and temporal basis. Natural resource survey data in general are not typically obtained by any rigorous scientific methodologies, and the results from year to year certainly vary due to the level of coverage as well as the weather conditions, which can vary considerably from year to year. Ecological and environmental variability as well as major data gaps in the natural ecosystems evaluated in this study provided for a complex analysis. It was understood that control sites and variability (spatial, temporal, and natural) are some of the most important concepts in impact assessments and were integrated as fully as possible into this study. In an attempt to fully evaluate potential effects of terminal groins, available natural resource data from inlet locations with no structures present were used as controls as well as to evaluate population data on a regional level. Spatial and temporal extent of each dataset varies based on local monitoring regimes and were beyond the control of this study. Considering the time scale of this study, readily available data could not be statistically evaluated based on quality and completeness therefore a Before-After and Control-Impact (BACI) analysis was precluded.



Other potential methodologies for determining the effect of a terminal groin on the environment were reviewed, including quantifying temporal changes in habitat areal coverage with the use of Geographic Information Systems and high resolution geo-referenced digital multispectral aerial photographs. However, based on experience, this methodology consumes more time than what was available for this study and can be difficult to accurately interpret in the vicinity of oceanic inlets due to their dynamic and ephemeral nature. Although biotic community changes over time weren't quantified within the vicinity of the selected terminal groin locations, habitats were evaluated on a visual basis.

Technical qualifiers that are in need of mention include the following:

- No new natural resource data were collected during this study;
- Existing secondary sources and raw data collected by other entities were evaluated for potential environmental effects;
- Readily available data were not directly related to the construction of a selected terminal groin;
- Beach nourishment, dredging, and terminal groin effects could not be evaluated separately;
- Historical nature of the selected terminal groin sites precluded the availability of pre-construction natural resource data and statistical evaluation; and
- Prior to construction and after construction data were only available for two sites and limited resources.

2. General Environmental Effects

a) Coastal and Marine Resources Effects

Tidal inlets provide tidal conveyance from open bodies of water to more sheltered lagoons, estuaries, or bays. Environmental factors such as tides, longshore transport, freshwater input, and wave climate influence inlet configurations (O'Brien 1976) and therefore have immediate and direct effects on biological resources within the system. In order to provide a concise summary of coastal resources, such as biological resources (i.e. birds and shellfish beds), sensitive shorelines (i.e. marshes and tidal flats), submerged habitats (i.e. seagrasses) and human resources; the NOAA Environmental Sensitivity Index (ESI) map portal program was utilized (NOAA 2008; Personal communication, K. Taylor, NC Geologic Survey, October 2009). Each selected terminal groin site includes a coastal classification map, a habitat map depicting the major sensitive habitats, and a species occurrence map which represents species' habitat range.

Dredging and placement of beach quality sand and the construction of terminal groins are typically designed and constructed in conjunction and therefore have the potential to affect biological resources in a variety of ways. This section discusses the effects of terminal groins as well as the placement of material as it relates to each natural resource.



The potential for adverse effects from beach restoration may result from actions of the dredging equipment (i.e. suction, sediment removal, hydraulic pumping of water and sediment); physical contact with dredging equipment and vessels; physical barriers imposed by the presence of dredging equipment (i.e. pipelines); and placement of dredged material on the beach within a proposed construction template (i.e. covering, suffocation) (USACE 2008a). Although beach placement of material and associated construction operations (i.e. operation of heavy equipment, pipeline route, etc.) may adversely affect some species and their habitat; the resulting constructed beach profile may promote restoration of important sea turtle nesting habitat that has been lost or degraded as a result of significant oceanfront erosion. Adverse affects may come in the form of the prevention of accretion of new habitat on the opposite side of the inlet, which may be more valuable to early successional species such as the piping plover, especially over the long term.

The placement of rock to construct a terminal groin would result in a temporary and footprint specific loss of the existing benthic community. The placement of rock may also result in the permanent loss of intertidal and nearshore subtidal habitat; however, this loss may be negligible when compared to the total amount of intertidal habitat within a specific project area. The loss of these habitats would be replaced by rocky, hardbottom material that would add diversity to the bottom habitat (USACE 2008a); thus providing a new habitat type that can be utilized by certain groups of invertebrates, juvenile/larval fish, and birds. However, according to NCDMF, rocky habitat adjacent to an inlet, created through the installation of a terminal groin, is not natural to NC and therefore is not needed by the native fish or bird community. The addition of rocky habitat within a sandy intertidal area is not necessarily a positive benefit, rather a habitat trade-off. Chapman and Bulleri (2003) have concluded that creating rocky habitat has led to the introduction of non-native invasives within the vicinity of a hard structure.

Potential effects of shoreline protection projects, including beach nourishment and hardened structures, vary according to the type of equipment used, the nature and location of sediment discharged, the time period in relation to life cycles of organisms that would potentially be affected, and the nature of the interaction of a particular species with the activities. To offset some of these effects there is evidence, as described in the Physical Assessment Section, that sand bypasses terminal groins which allows for the development of beaches inside an inlet, there is existence of subtidal bars trending into the inlet channel, development of marginal flood channels, historical shoaling and closure of tidal inlets, and landward migrating swash bars welding to the downdrift inlet shorelines.

The sections below describe specific biological resources and the considerations of the effects of the construction and maintenance of a terminal groin structure and associated fillet.



b) Benthic Resources

A seafloor with physical properties ranging from dense mud to well-cemented limestone including adequate elevation changes may be considered hardbottom or live bottoms. Such hardened or semi-hardened seafloor areas generally support a high diversity of benthic or sessile flora and fauna. Such areas are rich in biological activity and considered EFH (Boss et al. 1999). As supported by NOAA NMFS, a rock rubble structure extending below the intertidal zone in a sandy bottom location would likely induce and support the development of a diverse benthic community supporting higher trophic levels of both fish and birds within the vicinity and footprint of a terminal groin. Benthic macroinvertebrates and infaunal species have limited mobility, and some are sensitive to physical and chemical environmental changes. Thus, benthic infauna can be useful indicators of a wide range of natural and anthropogenic stresses. Many benthic species depend upon variable particle sizes and available interstitial pore space in the substrate. Most species are found in the upper 3.3 feet of the substrate due to available oxygen content and aeration properties, although some larger species may live deeper (USFWS 2002). The type of benthic taxa found dominating the bays and sounds of North Carolina include bivalves, polychaetes, and amphipods. Dominant benthic indicator species researched in relation to coastal projects include mole crabs (*Emerita talpoida*), coquina clams (*Donax variabilis*, *D. parvula*), some amphipods (almost all Haustoriids), and polychaetes (mostly *Capitella capitata* and *Scolelepis squamata*), all of which can be found in North Carolina's intertidal beaches (Peterson et al. 2006, 2000a, 2000b; Street et al. 2005; and USFWS 2002).

Based on a four-year analysis of the effects of inlet migration at Emerald Isle, NC; Carter (2008) concluded that benthic communities are rarely in equilibrium and can vary significantly in their distribution and biotic composition. In addition, natural ecosystem processes and physical variations make it difficult for researchers to distinguish between natural and anthropogenic disturbances (Grober 1992). Important considerations when evaluating potential effects to the benthic community include: the ability of the community to recolonize the area after a disturbance, restoration of some measure of community parameters (e.g., species richness and diversity), and the functional property of the community to higher trophic levels (i.e., resident and migratory fish and shorebirds).

As described by Wilber (2003), the placement of sand on the beach buries, at least temporarily, existing benthic habitat; which would reduce the availability of infauna to benthic feeders up to 1 kilometer from the area of sediment deposition (Bishop et al. 2006). The long-term and cumulative effects of beach nourishment on benthic infauna and surface sediments of Panama City beaches were investigated by Culter and Mahadevan (1982), resulting in seasonal variability of species composition and faunal densities. Species diversity was lowest in the swash zone and sandbar and highest offshore. No long-term adverse effects from beach nourishment were detected in the Florida or North Carolina studies (Culter and Mahadevan 1982; Carter 2008). However, a study on Pea Island found peak recruitment of coquina clams was in March and concluded that nourishment in March or April would depress the population in the region



of nourishment for at least a full year (Donoghue 1999). Even if invertebrate populations fully recover within one year of a nourishment/maintenance event, this is a significant amount of time with depressed food resources available to foraging shorebirds over a large area. According to North Carolina Wildlife Resources Commission (NCWRC), the cumulative impacts of multiple nourishment events are unknown for invertebrate populations.

In cases where sediment texture is substantially changed due to the placement of a higher fraction of fine sediments on the beach, recovery of benthic infaunal communities may be delayed (Reilly and Bellis 1983; Peterson et al. 2000a). Where there is a high correspondence between the fill site and ambient beach sediments (e.g. Nelson 1993; Van Dolah et al. 1994; Hackney et al. 1996; Jutte et al. 1999; Burlas et al. 2001), infaunal recolonization is more rapid and potential limitations to benthic food availability are reduced. As stated previously, any reduction in the numbers and/or biomass of intertidal macrofauna may have limiting effects on surf-feeding fishes and shorebirds due to a reduced food supply. In such instances, these animals may be temporarily displaced to other locations. Effects to these areas could be minimized by consideration of shorebird nesting and feeding habits and potentially re-seeding of coquina clams, an important food source.

Comprehensive environmental assessments of coastal engineering projects evaluate beneficial, as well as detrimental effects. In the case of rubble-mound structures (e.g., jetties, groins, breakwaters, etc.), one beneficial aspect of construction is the creation of artificial reef habitat. This is evidenced by the popularity of coastal rubble-mound structures as recreational fishing spots. However, few studies have examined the utilization patterns of these structures as shelter, foraging, spawning, or nursery habitat by fish and invertebrate populations. Consequently, a lack of documentation of beneficial effects of rubble-mound structures exists (CERC 1984); although Knot et al. and Van Dolah et al. (1984) sampled the macrobenthic communities of the intertidal and nearshore sub-tidal environments at Murrells Inlet, SC, and a comparison of species abundance between years and among localities (updrift and downdrift) suggested no widespread effects attributable to jetty construction. It has long been known that desirable reef habitat is created whenever new surfaces are introduced into nearshore areas; however, the actual changes and the derived benefits have not been adequately described (CERC 1980).

c) Fish and Fisheries

Inlets are important corridors (or bottlenecks) through which many fish must successfully pass to complete their life cycles (Street et al. 2005; Roberts et al. 1995). Larval fish diversity in North Carolina's inlets is very high. Sixty-one larval species have been found in Oregon Inlet; Atlantic croaker (*Micropogonias undulatus*) and summer flounder (*Paralichthys dentatus*) were particularly abundant (Hettler and Barker 1993). As noted by NOAA NMFS, effects on larval transport due to the presence of a terminal groin would likely occur, but the level of effect would depend on several factors; such as the species' spawning areas, egg types (demersal or buoyant), and the larval stage when the



structural encounter occurred (Personal communication, M. Sramek, NOAA NMFS, February 2010). As described by Street et al. (2005); Beaufort, Ocracoke, and Oregon Inlets also support significant larval fish passage, although Oregon Inlet may be especially important due to the great distance between it and adjacent inlets, its orientation along the shoreline, and the direction of prevailing winds. Oregon Inlet provides the only opening into Pamlico Sound north of Cape Hatteras for larvae spawned and transported from the Mid-Atlantic Bight.

Surf zone habitats have been viewed as harsh environments that are difficult to effectively sample (Schaefer 1967; Lasiak 1984), which may account for the relative lack of information regarding the dependence of young fish on this habitat type. The importance of surf zone habitat as a nursery area for juvenile fish along the high-energy beaches of the eastern United States and northern Gulf of Mexico is becoming increasingly evident (Ross et al. 1987; Lazzari et al. 1999; Layman 2000; and Able et al. 2009). Many of these species, such as pompano and kingfish, which use the surf zone as a nursery area also, have high site fidelity, making them vulnerable to localized impacts in benthic community changes (Ross and Lancaster 2002). Increases in coastal development and erosion control measures, along with a greater emphasis on defining and protecting critical fish habitats, have all contributed to a growing interest in how beach restoration projects affect surf-zone fish communities.

As described by Wilber (2003), beach nourishment may affect surf zone finfish through reductions in benthic prey and shelter availability, and the disruption of fish distribution patterns. The beach placement of sand buries, at least temporarily, existing benthic habitat, which would reduce the availability of infauna to benthic feeders. Another potential effect arises when hard-substrate habitats, such as groins, are partially or totally buried by sediments, which may reduce the value of these structures as foraging and shelter sites (Wilber 2003). Additionally, the physical disturbance caused by dredging and the pumping of sand onto the beach may affect fish distribution patterns. High suspended sediment concentrations can negatively affect the physiology and feeding behavior of visually orienting estuarine fish (LaSalle et al. 1991; Wilber and Clarke 2003).

Localized fish abundance and distribution patterns have been significantly associated with the presence of rock groins, with greater fish captures and higher species richness at areas nearest groins. The presence of rock groins may increase the sampling efficiency near these structures, resulting in more abundant and species-rich catches. Alternatively, groin habitat may provide a foraging site and shelter for fishes in the surf zone, and is associated with higher fish abundances and species richness than in other surf zone communities (Peters and Nelson 1987; Clark et al. 1996). As noted in the Physical Assessment Section, once a beach protrudes to near the end of the structure, either by natural longshore transport or through beach nourishment, wave processes transport sand around and over the groins into the tidal inlet. The same sand by-passing action would also affect the by-pass of estuarine dependant larval forms.



d) Shorebirds and Waterbirds

The dynamic coastal processes that characterize inlet and barrier beach systems create habitats maintained by coastal storm events and resulting overwash, which support various early successional nesting bird species such as the federally listed piping plover (*Charadrius melodus*). According to NCWRC (2009), the barrier islands and associated inlets on which many waterbirds depend are being severely altered by attempts to stabilize beaches and dunes. Habitats associated with inlets are particularly valuable to coastal birds (Harrington 2008) and as such, should be afforded extra protection. According to the US Shorebird Conservation Plan (Brown et al. 2001), data from several shorebird inventory programs in North America in the past two decades strongly suggest that populations of the majority of species are declining, some at rates exceeding 5 percent per year. The plan also states that coastal development and human activities in coastal zones have grown a great deal and have reduced intertidal habitats, prey base, and have usurped high tide resting areas used by shorebirds (NCWRC 2009; Lamonte et al. 2006). Populations of many colonial waterbird species are also showing declines. Coastal development, coastal protection, dredging, and human disturbance are listed as actions that can significantly affect the ability of coasts and intertidal waters to sustain waterbirds (Kushlan et al. 2002).

As described by the USACE (2009), many habitats used by birds in Florida are affected by large-scale beach management activities such as shoreline protection through beach nourishment, dune building and planting, or removal of wrack from beaches. The effect of beach management activities also significantly inhibits the creation and maintenance of soundside salt marsh habitat. These areas will be impacted by beach nourishment and the construction and maintenance of a storm berm. The presence of a storm berm prevents overwash fans from forming in the marsh. Overwash fans create early successional nesting habitat for plovers, terns, and skimmers, and provide for landward migration of barrier islands resulting in the extension of salt marsh into the estuary behind the island as it migrates.

Florida's coastal bird habitats are also affected by inlet management through activities such as jetty construction or inlet bypassing. The effects of coastal sediment management on birds have rarely been studied in Florida (USACE 2009). Consequently, despite a large amount of coordinated (and uncoordinated) coastal bird surveys (Sprandel et al. 1997; Douglass and Coburn 2002; Ferland and Haig 2002; Lamonte et al. 2006; and Gore et al. 2007) the year-round distribution, abundance, and habitat associations of Florida's shoreline-dependent birds is still poorly known. These data gaps challenge Florida's management of coastlines for birds.

Limited coordinated data to assess recommendations for one species may conflict with the needs of another. Similarly, it is problematic to propose management recommendations that would positively affect the entire community of shoreline-dependent birds when neither the community, nor the habitat needs, have been adequately described. Effects of various coastal management activities on shoreline-dependent birds (e.g., coastal engineering, beach management activities) can be only partially addressed (relative to the limited number of species or seasons where data have been collected).



A great variety of birds in the South Atlantic Bight use terminal groins as loafing or roosting sites (Personal communication, D. Allen, NCWRC, October 2009). However, birds in a few ecological categories feed on or near groins and can be considered part of the rubble structure community. These include surface-searching shorebirds, aerial-searching birds, floating and diving waterbirds, and wading birds. The ruddy turnstone is often found feeding on groins in groups of 100 or more in the Fort Macon State Park area while purple sandpipers are also occasionally abundant in flocks of 40 to 50 on the jetties at Masonboro Inlet (Personal communication, R. Newman, Fort Macon State Park, October 2009; Personal communication, J. Fussell, Birder and Author, February 2010). Both species use rocks and groins as their primary feeding habitats. Other shorebirds use them only on occasion, feeding on surrounding habitats as well (Peterson and Peterson 1979; Thayer et al. 1984).

As natural sand bypass continues around and through a terminal groin, it becomes largely covered with sand and therefore is no longer available to species such as the ruddy turnstone and purple sandpiper. This has been the case with the terminal groin at Fort Macon. According to local bird experts, the Fort Macon terminal groin attracted purple sandpipers and the occasional vagrant eider or harlequin duck in the 1960's and 1970's; in more recent years, it has been much less attractive to these birds.

Beach and early successional nesting birds that utilize dry beach overwash habitats include terns (*Laridae* spp.), black skimmers (*Rhychops niger*), Wilson's plovers (*Charadrius wilsonia*), piping plovers, and American oystercatchers (*Haematopus palliatus*). These species nest on bare sand and shell with little or no vegetation and will change nesting areas in response to changing environmental conditions, such as increased vegetation. Waterbirds use group dynamics to select suitable nesting areas. This grouping creates nesting, resting, and foraging areas with large colonies that can include multiple species of waterbirds (CPE 2009). This is one reason why it's important that these birds have a number of suitable nesting, foraging, and roosting sites along the coast.



3. Federally Threatened and Endangered Species Effects

Any potential effects on federally listed threatened and endangered species would be limited to those species that occur in habitats present in the project areas (Table III-2). Updated lists of threatened and endangered (T&E) species for the five study sites (Carteret and Dare Counties, North Carolina; and Nassau, Lee, and Pinellas Counties, Florida) were obtained from the NMFS (Southeast Regional Office, St. Petersburg, FL) (<http://sero.nmfs.noaa.gov/pr/pdf/North%20Carolina.pdf>; <http://sero.nmfs.noaa.gov/pr/pdf/Species%20List/South%20Atlantic.pdf>) and the USFWS (Field Office, Raleigh, NC) (http://www.fws.gov/raleigh/es_tes.html) websites. These lists were combined to develop the following composite list of T&E species that could be present within the areas of evaluation based upon their geographic range. However, the actual occurrence of a species in the area would depend upon the availability of suitable habitat, the season of the year relative to a species' temperature tolerance, migratory habits, and other factors.

a) *Mammals*

(1) *West Indian Manatee*

The West Indian manatee (*Trichechus manatus*) was listed as an endangered species in 1967 [under a law that preceded the Endangered Species Act (ESA) of 1973], and then a federally protected species under the ESA. The manatee is also protected under the Marine Mammal Protection Act of 1972 (USFWS 2007b). Manatees primarily feed on aquatic vegetation, but can be found feeding on fish, consuming between four and nine percent of their body weight in a single day (USFWS 2007b). Sheltered areas such as bays, sounds, coves, and canals are important areas for resting, feeding, and reproductive activities (Humphrey 1992). The West Indian manatee can be found occupying the coastal, estuarine, and some riverine habitats from Virginia to the Florida Keys, the Caribbean Islands, Mexico, Central America, and northern South America (Garcia-Rodriguez et al. 1998; USFWS 2007b). Based on the extensive literature search conducted during this study, effects of terminal groin structures are unlikely to affect the West Indian manatee.

Table III-2. Threatened and endangered species potentially present within the selected study sites

Species Common Names	Scientific Name	Federal Status
MAMMALS		
West Indian manatee	<i>Trichechus manatus</i>	Endangered
North Atlantic right whale	<i>Eubaleana glacialis</i>	Endangered
Humpback whale	<i>Megaptera novaeangliae</i>	Endangered
BIRDS		
Piping plover	<i>Charadrius melodus</i>	Threatened
Roseate tern	<i>Sterna dougallii dougallii</i>	Threatened
REPTILES		
Green sea turtle	<i>Chelonia mydas</i>	Threatened
Hawksbill turtle	<i>Eretmochelys imbricata</i>	Endangered
Kemp's ridley sea turtle	<i>Lepidochelys kempii</i>	Endangered
Leatherback sea turtle	<i>Dermochelys coriacea</i>	Endangered
Loggerhead sea turtle	<i>Caretta caretta</i>	Threatened
FISH		
Shortnose sturgeon	<i>Acipenser brevirostrum</i>	Endangered
Gulf sturgeon	<i>Acipenser oxyrinchus desotoi</i>	Threatened
Smalltooth sawfish	<i>Pristis pectinata</i>	Endangered
VASCULAR PLANT		
Seabeach amaranth	<i>Amaranthus pumilus</i>	Threatened
Status	Definition	
Endangered	A taxon "in danger of extinction throughout all or a significant portion of its range."	
Threatened	A taxon "likely to become endangered within the foreseeable future throughout all or a significant portion of its range."	

(2) Humpback Whale and North Atlantic Right Whale (NARW)

These whale species occur temporally off the coast of North Carolina and Florida. Of all the whale species known to occur in the Atlantic, only the North Atlantic right whale (NARW) (*Eubaleana glacialis*) and the humpback whale (*Megaptera novaeangliae*) routinely come close to inshore waters. Humpback whales were listed as “endangered” throughout their range on 2 June 1970 under the ESA and are considered “depleted” under the Marine Mammal Protection Act. Humpback whales are often found in protected waters over shallow banks and shelf waters for breeding and feeding. They migrate toward the poles in summer and toward the tropics in winter and are in the vicinity of the North Carolina coast during seasonal migrations, especially between



December and April. Since 1991, humpback whales have been seen in nearshore waters of North Carolina with peak abundance in January through March (NMFS 2003).

The frequency with which NARWs occur in offshore waters in the southeastern U.S. remains unclear (NMFS 2003). While it usually winters in the waters between Georgia and Florida, the NARW can, on occasion, be found in the waters off North Carolina (Georgia Department of Natural Resources 1999). NARWs swim very close to the shoreline and are often noted less than a mile offshore (Schmidly 1981). NARWs have been documented along the North Carolina coast, as close as 820 feet from the beach, between December and April with sightings being most common from mid to late March (USACE 2008b). The occurrence of NARWs in North Carolina waters is usually associated with spring or fall migrations. Due to their occurrence in the nearshore waters, offshore vessel movements could result in an encounter with humpback and NARW species. However, with regards to the construction and maintenance of terminal groins, these whale species would not likely be affected. Designated Critical Habitat for the NARW is located in coastal waters of northeastern Florida, yet beyond the effect of marine structures [Coastal Planning and Engineering, Inc. (CPE) 2008].

b) Shorebirds and Waterbirds

Piping Plover

The piping plover is federally listed under the ESA, as amended with three separate breeding populations in North America: 1) the Atlantic Coast population (threatened), 2) the Northern Great Plains population (threatened), and 3) the Great Lakes population (endangered). Piping plovers are also listed as threatened throughout their wintering range (USFWS 1996a). Only the Atlantic Coast population breeds along the east coast of North America, from the Canadian Maritime Provinces to North Carolina whereas all three populations migrate to the coastal shorelines of the South Atlantic, Gulf of Mexico, and the beaches of the Caribbean Islands to winter (USFWS 2006a). Piping plovers are known to utilize all inlet areas on the North Carolina coast for breeding and/or wintering. Coastal North Carolina is at the southern end of the breeding range and the northern end of the wintering range of piping plovers.

Piping plovers depend on the natural barrier island and inlet processes that create and maintain broad flats and intertidal areas, overwash zones, and maintain early successional habitat. USFWS (1996a) identifies inlet shorelines and associated sandflats as a primary habitat for wintering and breeding piping plovers. Factors that affect distribution, abundance, and survival of the federally-threatened piping plover on wintering grounds are poorly understood (Cohen et al. 2008). Wintering plovers on the Atlantic Coast prefer wide beaches in the vicinity of accreting coastal inlets (Nicholls and Baldassarre 1990; Wilkinson and Spinks 1994; USFWS 1996). At inlets, foraging plovers are associated with moist substrate features such as intertidal sandy mudflats, algal flats, and ephemeral pools (Nicholls and Baldassarre 1990; Wilkinson and Spinks 1994). Because tide and weather variation often cause plovers to move among habitat patches, a complex of patches may be important to local wintering populations (Johnson and Baldassarre



1988; Drake et al. 2001). Wintering habitat, like Atlantic Coast breeding habitat, is dependent on natural forces of creation and renewal. Man-made structures along the shoreline or manipulation of natural inlets can upset this dynamic process and result in habitat loss or degradation (USFWS 1996).

As described by Cohen (2008), inlet stabilization with rock jetties and channel dredging for navigation alter the dynamics of sediment transport and affect the location and movement rate of barrier islands (Camfield and Holmes 1995). The maintenance of an inlet channel location acts to stabilize the inlet. Stabilization of inlets is considered a serious threat to piping plovers because it can lead to a net loss of suitable habitat (USFWS 1996).

Roseate Tern

As described by the South Atlantic Fisheries Management Council (SAFMC) (1999), the roseate tern (*Sterna dougallii dougallii*) is distributed worldwide in a variety of coastal habitats. The North American subspecies is divided into two separate breeding populations, one in the northeastern U.S. and Nova Scotia, and one in the southeastern U.S. and Caribbean. Wintering areas are concentrated along the north and northeastern coasts of South America. It is not known if these two populations winter in proximity to each other. The roseate tern was listed as endangered in northeastern North America and threatened in the Caribbean and Florida in 1987 in response to nesting habitat loss, competition from expanding gull populations, and increased predation. Strictly a coastal species, this bird is usually observed foraging in nearshore surf. In the winter, the roseate tern is pelagic in its habits. Open sandy beaches isolated from human activity are optimal nesting habitat for the roseate tern. This species is not discussed further in the document as no population data was available for evaluation.

c) Sea Turtles

Five species of sea turtles are known to occur off North Carolina and Florida beaches: the green sea turtle (*Chelonia mydas*), loggerhead sea turtle (*Caretta caretta*), leatherback sea turtle (*Dermochelys coriacea*), hawksbill sea turtle (*Eretmochelys imbricate*), and Kemp's ridley sea turtle (*Lepidochelys kempii*). Sea turtles prefer to nest on wide sloping beaches or near the base of the dunes (Kikukawa et al. 1999). In order for nesting to be successful, the following conditions must be met: the supratidal beach must be wide enough to allow nesting; access must be unobstructed (i.e. fencing, seawalls); sand compaction must allow for nest excavation; and the nesting area must be high enough in elevation to preclude tidal inundation throughout the nesting season. Sand composition, color, and grain size can affect the incubation time, gender, and hatching success of turtle hatchlings (Street et al. 2005; Personal communication, H. Hall, USFWS, November 2009).

The potential for future armoring encompasses the primary nesting beaches for sea turtles along the east coast of North Carolina, as well as the southeast and southwest coasts of



Florida (Schroeder and Mosier 2000; Mosier 1998). The use of hard structures both parallel and perpendicular to the shoreline can lead to habitat loss for nesting sea turtles and according to USFWS (2008), the data on effects of groins on sea turtle mortality are insufficient to make a threat determination. Hard structures can both directly and indirectly affect sea turtles. Direct affects include: (1) prevention of access to suitable nesting sites, (2) abandonment of nesting attempts due to interaction with the structure, and (3) interference with proper nest cavity construction and nest covering. Furthermore, shore parallel hard structures such as T-head and other composite groins can (4) impede and/or trap nesting females and hatchlings, (5) concentrate predators, and (6) alter current regimes and longshore sediment transport. Indirect effects include: (1) the permanent loss of nesting habitat or escarpment formation as a result of beach profile and width alteration; (2) increase in clutch mortality as a result of frequent inundation and/or exacerbated erosion, and (3) increase in hatchling and adult female energy expenditure in attempts to overcome structures.

Depending on the design, hard structures can physically block a nesting female from accessing a more suitable higher nesting elevation. In a study conducted by Mosier (2000) of three nesting beaches on the east coast of Florida, 86 percent of nesting females that encountered a hard structure during emergence returned to the water without nesting as a result of the inability to access higher elevation nesting habitat. Nests that are laid in low elevation environments are vulnerable to wash out, and nest incubation may be altered resulting in loss of nest or decreased nest success.

According to Lucas et al. (2004) in a study designed to assess sea turtle response to beach attributes (i.e. hard structures), turtles emerged onto portions of the beach where anthropogenic structures threatened to block access to optimal nesting habitat; however, upon encountering the structures, turtles abandoned the nesting sequence. This study indicated that only the most seaward structures affected sea turtle nesting. Depending on the design of shore perpendicular structures such as straight and composite groins (i.e. T-head), the structure may act as an impediment or a trap (Foote et al. 2003) to nesting females and/or hatchlings (Davis et al. 2002). Stem features of the groin may be exposed above the beach surface or may be buried by accreting sand. This results in potential impediments to the nesting process either during nest site selection or during nest digging, thus resulting in potential false crawls or false digs and subsequent increase in energy expenditure.

In most cases, groins are used as design components in combination with beach fill, in “critical erosion” or hot spot areas. Therefore, pre-project nesting conditions are generally degraded with limited sea turtle crawl activity. According to Davis et al. (2002), depending on the quantity of added beach fill, the rate of sediment accumulation, and the groin crest elevations; hatchlings may potentially be trapped by the groin both in the water and/or on the beach. The resultant increased energy expenditure to traverse around a structure depletes the critical “frenzy” energy reserves of hatchlings necessary to reach the safety of offshore developmental areas. Furthermore, predator concentration, including bird and fish species, may occur within the vicinity of high relief hard



structures. As hatchlings become trapped by a structure during egress offshore, the period of time that they are most vulnerable to predation increases, resulting in increased losses (Davis et al. 2002).

d) Fish

Atlantic Sturgeon

The Atlantic sturgeon (*Acipenser oxyrinchus*), nominated for listing as endangered, is a demersal, anadromous species. This species migrate from the marine environment to freshwater to spawn during late winter-early summer. Juveniles remain in the freshwater-estuary system for three to five years before migrating to the near-shore marine environment as adults. Tagging studies indicate that Atlantic sturgeon migrate extensively in the marine environment.

Management of this species is conducted under the Atlantic States Marine Fisheries Commission. An Interstate Fishery Management Plan was implemented in 1990 which implemented strict state regulations on sturgeon fisheries. Should the status of the Atlantic sturgeon change, it would be potentially impacted, since the species occurs in nearshore ocean waters.

Shortnose Sturgeon

The shortnose sturgeon (*Acipenser brevirostrum*) was listed as endangered on 11 March 1967 and has remained on the endangered species list since enactment of the ESA in 1973. Historically, shortnose sturgeon inhabited most major rivers on the Atlantic coast of North America south of the Saint John River in Canada.

Shortnose sturgeons are found in rivers, estuaries, and the sea along the east coast of North America, but populations are confined mostly to natal rivers and estuaries (Vladykov and Greeley 1963). Their southerly distribution historically extended to the Indian River, Florida (Evermann and Bean 1898). The species appears to be estuarine anadromous in the southern part of its range, but in some northern rivers it is "freshwater amphidromous", i.e., adults spawn in freshwater but regularly enter saltwater habitats during their life (Kieffer and Kynard 1993). Adults in southern rivers forage at the interface of fresh tidal water and saline estuaries and enter the upper reaches of rivers to spawn in early spring (Savannah River: Hall et al. 1991; Altamaha River: Heidt and Gilbert 1979; Flouronoy et al. 1992; Rogers and Weber 1995; Ogeechee River: Weber 1996). Shortnose sturgeon appear to spend most of their life in their natal river systems, only occasionally entering the marine environment; therefore, effects to this species from terminal groin construction and maintenance is not likely.



Gulf Sturgeon

The gulf sturgeon (*Acipenser oxyrinchus desotoi*) is a federal and state listed threatened species [Florida Fish and Wildlife Conservation Commission (FFWCC) 2004]. Gulf sturgeons are anadromous fish inhabiting coastal rivers from Louisiana to Florida, where critical habitat has been designated by USFWS for this species. Typically, adult fish move to spawning grounds in the rivers from February through April, and then move out of the rivers into the Gulf of Mexico and its estuaries and bays between September and November, where they feed and spend the winter (NMFS 2009). The effects from a terminal groin on this species are not likely.

Smalltooth Sawfish

When the U.S. Distinct Population Segment (DPS) of smalltooth sawfish (*Pristis pectinata*) was listed as endangered under the ESA on 1 April 2003, it became the first elasmobranch on the Endangered Species List. Smalltooth sawfish were once widespread throughout Florida and were commonly encountered from Texas to North Carolina. Currently, smalltooth sawfish can only be found with any regularity in south Florida between the Caloosahatchee River and the Florida Keys.

The smalltooth sawfish is a tropical marine and estuarine elasmobranch with a circumtropical distribution. Shallow estuarine (and sometimes freshwater) areas appear to be especially important for juvenile sawfish; however, recent data from sawfish encounter reports and satellite tagging indicate that mature animals regularly occur in waters in excess of 165 feet (ft) (Simpfendorfer 2002). The preferred substrate types range from mud, sand, seagrass, limestone, rock, coral reef, to sponge. This species also has strong associations with mangroves, seagrass, and inshore bars or banks of rivers (Carlson et al. 2007).

As described by CPE (2008), the smalltooth sawfish has been mostly extirpated in more northern counties of south Florida; and so it is not likely to be found within the sites evaluated in this study.

e) Vascular Plants

(1) Seabeach Amaranth

Barrier islands are dynamic environments, with topographic and vegetation profiles dictated by the interaction of plant growth habits and physical processes such as wind-driven sand, salt spray, and wave-driven erosion and accretion (Myers and Ewel 1990). High temperatures, strong winds, and varying wet and dry conditions typical of a dune environment along a barrier island system provide unique conditions for plant species with specific adaptations. Sand dunes and vegetation that comprise the dune system are important to the coastline since they provide storm surge protection, recreation, and wildlife habitat.



Seabeach amaranth (*Amaranthus pumilus*) was listed as threatened on 7 April 1993 under the ESA of 1973. Before its listing, seabeach amaranth had experienced a reduction in range, population size, and population numbers. Seabeach amaranth is an annual plant that grows on the dunes of Atlantic Ocean beaches. Historically, this species was found from Massachusetts to South Carolina. According to USACE surveys between 1992 and 2004 (unpublished data), its distribution is now limited to North and South Carolina with some populations on Long Island, New York (USACE 2006).

The primary habitat of seabeach amaranth consists of overwash flats at accreting ends of islands and lower foredunes and upper strands of non-eroding barrier island beaches. Seabeach amaranth may form small temporary populations in other habitats, including sound-side beaches, blowouts in foredunes, and sand and shell material placed as beach nourishment or dredged material (USFWS 1993; USFWS 2007a). Seabeach amaranth appears to function in a relatively natural and dynamic manner, allowing it to occupy suitable habitat as it becomes available (USFWS 1993).

4. Water Quality Effects

The construction of a terminal groin potentially produces temporary localized effects to ambient water quality during and proximal to the structural construction and fill areas [Dial Cordy and Associates (DC&A) 2003]. Turbidity is a major impact of groin construction (USACE 1976a). As confirmed by the Captiva Erosion Prevention District (CEPD 2002), short-term environmental effects, primarily elevated turbidity levels in the water column also occur as a result of beach nourishment. Should turbidity levels become problematic, best management practices to be considered could include the washing of stone prior to placement or the use of turbidity curtains. Water quality effects anticipated during and immediately following construction of a terminal groin may also have short-term effects to EFH. As described by Dolan (1999), the majority of larval fish migrates along the coast within the inshore longshore transport system and therefore could be negatively affected if turbidity levels increase significantly.

Resuspension of toxic materials can also occur, as can some noise, air, and water pollution. Compared to jetties and breakwaters, these physical effects should be less because groins are relatively small structures (Mulvihill et al. 1980).

A frequently cited environmental concern related to beach nourishment operations involves short- and long-term effects of suspended sediments, either during the actual filling process or over an indefinite period as the new beach profile responds to prevailing physical forces (USACE 2001). During the filling process, concerns are generally associated with the presence of very high concentrations of suspended sediments and plumes of turbid water in the vicinity of the sediment discharge. Several factors can contribute to the magnitude of re-suspension and spatial extent of plumes, including prevalent meteorological and sea state conditions, granulometry of the fill sediments (e.g., % silts or clays), and mode of placement (e.g., hydraulic pipeline or vessel pump-out).



5. Anthropogenic Effects (Recreation/Aesthetics/Public Access)

Short-term effects to recreational shoreline uses include limiting and/or blocking access to the beach front during the construction of a terminal groin, initial restoration of the beach (berm and dune), and each periodic renourishment. CEPD (2002) concluded that armor and seawalls could provide a significant degree of protection to upland structures, but would result in a reduction of recreational beaches. However, generally speaking, terminal groin locations become popular recreational fishing areas (Personal communication, M. Sramek, NOAA NMFS, February 2010).

A terminal groin is typically a permanent hard structure that can have long-term permanent effects on recreational fishermen by requiring recreational boats or beach vehicles to slow down or alter courses. However, according to USACE (2008a), prior to the initiation of construction, it is “Standard Operating Procedure” for the USACE to coordinate with the US Coast Guard to ensure that new permanent structures, such as terminal groins, are placed on appropriate maps and are equipped with appropriate navigation aids, if needed. As seen at Oregon Inlet, the construction of a terminal groin has offered alternative locations for recreational fishing, thereby offsetting potential negative effects associated with navigation. According to the USACE (2008a), fishing from a terminal groin is highly discouraged and not-supported by the USACE because fishing from and walking on stone groins is known to be unsafe, potentially resulting in bodily injury. However, periodic renourishment may ensure the long-term existence of the sandy beach, berm, and dune; thus preserving future recreational uses such as sunbathing, walking, birding, and surf-fishing. The presence of a terminal groin in concert with a shoreline protection plan may provide long-term infrastructure protection, shoreline benefits, and beach access to public recreational facilities.

The construction of a terminal groin structure may have potential direct and long-term effects on aesthetic and scenic resources by visually effecting view sheds of the surrounding coastal and marine region (USACE 2008b). Visual effects can be from shoreward- and waterward-facing perspectives. The terminal groin may have an adverse effect of trapping floating debris and trash, creating an unwanted view and potentially effecting marine species from debris ingestion and entanglement. Additionally, the construction of a terminal groin has the potential to affect buried cultural resources. In more recent construction locations, remote sensing efforts for cultural resources were performed and the results aid in the design and placement of the terminal groin footprint.



6. Summary of General Environmental Effects

In summary and based on an extensive review of scientific literature and regulatory documentation, potential effects of terminal groins in conjunction with shoreline management (i.e. beach nourishment) on natural resources vary according to the type of construction equipment used, the nature and location of sediment discharged, the time period of construction and maintenance in relation to life cycles of organisms that could potentially be affected, and the nature of the interaction of a particular species. In terms of benthic infauna, where there is a high correspondence between the fill site and ambient beach sediments (e.g. Nelson 1993; Van Dolah et al. 1994; Hackney et al. 1996; Jutte et al. 1999; Burlas et al. 2001), infaunal recolonization is more rapid and potential limitations to benthic food availability are reduced. In the event of a beach nourishment maintenance program downdrift of a terminal groin, beach invertebrates would more often be depressed in abundance due to temporary burial and the shorebirds and fishes that feed upon them would be deprived of food for longer periods of time. However, this would be short-term effect and recovery should occur rapidly. As described by Wilber (2003), beach nourishment may affect surf zone finfish through reductions in benthic prey and shelter availability, and the disruption of fish distribution patterns. In terms of larval transport, a terminal groin may reduce unrestricted access into inlet systems.

The construction of a terminal groin, beach nourishment, and dune construction prevents overwash and contributes to a loss of habitat for breeding and non-breeding waterbirds, including piping plovers. According to the Atlantic Coast Piping Plover Recovery Plan (USFWS 1996), nourishment of eroding beaches impedes overwash that would otherwise create and maintain ephemeral pools and bayside mudflats; preferred piping plover habitat. Tidal flats and ponds are important feeding areas to piping plovers at the start of the nesting season and at other times of the year (Fraser 2005). These areas are created during storm-caused overwash and other erosional processes (Leatherman 1982), and beach stabilization efforts reduce the number and extent of these overwash events (Dean 1999). Beach stabilization, dune construction and disruption of natural processes (erosion, accretion, overwash, longshore transport, etc.) are listed as major contributing factors to the loss of suitable breeding and non-breeding habitat for colonial waterbirds (Hunter et al. 2006).

Overwash is also important in maintaining barrier islands. Where large man-made dunes and/or hardened structures prevent overwash, beach sediment in front of the dunes can be transported offshore during storms causing the island to narrow, while if overwash is allowed to occur, the net volume of sand is often maintained and the island migrates landward (Donnelly et al. 2006). Furthermore, the prevention of island overwash can lead to sediment starvation on the sound side. Cohen (2008) described inlet stabilization with rock jetties and channel dredging for navigation as alterations in the dynamics of sediment transport and affects the location and movement rate of barrier islands (Camfield and Holmes 1995), which might in turn affect the availability of shorebird habitat.



As it relates to sea turtles, terminal groins are typically used in combination with a long-term shoreline protection program in which beach fill is used in “critical erosion” or hot spot areas. Therefore, pre-project nesting conditions are generally degraded with limited sea turtle activity necessitating the need for modification of the shoreline. According to Davis et al. (2002), depending on the quantity of added beach fill, the rate of sediment accumulation, and the groin crest elevations; hatchlings may potentially be trapped by the terminal groin both in the water and/or on the beach. Furthermore, predator concentration, including bird and fish species, may occur within the vicinity of high relief hard structures.

The primary habitat for seabeach amaranth consists of overwash flats at accreting ends of islands and lower foredunes and upper strands of non-eroding barrier island beaches. Seabeach amaranth may form small temporary populations in other habitats, including sound-side beaches, blowouts in foredunes, and sand and shell material placed as beach nourishment or dredged material (USFWS 1993; USFWS 2007a). Seabeach amaranth appears to function in a relatively natural and dynamic manner, allowing it to occupy suitable habitat as it becomes available (USFWS 1993). From a water quality perspective, a frequently cited environmental concern involves short- and long-term effects of suspended sediments, either during the actual filling process or over an indefinite period as the new beach profile responds to prevailing physical forces (USACE 2001). During the filling process, concerns are generally associated with the presence of very high concentrations of suspended sediments and plumes of turbid water in the vicinity of the sediment discharge. From a social perspective, the terminal groin may have an adverse effect of trapping floating debris and trash, creating an unwanted view and potentially effecting marine species from debris ingestion and entanglement. Yet, the presence of a terminal groin in concert with a shoreline protection plan may provide long-term infrastructure protection, shoreline benefits, and beach access to public recreational facilities (USACE 2008a, b).



B. Environmental Assessment of the Five Study Sites

The potential environmental effects from the construction and maintenance of the selected terminal groins on the marine benthic community, shorebird use, fisheries, coastal habitat and associated biota, and protected species (marine reptiles, marine mammals, shorebirds) are provided below.

1. Oregon Inlet

a) General Site Description

Oregon Inlet was created by a hurricane on 8 September 1846. The inlet separates Bodie Island to the north and Pea Island/Hatteras Island to the south (Figure III-1). For the purpose of this report, Pea Island/Hatteras Island will be referred to as the Pea Island National Wildlife Refuge (PINWR). As with most natural tidal inlets, Oregon Inlet has had a history of dynamic change and migration since its opening, having migrated more than two miles south of its original location.

Because of the constantly shifting features of Oregon Inlet (Figure III-2), the existing Herbert C. Bonner Bridge has been a maintenance issue for the North Carolina Department of Transportation (NCDOT) since it was constructed in 1962.

To ensure the Highway 12 transportation corridor was not lost, the USACE utilized engineering and design analysis of navigation jetties for Oregon Inlet in conjunction with the Manteo Shallowbag Bay project (NCDOT 1989) to design a terminal groin for the northern end of PINWR. The freestanding nature of the terminal groin in a position mimicking the 1985 shoreline relied on the natural coastal processes to deposit sediment along its landward (southern) side.



Figure III-1. Oregon Inlet Terminal Groin and Revetment

Several environmental documents have been prepared in conjunction with the construction and maintenance of the Oregon Inlet terminal groin. Through finalization of these documents, including those of USFWS, a determination was made that the terminal groin and beach nourishment would not significantly affect any part of the natural environment and that sand management would have a positive effect on the natural environment. Accordingly, it was determined that the preparation of an Environmental Impact Statement for the construction of a terminal groin would not be required (USFWS 1989). Additional supporting documents developed included:

An Environmental Assessment (EA) that summarizes two (2) alternatives and subsequent environmental effects for these actions (June 1989); EA developed by the NCDOT (1 May 1989); and USFWS's Biological Opinions (26 May 1989 and 19 June 1989).

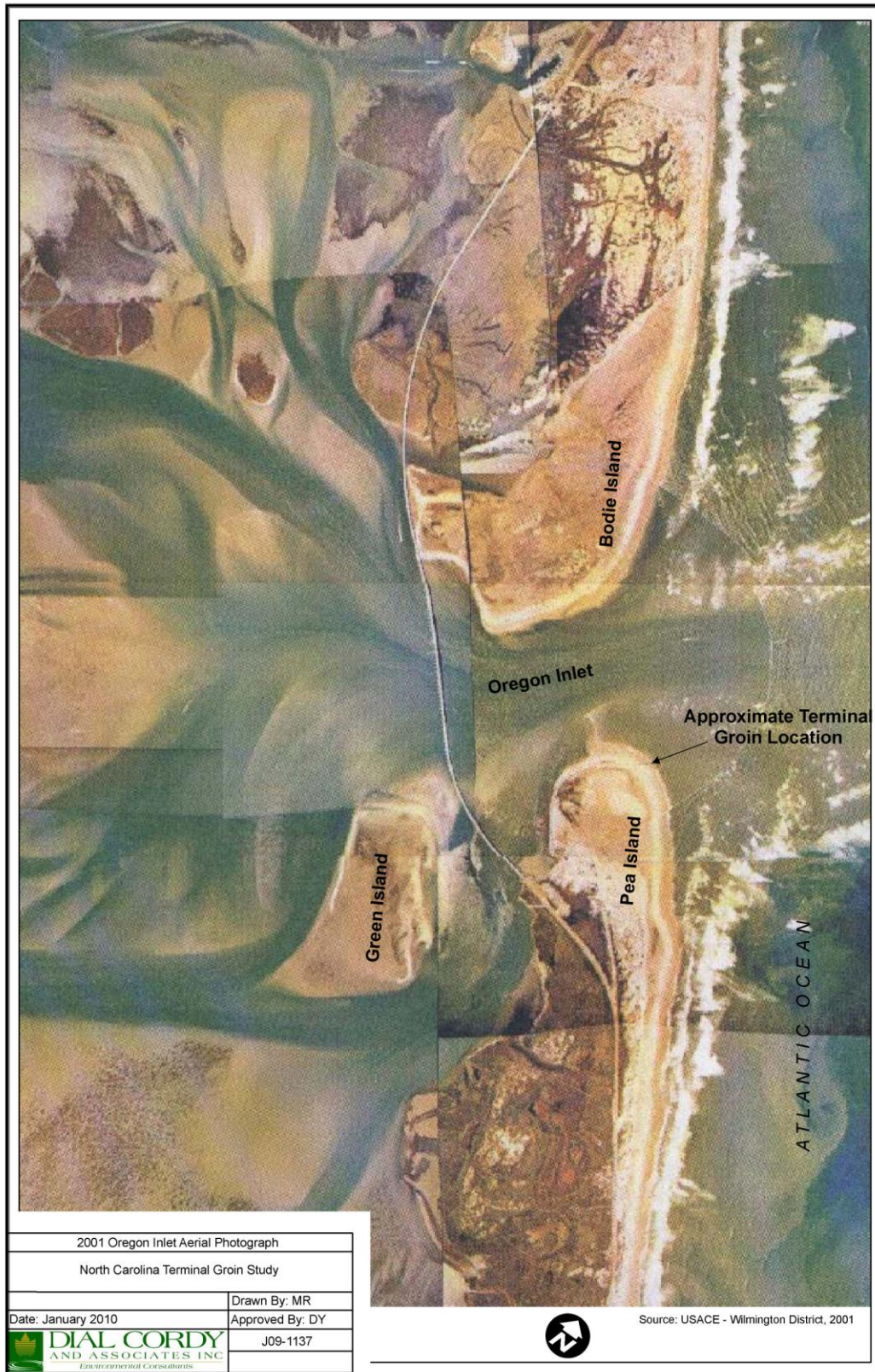


Figure III-2. 2001 Oregon Inlet Aerial Photograph



(1) Aesthetics

In general, the northern end of Hatteras Island and southern end of Bodie Island have a low vertical profile with slightly rolling terrain and scattered vegetation (Figure III-2). As described by the NCDOT (2008), sandy beaches are along the oceanfront and inlet side of the islands. Salt marsh and mudflats are on the sound side of the island. Other than the marsh on the sound side of the island and the general undeveloped character of the island, there are no unique physical features related to landform or vegetation. Man-made vertical elements are present on both the Hatteras Island and Bodie Island sides of Oregon Inlet.

On the Hatteras Island side of Oregon Inlet, a public-use parking lot is on the east side of NC 12 with the terminal groin and the top of the (former) US Coast Guard Station being visible. On Bodie Island, there is a campground on the east side of NC 12. The US Coast Guard Station, a large radio tower, and Oregon Inlet Marina are on the west side of NC 12. The Bonner Bridge structure is a prominent visual feature on both sides of Oregon Inlet. The man-made feature contrasts with the natural characteristics of the island. Salt marsh and mudflats are on the soundside of the islands with emergent wetland vegetation such as needlerush (*Juncus roemerianus*) and smooth cordgrass (*Spartina alterniflora*). The terrain generally is flat with some dunes bordering the beach area. Low shrubs and grasses are more prevalent further inland (NCDOT 2008).

(2) Recreation

The undeveloped and protected character of the area provides a setting for many recreational activities. NCDOT (2008) discussed two publicly owned recreation areas within the project area: the Cape Hatteras National Seashore (CAHA) and the PINWR. Hatteras Island as a whole is used for a variety of recreational activities. Activities within the project area include: surf and inlet fishing, surfing, wind and kite boarding, birding, hiking, and cycling along NC 12.

The heaviest recreational fishing effort in the vicinity of the PINWR is in the surrounding sound system from October through April (USFWS 2008). Fishing pressure on the PINWR is relatively low and is a reflection of the isolation of the area and limited access, rather than low catch quotas. During 2007, there were an estimated 2,000 fishing visits to the PINWR (NCDOT 2008).

(3) Public Access

The General Management Plan and Amended EA for CAHA [National Park Service (NPS) 1984] and the Draft Revised Statement for Management (NPS 1991) serve as the NPS plans for the CAHA. These management documents provide for the preservation of cultural resources and the flora, fauna, and natural physiographic conditions, while allowing appropriate recreational use and public access to the oceanside and soundside shores. Included in these plans are provisions for controlling off-road vehicles, accessible oceanside and soundside sites, allowing natural seashore dynamics to occur, controlling exotic vegetation, preparing natural and cultural resource studies, and cooperating with state and local governments to achieve mutual planning objectives.



PINWR officials intend to maintain some type of public access within the PINWR, including access to the (former) US Coast Guard Station.

b) Natural Resources

Habitats on the Outer Banks are highly ephemeral in nature because of the high level of natural disturbance present in barrier island ecosystems. Plants and wildlife such as seabeach amaranth and piping plovers have evolved to specialize in these habitats. The USFWS is responsible for the natural resources management within the PINWR (Personal communication, D. Stewart, USFWS, November 2009). As a first priority, federal law and regulation require the PINWR manager to ensure that all uses of the PINWR are compatible with Executive Order 7864 and the National Wildlife PINWR System Improvement Act of 1997, and that any allowed use of the PINWR be compatible with the mission (“wildlife first”) and purpose of the PINWR. The primary purpose of the PINWR is to be a breeding ground for migratory birds and other wildlife. The PINWR is a Section 4(f) resource (NCDOT 2008). In addition, it is a significant publicly owned recreation area and also a significant historic site eligible for inclusion in the National Register of Historical Places (NRHP). The PINWR provides habitat for a wide variety of wildlife (NCDOT 2008) as depicted by the extensive marine and estuarine habitats within the vicinity of the Pea Island terminal groin (Figure III-3).

The Cape Hatteras National Seashore, administered by the National Park Service (NPS), which includes and is adjacent to Oregon Inlet contain nationally significant natural and cultural resources and values. These resources play a vital role in the state’s ecosystem and local economies. CAHA, along with the PINWR, is home to many of the federally protected species that depend upon inlet shoreline habitat. The inlet shorelines along CAHA are among the few remaining areas where natural barrier island processes occur relatively unimpeded within the Seashore. As a result, the inlets within the Seashore have become even more important as protected wildlife habitat.

Allowing natural barrier island change, which has been prevented on PINWR by the presence of NC 12 and human dune building for many decades, would allow the formation of ephemeral habitats that are essential to maintaining the natural ecological character of a barrier island. Overwash fans, new inlets, and low sloping beaches may be formed that serve as habitat for resting, feeding, and nesting of avian species (NCDOT 2008). As described by USFWS (2008); Oregon Inlet dredging, Bonner Bridge, and NC Highway 12 maintenance and protection have influenced the loss of acreage by subduing and altering natural processes such as overwash. The Pea Island terminal groin and impact area consist of approximately 55 acres as evaluated in 2007, thus restoring and stabilizing the tip of Pea Island (USFWS 2008; Personal communication B. Dennis, USACE, November 2009).



Figure III-3. Coastal Classification of Habitat for Oregon Inlet, NC



Although the USACE confirmed positive impacts on shoreline change in the vicinity of the terminal groin, Dolan (2001b) confirmed that changes in the configuration of the beaches and the distribution of sediment grains sizes and mineral content would have an important impact with respect to swash zone fauna, bird and turtle nesting success, and ghost crab distribution. Although the sand from the Oregon Inlet dredging is considered to be of "beach quality," it was more often than not significantly different in size and heavy mineral content from the lower beach-face or swash zone of the native beaches. These differences lead to significant alterations of the beach configuration and therefore had indirect effects to the habitat of the organisms that live in these areas (Dolan 2001b). As discussed in the Physical Assessment Section, sand is sequestered at the northern end of Pea Island from storm overwash into the fillet region and beach sand blown into the back dune area adding to the area's sand reservoir. These accumulating sand events result in habitat changes that support certain bird species yet deter others that require overwash inlet areas.

(1) Seabeach Amaranth

Habitat for the federally threatened seabeach amaranth does occur in the vicinity of the terminal groin at Oregon Inlet; however, a search of the NCNHP database and the USACE's recent survey results disclosed no current or historical records of the species for the PINWR area (Personal communication, H. LeGrand, NCNHP, October 2009; Personal communication, D. Piatkowski, USACE, November 2009). This species was not documented on Bodie Island spit prior to 2004, despite surveys since 1985 (NCDOT 2008). According to NCDOT (2008), the NPS located a single seabeach amaranth on the Bodie Island flats in 2004 and two plants in 2005. No plants have been found since 2006 and the plant is currently thought to possibly be extirpated from CAHA (NPS 2009a).

As discussed by NPS (2009a), the life history of seabeach amaranth as a pioneer species accounts for the variability in plant numbers and locations of populations through time. Distribution by wind and water of seed sources into appropriate habitats is somewhat random by nature. The plants intolerance for competition by other plants limits it to areas marginally conducive to plant growth. Additionally, overwash is known to affect the plants' ability to grow. The dynamic nature of coastal islands creates and eliminates potential habitat quickly.

(2) Sea Turtles

As shown in Figure III-4, the NOAA ESI database includes habitat for the green sea turtle and loggerhead sea turtle for the Oregon Inlet area. Sea turtle nesting data from the PINWR within five miles south of Oregon Inlet dates back to 1990 (Figure III-5).



Figure III-4. Species Occurrence for Oregon Inlet, NC

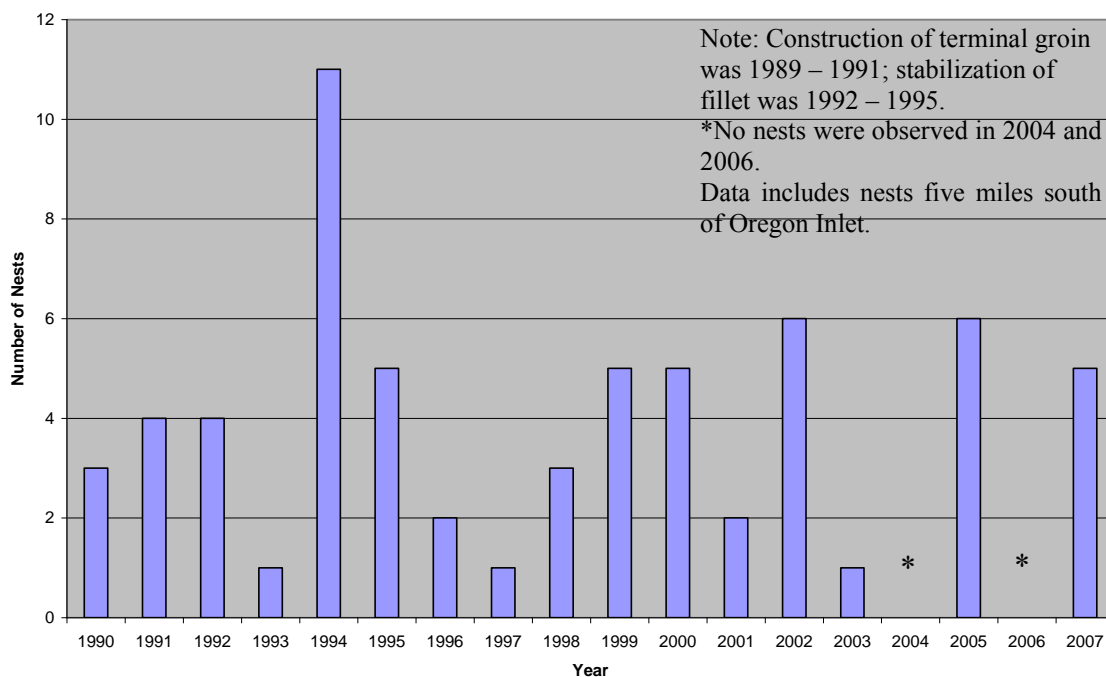


Figure III-5. Loggerhead Sea Turtle Nesting Data from PINWR

The PINWR has an average of 10 to 12 nests per year although on average, 3.4 loggerhead nests have been recorded within five miles south of Oregon Inlet annually over the course of the last 19 years. The number of loggerhead nests recorded from 1990 through 1993 ranged from one to four. The highest annual total was recorded in 1994, when a total of 11 nests were confirmed. Over the next three years, the number of nests steadily declined, reaching a low of one nest in 1997. The number of nests increased to three in 1998, and five nests were recorded each year in 1999 and 2000. Since 2000, the number of annual nests has ranged from zero to six, with an annual average of 2.5 nests. No nests were recorded in three out of the last five years (2004, 2006, and 2008).

Sea turtle nesting habitat on PINWR is subject to the effects of frequent tropical storms and regular beach renourishment projects. Since 1991, PINWR has experienced tropical storms and/or hurricanes each year with the exception of 1994, 2001, 2003, and 2005. Since 1990, beach renourishment projects have placed sand on PINWR beaches each year with the exception of 1994, 2006, and 2007. Due to the consistently low annual nesting densities and the high frequencies of both storm and renourishment events, no relationships between nesting densities and storm or renourishment events are readily apparent.

Sea turtle nesting densities on the south side of Oregon Inlet have been significantly higher than densities on the north side of the inlet. Between 1990 and 2000, a total of 43 nests were recorded within the area five miles south of the inlet. In contrast, a total of 12 nests were recorded during this period within the area five miles north of the inlet. The NCWRC tracks sea turtle nesting within sea turtle management zones, which consist of one mile increments measured along the North Carolina coastline (Table III-3 and Table



III-4). Oregon Inlet lies between Management Zone 57 to the north and Management Zone 58 to the south.

On Pea Island, sea turtle nesting within one mile of the inlet (Zone 58) has been relatively low, with a total of 4 nests recorded between 1990 and 2000. During the same period, nesting densities further south were substantially higher and evenly distributed, with a range of 7 to 12 nests in the next 4 management zones (Zones 59 – 62). In comparison, nesting densities on Bodie Island ranged from 1 to 4 within the five management zones immediately north of the inlet (Zones 53 - 57) (USACE 2001).

The first green sea turtle known to nest on PINWR was in 1993 (USFWS 2008). One of the nests on the PINWR during the 2007 nesting season was identified as a green sea turtle nest.

Table III-3. Sea turtle management zones south of Oregon Inlet

Year	Sea Turtle Management Zones				
	58	59	60	61	62
1990	0	0	1	0	1
1991	0	3	0	0	1
1992	1	1	0	0	2
1993	0	0	0	1	0
1994	0	5	2	1	3
1995	2	0	1	2	0
1996	0	1	0	1	0
1997	1	0	0	0	0
1998	0	0	3	0	0
1999	0	1	2	0	2
2000	0	1	0	2	2
Total	4	12	9	7	11

Table III-4. Sea turtle management zones north of Oregon Inlet

Year	Sea Turtle Management Zones				
	53	54	55	56	57
1990	0	0	1	0	1
1991	1	0	0	0	0
1992	1	0	1	0	0
1993	0	0	0	0	0
1994	0	0	0	1	0
1995	0	1	2	0	0
1996	0	0	0	0	0
1997	0	0	0	0	0
1998	1	1	0	0	0
1999	0	1	NA	NA	NA
2000	NA	NA	NA	NA	NA
Total	2	1	4	1	1



As described by USFWS (2008), Pea Island has a severe beach erosion problem, resulting in a narrow beach and frequent overwash. Based on a study conducted by Riggs and Ames (2009), an eroding and receding beach backed by a constructed barrier dune-ridge that is fixed in space and time results in a steep beach that gets steeper with time until the dune-ridge is scaped and then breached by storms. Steep beaches are too high energy for turtle and shore bird nesting sites. Beach nourishment projects temporarily stop the recession, but do not stop the erosion and quickly return to the same unstable, steep beach profile removing that habitat as favorable nesting sites (Riggs and Ames 2009). In 1994, PINWR personnel determined that the best management strategy to optimize survival of turtle hatchlings was to move nests to a turtle safe- zone. Subsequent to that decision, guidelines specific to coastal processes and conditions at the PINWR were developed to facilitate the appropriate relocation of turtle nests. Likely nesting turtles avoid inlet areas with or without terminal groins. Without pre-groin turtle nesting data, conclusions on the terminal groin's effects on nesting turtles is limited (Personal communication, D. Stewart, USFWS, February 2010).

(3) *Seagrass*

Extensive seagrass (also known as submerged aquatic vegetation or SAV) beds occur near Oregon Inlet and throughout shallow portions of Pamlico Sound (Figure III-6) (Personal Communication, D. Field, NOAA, February 2010). These seagrass beds form a complex and important ecosystem. Submerged beds of eelgrass (*Zostera marina*), shoalgrass (*Halodule wrightii*), and widgeon grass (*Ruppia maritima*) exist together and separately. Seagrasses can occur in isolated patches and as extensive beds. The importance of seagrass systems to estuarine ecology has been widely recognized (Thayer et al. 1975, 1979, 1981; Zieman 1975; Thayer and Phillips 1977; Fonseca et al. 1979; McRoy and Helfferich 1980; Ferguson et al. 1981; Zimmerman and Minello 1984; Weinstein 1985).

Numerous studies have documented seagrass habitats as important nursery areas for many fish species (Adams 1976; Thayer et al. 1979; Weinstein and Heck 1979; Miller and Dunn 1980; Stoner 1980; Homziak et al. 1982; Epperly and Ross 1986; Kenworthy et al. 1988; McMichael and Peters 1989; Noble and Monroe 1990). The North Carolina Division of Marine Fisheries (NCDMF) data was generated from boat surveys conducted between 1995 and 2001. The dynamic nature of the area around Oregon Inlet results in ephemeral habitats, particularly in shallow water and shoreline areas. A survey conducted by NCDOT in the fall of 2007 found that only 25 percent of the SAV habitat contained SAV. SAV can be affected by a variety of factors including light availability, water temperature, sediment composition, wave energy, tidal range, and a variety of other factors. These factors may influence the location and the amount of SAV from year to year. See Figure III-6 for Seagrass Habitat locations.

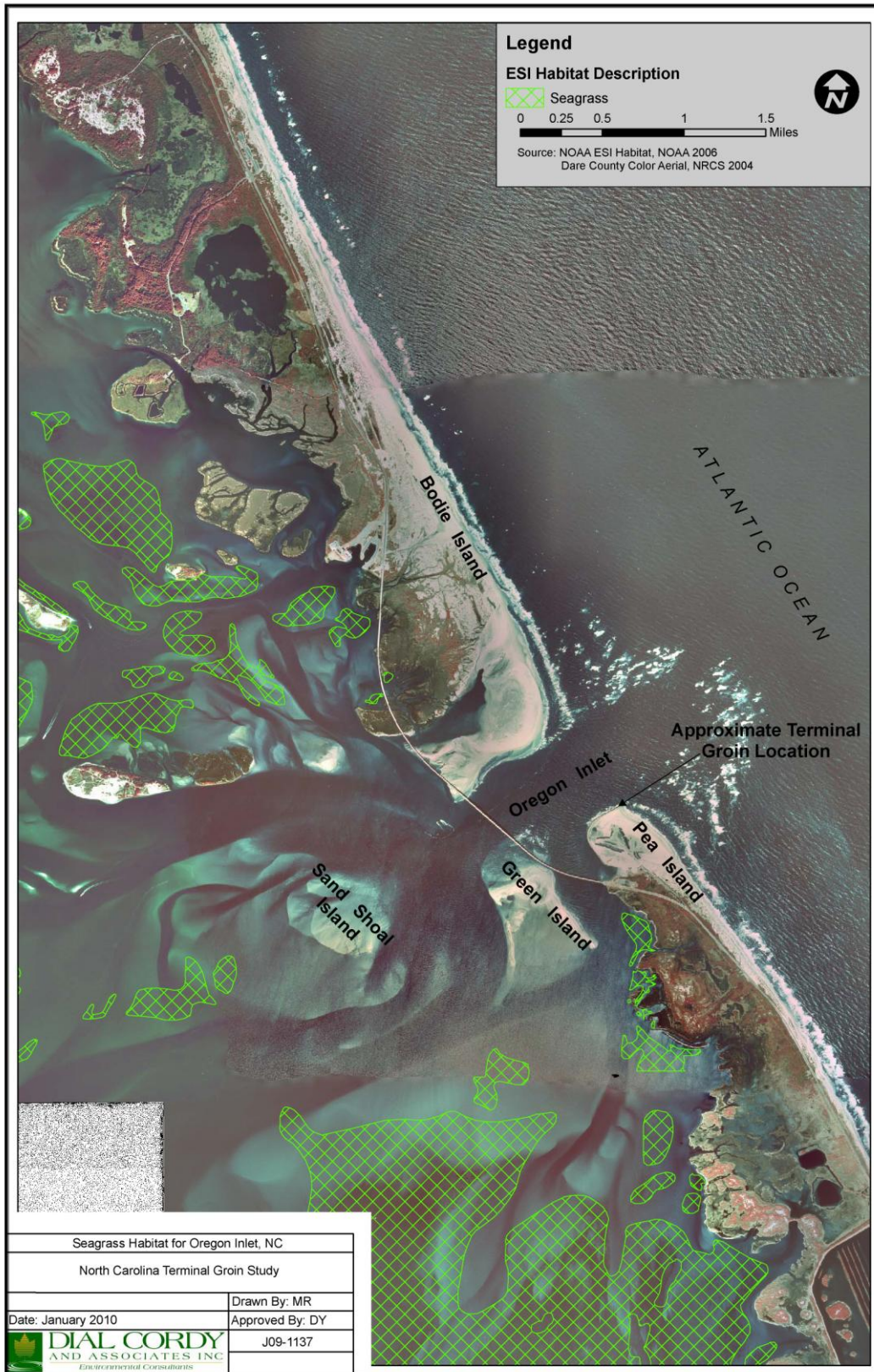


Figure III-6. Seagrass Habitat for Oregon Inlet, NC

(4) Shorebirds and Waterbirds

Shorebird species have been monitored within the Oregon Inlet system for many decades (Dinsmore et al. 1998; Personal communication, D. Stewart, USFWS, November 2009). For purposes of this study, non-breeding shorebird observational data, provided by USFWS in the form of annual narrative reports, recorded during 1950, 1960, and 1970 were compared with data collected during 2006 and 2007 (Table III-8) (USFWS 2007d, 2008). Selected species that were evaluated include American oystercatcher, black skimmer, common tern (*Sterna hirundo*), least tern (*Sterna antillarum*), gull-billed tern (*Sterna nilotica*), Caspian tern (*Hydroprogne caspia*), and red knot (*Calidris canutus*). It should be noted that the units of measurement that were used to estimate shorebird utilization changed between 1960 and 1970.

In 1950 and 1960, the total number of individuals within the PINWR boundaries was estimated (USFWS 1951, 1961). In 1970, 2006, and 2007, the estimated species days use (average population X number of days present) of the PINWR was recorded (USFWS 1971, 2007d, 2008). As shown in Figure III-7 estimates for 1950 include 500 black skimmers, 400 common terns, 1,000 least terns, and 150 red knots.

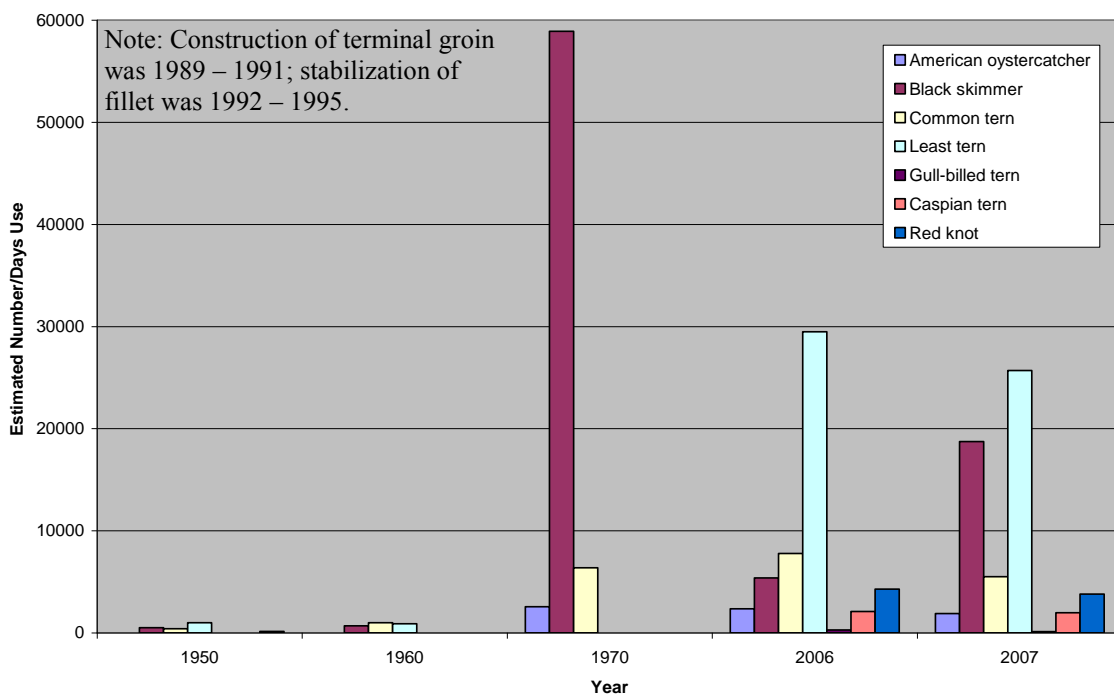


Figure III-7. Shorebird Survey Data in the Vicinity of Oregon Inlet

Estimates for 1960 included 700 black skimmers, 1,000 common terns, and 900 least terns. Based on observations in 1970, the number of days use for black skimmers was estimated at 58,900 days. American oystercatchers (2,560 days use) and common terns (6,370 days use) were the only other species recorded during 1970. The 1970 total for all three species was 67,830 days use. During 2006 and 2007, all of the selected species were observed within the PINWR. Least terns were the most common species, with an estimated 29,486 days use in 2006 and 25,694 days use in 2007. The estimated number



of days use for black skimmers declined to 5,387 days in 2006, followed by an increase to 18,727 days in 2007. With the exception of the black skimmer, the estimated number of days use for all species declined between 2006 and 2007. However, due to the large increase in the black skimmer population, the total number of days use for all species increased from 52,185 in 2006 to 57,924 in 2007, with peak numbers of 428 in September 2007. As described by USFWS (2008), black skimmers and least terns were observed nesting behind the terminal groin during 2007. The pre-construction (pre-1990) historical shorebird non-breeding data as described above suggests the immediate groin location was not highly used. Following construction, a large sandflat developed behind the groin where shorebirds and colonial waterbirds nested (and still nest to some extent). As shown in Figure III-8 and Figure III-9 (comparison of 1991 aerial to 2009 aerial), some of this area is still kept in good bare sand condition by overwash from the ocean during storms, but much of the area is becoming or retaining heavy vegetation. According to Riggs and Ames (2009), the Pea Island fillet is rapidly evolving which jeopardizes the overall nesting habitats for many of the species.

NCWRC has monitored shorebird nesting activity at Oregon Inlet since 1988. Nesting activity on the former Sand Shoal Island was monitored annually from 1988 through 1993 (Figure III-10). The total number of nests for all species ranged from 315 nests in 1989 to 2,242 nests in 1993. Based on the 6 years of survey data, an average of 1,193 nests were recorded annually on Sand Shoal Island. Sand Shoal Island was permanently inundated from 1994 onward; and consequently, no data for this site was collected after 1993. Shorebird nesting activity on Oregon Inlet Beach, South (Pea Island) has been monitored intermittently since 1992 (Figure III-11). Survey years include 1992, 1993, 1995, 1997, 1999, 2001, 2002, 2003, 2004, and 2007. The total number of nests for all species ranged from 9 nests in 1992 to 409 nests in 1999. Based on the 10 years of survey data, an average of 187 nests were recorded annually on the northern end of Pea Island (Oregon Inlet, South). Surveys of Oregon Inlet Shoal were conducted during 2001, 2004, and 2007 (Figure III-12). The total number of nests for all species ranged from 103 nests in 2007 to 292 nests in 2004. Based on the 3 years of survey data, an average of 195 nests were recorded annually on Oregon Inlet Shoal. Surveys of the northern end of Bodie Island (Beach Northside Oregon Inlet) were conducted during 2004 and 2007. Nesting records for this area are limited to 10 least tern nests in 2004 and 1 common tern nest in 2007.

Terns, oystercatchers, black skimmers, and piping plovers depend on natural overwash-dominated habitats that provide essential feeding habitats; however, these habitats are being converted to vegetated dune communities and marsh habitat as a result of the terminal groin preventing overwash events and the maintenance of constructed barrier dune-ridges (Personal communication, D. Stewart, USFWS, February 2010; Riggs and Ames 2009). Together the dune fields and marshes currently constitute a major portion of the fillet. This leaves a small portion of the original fillet area along the ocean shoreline that represents nesting habitat for many threatened species. However, because the ocean front is low, nesting is often terminated by flooding events (Riggs and Ames 2009).

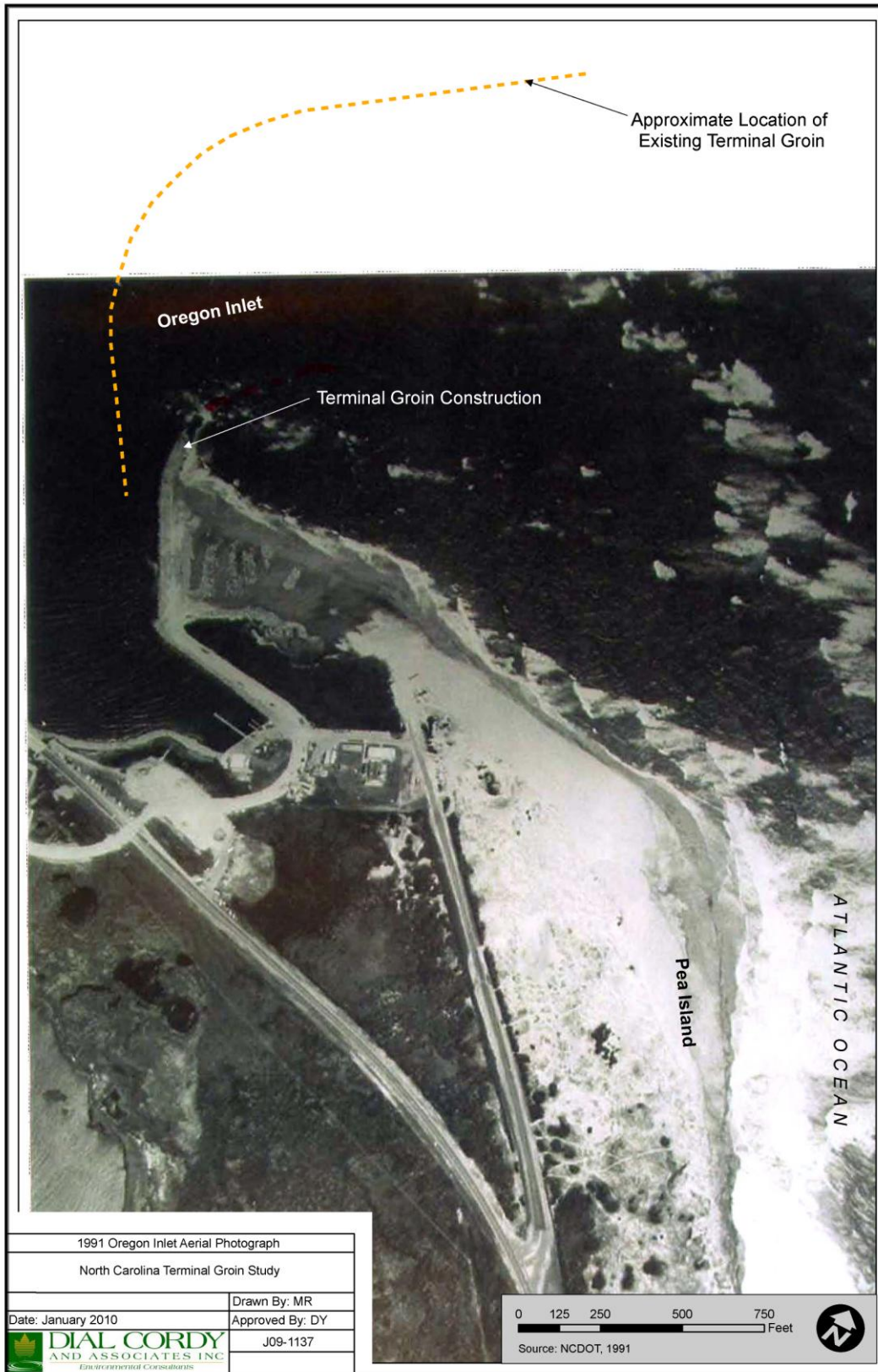


Figure III-8. 1991 Oregon Inlet Aerial Photograph

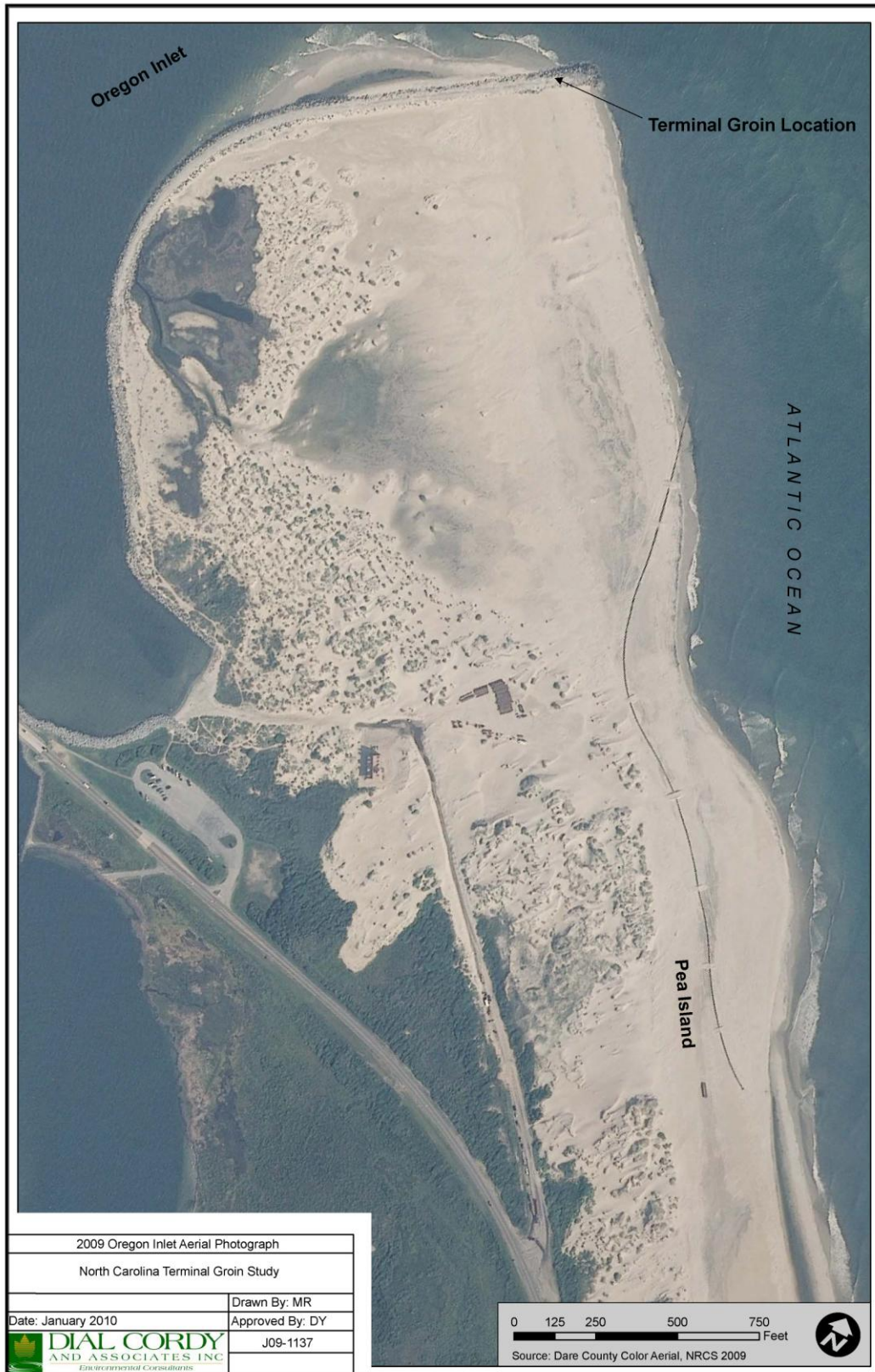


Figure III-9. 2009 Oregon Inlet Aerial Photograph

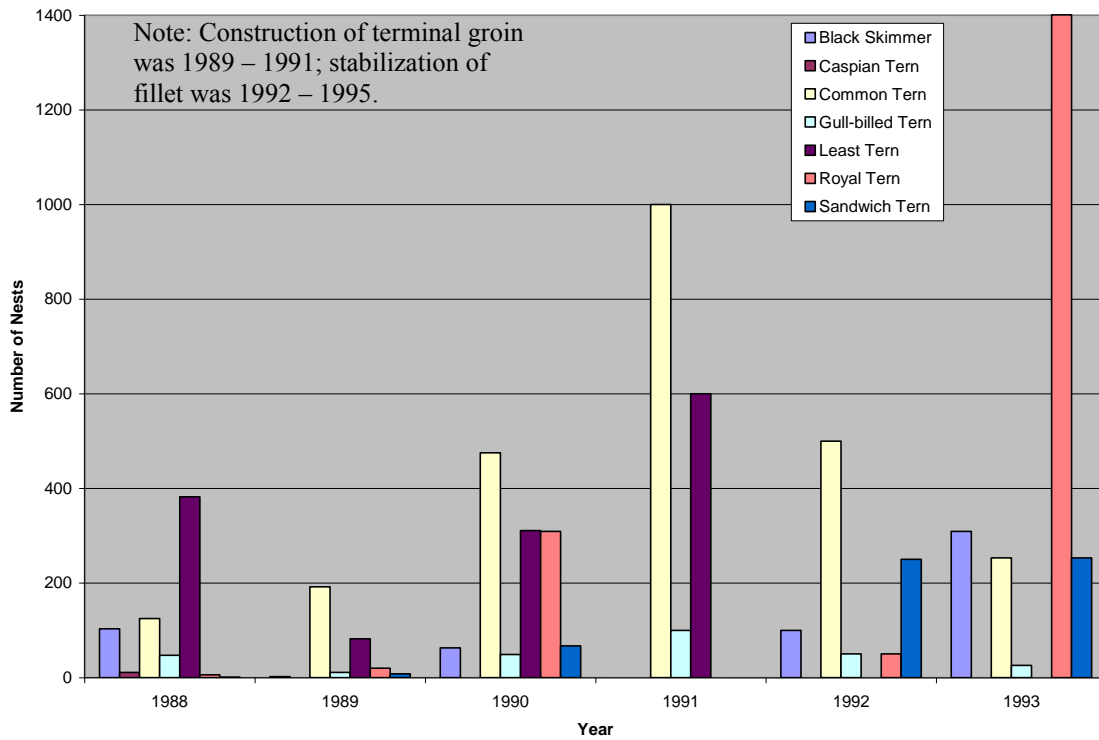


Figure III-10. Shorebird and Colonial Waterbird Nesting Activity on Sand Shoal Island, Formerly Located within the Vicinity of Oregon Inlet

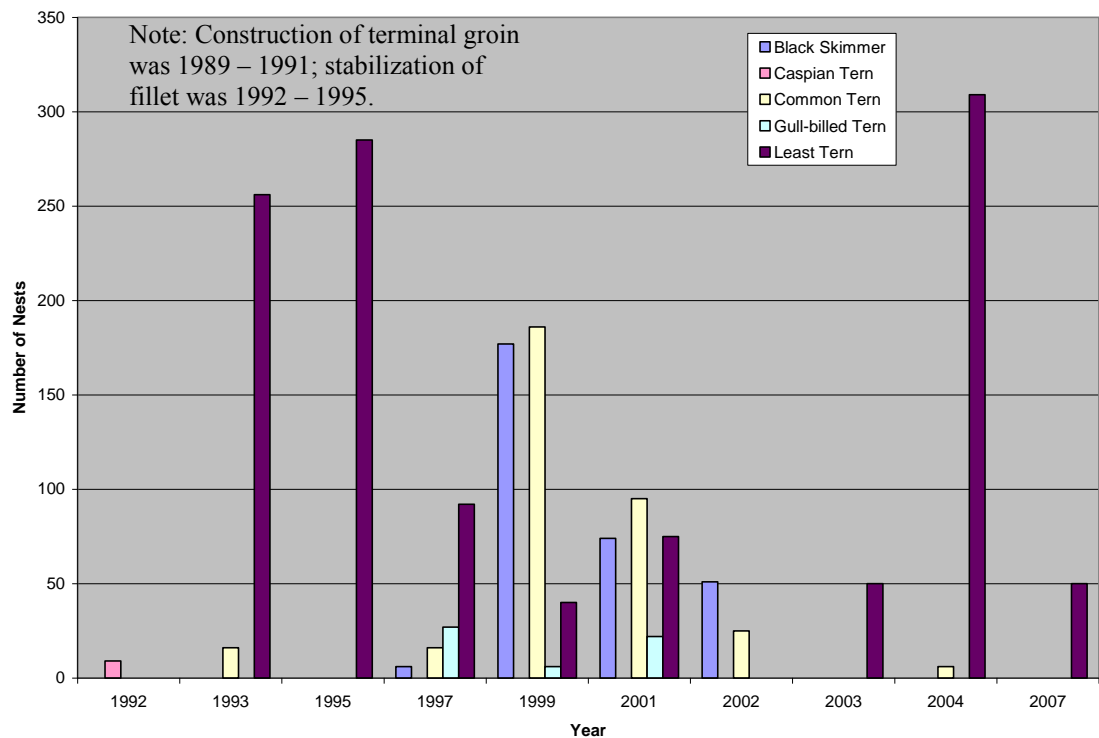


Figure III-11. Shorebird and Colonial Waterbird Nesting Activity on the Northern End of PINWR

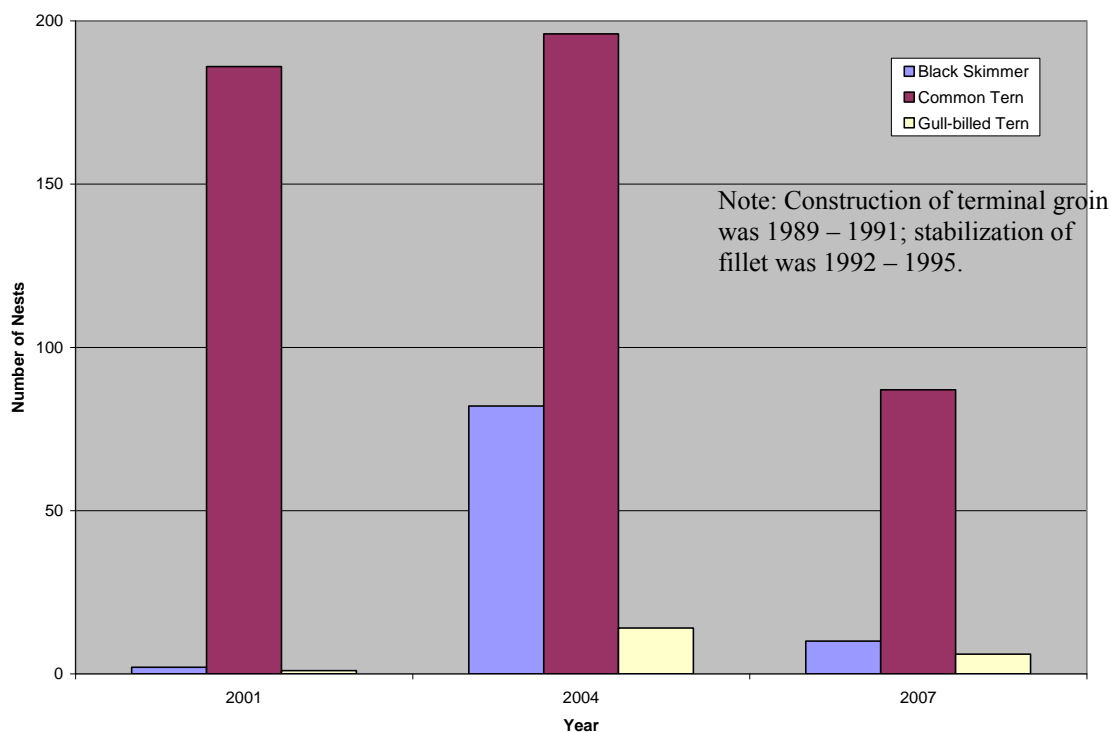


Figure III-12. Shorebird and Colonial Waterbird Nesting Activity for Oregon Inlet Shoal

Shorebird habitats on PINWR are subject to the effects of frequent tropical storms and regular beach renourishment projects. Since 1991, PINWR has experienced tropical storms and/or hurricanes each year with the exception of 1994, 2001, 2003, and 2005. Since 1990, beach renourishment projects have placed sand on PINWR beaches each year with the exception of 1994, 2006, and 2007. Due to the limited shorebird data set and the high frequencies of both storm and renourishment events, no relationships between nesting densities and storm or renourishment events are readily apparent.

Federally Threatened Species

Piping Plover

Oregon Inlet serves primarily as a wintering area for the migrating/wintering (non-breeding) piping plover. Areas on either side of Oregon Inlet have been designated as critical habitat for wintering piping plovers. Successful nesting has been documented on Pea Island in the area just south of the terminal groin. According to USFWS (2006b), between one and three nesting attempts have occurred annually since 1996. Over those nine years, breeding piping plovers have attempted to nest 12 times and have fledged 5 chicks (USFWS 2006b). Recent nesting attempts on Bodie Island spit have resulted in a nest in 2002, 2004, 2007, and 2008 (NPS 2009b). Annual piping plover observational data were obtained from NCWRC and USFWS for Bodie Island spit, Pea Island – northern beach, and Oregon Inlet Shoals (Figure Figure III-13 and Figure III-14).



Figure III-13. Annual Piping Plover Observations in the Vicinity of Pea Island

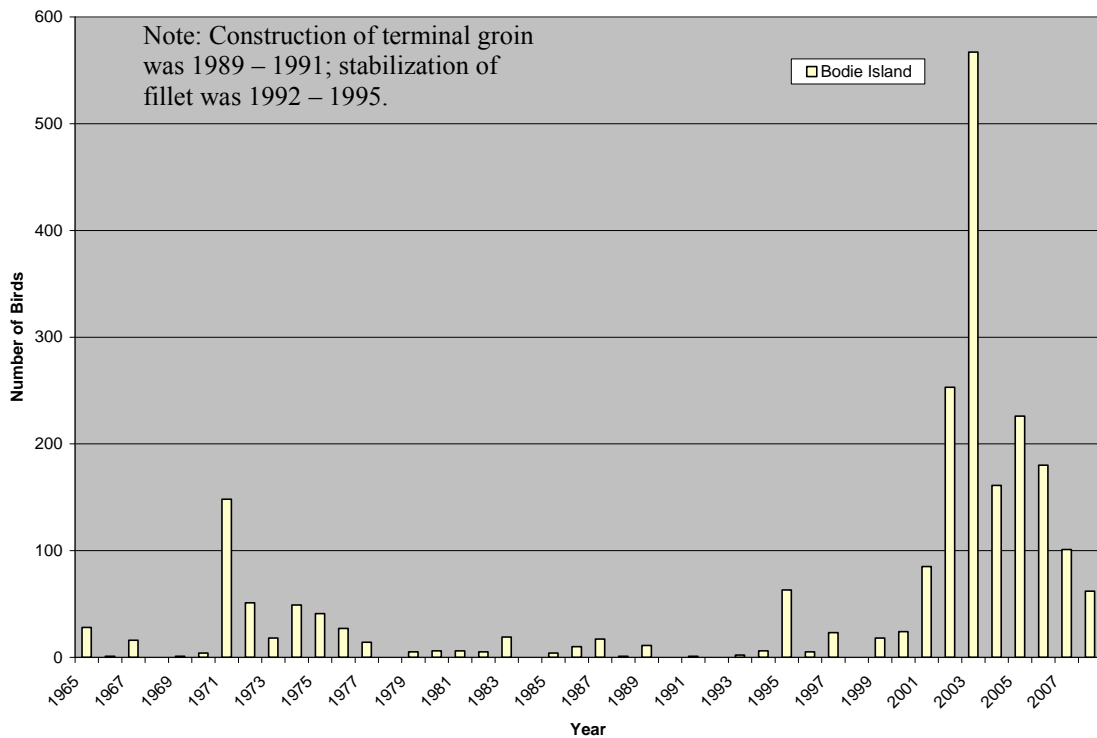


Figure III-14. Annual Piping Plover Observations in the Vicinity of Bodie Island Spit



Prior to 2001, annual piping plover observations on Bodie Island spit (just north of Oregon Inlet) were relatively low, with an annual average of 18 individuals observed from 1965 through 2000. The period of 2001 through 2003 was marked by a sharp increase in piping plover observations on Bodie Island spit. Annual observations during this period increased sharply to 85 individuals in 2001 and peaked at 567 individuals in 2003. Subsequent to 2003, annual piping plover observations on Bodie Island spit steadily declined, reaching a low of 62 individuals in 2008.

Pea Island piping plover records from NCWRC date to 1986. Prior to 2000, annual piping plover observations on the northern end of Pea Island were relatively low, with an annual range of 0 to 8 individuals and an annual average of 2 individuals observed from 1986 through 1999. In 2000, observations on Pea Island increased sharply to 87 individuals. Annual observations subsequently declined to 33 individuals in 2001, and increased sharply to 307 individuals in 2002. Pea Island observations declined steadily over the next three years, reaching a low of 4 individuals in 2005. Annual observations increased to 19 individuals in 2006; however, no piping plovers were reported from Pea Island during 2007 or 2008. In 2009, a total of 40 individuals were observed on Pea Island.

Piping plover records for Oregon Inlet Shoals date to 2001, when a total of 30 individuals were observed. Observations increased to 150 individuals in 2002 and reached a peak of 175 individuals in 2003. The number of individuals observed on Oregon Inlet Shoals in 2004 remained relatively high at 118; however, observations declined sharply to 8 individuals in 2005 and 2 individuals in 2006. No piping plovers were reported from Oregon Inlet Shoals during 2007 or 2008. Fluctuations in annual observations at all three sites (i.e., Pea Island, Oregon Inlet Shoals, and Bodie Island) followed a similar pattern from 2000 through 2008. This common pattern is characterized by sharp increases in the number of annual observations from 2000 through 2003, followed by sharp declines from 2004 through 2008. In fact, the number of piping plovers that use the site during migration and winter has declined as the vegetation has encroached into the site (Personal communication, D. Allen, NCWRC, October 2009).

Based on Cohen et al.'s (2008) study, piping plover habitat use at Oregon Inlet is strongly influenced by tidal stage. When water levels are low, exposing the intertidal areas of the sound islands, plovers prefer sound islands over both the ocean and sound sides of the barrier islands. Other studies have shown that where wintering shorebird habitat availability depends on the tide, habitat selection is a function of safety at roost sites (Rogers et al. 2006), foraging habitat quality (Burger et al. 1977; Smith and Nol 2000; van Gils et al. 2006), and the distances between roosts and foraging areas (Dias et al. 2006; van Gils et al. 2006). As described by USFWS (2008) and depicted in Figure III-8 and Figure III-9, habitat behind the terminal groin has undergone succession due to wind and water-borne sand, and it is no longer as suitable for piping plover nesting and foraging habitat. Since the piping plover is primarily a winter resident at Oregon Inlet, the major threat to this species in the vicinity of the inlet is the degradation of beach foraging habitat (USACE 2001). The construction of the terminal groin resulted in the



formation of about a 50-acre fillet; thus, restoring and stabilizing the tip of Pea Island (Dennis and Miller 1993), and therefore providing valuable habitat in the years following construction for piping plovers (Figure III-13). However, in more recent years the presence of the terminal groin, as well as other actions such as dredging and nourishment, has adversely modified habitat important to piping plovers by eliminating intertidal flats and allowing encroachment of vegetation in stabilized areas, and generally impeding inlet dynamics that create and maintain habitats piping plovers require.

Intense human disturbance in shorebird winter habitat can be functionally equivalent to habitat loss if the disturbance prevents birds from using an area (Goss-Custard et al. 1996), and can lead to roost abandonment and local population decline (Burton et al. 1996). In Cohen et al.'s (2008) study, piping plovers commonly roosted on the ocean beach south of Oregon Inlet and rarely roosted on the ocean beach north of the inlet, despite the fact that the southern beach was 2.1 and 4.5 times farther than the two most frequently-used foraging sites. The northern beach was used by off-road vehicles (ORVs) while the southern beach had only limited pedestrian traffic.

Most of the sound islands, such as Oregon Inlet Shoal (or Green Island) (Figure III-8 and Figure III-9) used by plovers were artificially created by the USACE, suggesting that constructed sand flats can successfully mitigate habitat loss due to other beach and inlet management activities or recreational disturbance, and may be useful in habitat restoration projects in general. However, in the case of Sand Shoal, no shorebird data has been collected by NCWRC since it washed away in the mid-1990's due to the dynamic nature of Oregon Inlet and USACE dredging practices (Personal communication, D. Allen, NCWRC, October 2009). Due to reoccurring habitat changes, birds will rotate between PINWR (behind the terminal groin) and the sound islands in which NCWRC indicated that most of the artificially created islands would not have been affected by the terminal groin except for Green Island, a natural shoal island (Personal communication, D. Allen, NCWRC, October 2009).

Plovers use engineered islands in which the most recent sand deposition ranged from 28 years to less than ten years, suggesting that restoration efforts could have short- and long-term benefits (Cohen et al. 2008). Comparing NCDOT aerials as the terminal groin was constructed (1991, Figure III-8) and after (2009, Figure III-9), the loss of vegetation habitat is evident; however, the additional dune and sand created flats may provide plover and other shorebirds supplemental habitat. Piping plover habitat on PINWR is subject to the effects of frequent tropical storms and regular beach renourishment projects. Since 1991, PINWR has experienced tropical storms and/or hurricanes each year with the exception of 1994, 2001, 2003, and 2005. Since 1990, beach renourishment projects have placed sand on PINWR beaches each year with the exception of 1994, 2006, and 2007. Due to the high frequencies of storm and renourishment events and the lack of information regarding specific effects of individual storms/renourishment events on piping plover habitat, no relationships between piping plover observations and storm or renourishment events are readily apparent.



(5) Fish and Fisheries

As described by Street et al. (2005); Beaufort, Ocracoke, and Oregon Inlets also support significant larval fish passage, although Oregon Inlet may be especially important due to the great distance between it and adjacent inlets, its orientation along the shoreline, and the direction of prevailing winds. Oregon Inlet provides the only opening into Pamlico Sound north of Cape Hatteras for larvae spawned and transported from the Mid-Atlantic Bight. Oregon Inlet serves as an important passageway for the larvae of many commercially and economically important species. Larval fishes hatch in the open ocean, migrate inshore, pass through Oregon Inlet, and enter important nursery areas in the sounds. Passage through the inlet is a critical life cycle requirement for many species (USACE 2001). Oregon Inlet has very high larval fish diversity. Hettler and Barker (1993) documented 61 larval fish species that utilize the inlet. Different species utilize the inlet at different times of the year, and utilization is continuous throughout the year (Hettler and Barker 1993). Research indicates that larval fish in the ocean migrate westward until they encounter the shoreline and then move along the shoreline until they encounter the inlet. Consequently, shoreline structures that impede this lateral movement may have significant effects on transport through the inlet (USACE 2001).

The estuarine and ocean waters adjacent to the terminal groin support a great diversity of fish and shellfish species (NCDOT 1989). Seasonal variations in abundance and occurrence of fish and shellfish species are common, resulting from seasonal cycles of water temperature and the migratory patterns of species. As described by NCDOT (1989), common sport and commercial species found in the area include Atlantic croaker, spot, weakfish, spotted seatrout, bluefish, red drum, summer flounder, blue crab (*Callinectes sapidus*), and penaeid pink, white, and brown shrimp (*Farfantepenaeus duorarum*, *Lilopenanaeus setiferus*, and *Farfantepenaeus aztecus*); respectively.

Joyner et al. (1998) conducted a study of the post-stabilization morphology of Oregon Inlet to determine the relationship between the growth of the Bodie Island spit to the north and the resulting bathymetric changes in the inlet. This study provided insight as to the expected changes in configuration of the main inlet channel as the southern migration of Bodie Island spit approached the terminal groin along northern PINWR. Accretion of the spit on Bodie Island and the location of the terminal groin were responsible for a change in location and orientation of the main channel section. Channel deepening also occurred and in order to maintain a constant cross-sectional area, a narrowing inlet must become deeper to accommodate the same discharge volume (also known as tidal prism). The data shows that this has happened since the terminal groin was constructed. According to Joyner et al. (1998), Oregon Inlet exhibited changes as expected with the stabilization of a single side of a tidal inlet. An inlet's morphological changes may affect larval and fish transport. According to Street et al. (2005), the construction of new or expanded jetties or groins along North Carolina's ocean shoreline should not be allowed until field research has been completed to assess the effect of jetties on successful larval passage through inlets into estuaries, particularly in Pamlico Sound where inlets are limited.



(6) *Benthic Resources*

In association with the construction of the terminal groin and placement of Oregon Inlet maintenance dredged material on Pea Island, the USFWS has monitored infauna along the PINWR's shoreline since the early 1990s. Effects on mole crabs, coquina clams, polychaetes (marine worm), and ghost crabs (*Ocypode quadrata*) have been routinely monitored. In a

1 September 1994 report, preliminary monitoring results showed mole crab and coquina numbers were significantly reduced following shoreline placement of Oregon Inlet maintenance dredged material. Ghost crab numbers did not seem affected and the marine worm numbers increased (Dolan 1994).

In a 10 September 2001 report, swash zone organisms including mole crabs, coquina clams, polychaetes, and amphipods were monitored assessing dredged material placement along PINWR down drift of the terminal groin. Hopper dredge plants placed Oregon Inlet maintenance material in an inshore zone at water depths between 12 and 18 feet. The numbers of organisms immediately onshore of the placement areas were reduced; however, the sediment volume placed during 2000 through 2001 was not enough to significantly inhibit the beach face organisms for an extended period of time (Dolan 2001a).

A "Summary of Results of Dredging and Sand Bypassing" dated 20 October 2001 compared effects from both hopper nearshore placement and direct pipeline placement of maintenance dredged material from Oregon Inlet on downdrift shorelines from Pea Island's terminal groin (Dolan 2001b). Within the past 20 years, approximately six million cubic yards of maintenance dredged material have been bypassed from the inlet to Pea Island by shallow-draft hopper dredges and by direct pipeline placement. Shallow placement by hopper dredges reduced the sediment budget sand losses; yet altered the onshore beaches sediment characteristics. Direct pipeline placement provided maximum effect on erosion, but with the highest potential for biological effects. Beach-face fauna are covered for extended periods of time and pipeline discharges directed into the upper reaches of the shoreline dislocate ghost crabs and shorebirds (Dolan 2001b).

The underlying effects on the infaunal communities within a terminal groin fill is directly related to the fill material size, the volume of material placed, and the seasonal material placement (Personal communication, H. Hall, USFWS, February 2010). Mole crabs and coquina clams stay within the swash zone but move up and down the beach through wave action transport. Mole crabs vibrate lower limbs creating a "quicksand" condition allowing ease of burrowing. If placed material is too well sorted, contains a surplus of heavy minerals, too coarse, or too fine; the mole crabs' ability to burrow is compromised or deterred (Dolan 1999). These infauna species are also responsive to ambient water and air temperatures. On PINWR, they appear in early April, peak in late summer, and hibernate for the winter off the beach-face and in the nearshore zone. The placement of terminal groin fill in late summer may affect the populations' yearly cycle, possibly carrying over to the spring re-emergence. The health of these macroinvertebrates is also tied to water quality. If the terminal groin's fill material has an elevated percentage of



silts and clays (resulting in higher surf zone turbidity levels), these filter feeding organisms' swash zone distribution and offshore wintering characteristics may be significantly affected (Dolan 1999). PINWR places sand on the beach in a manner that mimics a cusped pattern. These intermittent placements create a series of undisturbed and disturbed placement zones (Personal communication, D. Stewart, USFWS, February 2010). The Physical Assessment for Oregon Inlet discusses sediment placed from 1990 and 2002 as finer-grained and containing greater quantities of heavy minerals than the native sand. This variation in sand gradation can affect benthic resources and thereby affect upper trophic levels.

Scarps may refer to hardbottom areas which are amply hardened and distinguish themselves in elevation from adjacent seafloor contours. Few of these elevation distinguished features were found in a survey conducted in 1998, adjacent to Bodie Island, north of Oregon Inlet (Boss et al. 1999).

According to the USACE (2001) a sessile community has likely developed on the terminal groin's structural components. Site specific studies supporting this inference were not found; however, a comparison was made to the natural coquina outcropping in southern North Carolina as to possible species that may take residence on the subtidal elements of Oregon Inlet's terminal groin. Such potential species included sea lettuce (*Ulva lactuca*), hollow green weeds (*Enteromorpha* sp.), sea anemone (*Bunodosoma cavernata*), oysterdrill (*Urosalpinx cinerea*), calcareous tube worm (*Eupomotus dianthus*), and various polychaetes and crabs (USACE 2001).

Live hardbottom habitat has not been documented along or near Bodie or Pea Island shorelines adjacent to Oregon Inlet although hardbottom has been documented offshore of Oregon Inlet (Moser and Taylor 1995; SEAMAP 2001; Personal communication, A. Deaton, NCDMF, February 2010). As noted in NCDOT (2008), no live/hardbottom habitat is designated in the vicinity of Oregon Inlet by the SAFMC. Hardbottom outcroppings within depths potentially affected by the terminal groin or associated beneficial use of dredged sand have not been recorded.

c) Summary of Findings

The following summary is a result of extensive scientific literature review and preliminary evaluation of pre-existing biological data. CAHA along with the PINWR is home to many of the federally protected species that depend upon inlet shoreline habitat. As described by USFWS (2008); Oregon Inlet dredging, the Bonner Bridge, NC Highway 12 maintenance and protection, and the presence of the terminal groin have influenced the loss of oceanfront and inlet habitat by subduing and altering natural processes such as overwash.

The pre-construction (pre-1990) historical bird data suggests the immediate groin location was not highly used. Following construction of the terminal groin, a large sandflat developed behind the groin where shorebirds and colonial waterbirds nested (and



still nest to some extent). Some of this area is still kept in good bare sand condition by overwash from the ocean during storms; but much of the area is retaining heavy vegetation. According to Riggs and Ames (2009), the Pea Island fillet is rapidly evolving which jeopardizes the overall nesting habitats for many bird species.

Oregon Inlet serves primarily as a wintering area for the migrating/wintering (non-breeding) piping plover. Areas on either side of Oregon Inlet have been designated as critical habitat for wintering piping plovers. Successful nesting has been documented on Pea Island in the area just south of the terminal groin. Fluctuations in annual observations at Pea Island, Oregon Inlet Shoals, and Bodie Island followed a similar pattern from 2000 through 2008. This common pattern is characterized by sharp increases in the number of annual observations from 2000 through 2003, followed by sharp declines from 2004 through 2008. The presence of the terminal groin, as well as other actions such as dredging and nourishment, has adversely modified habitat important to piping plovers by eliminating intertidal flats and allowing encroachment of vegetation in stabilized areas, and generally impeding inlet dynamics that create and maintain habitats piping plovers require.

In terms of sea turtles, the PINWR has an average of 10 to 12 nests per year although on average, 3.4 loggerhead nests have been recorded within five miles south of Oregon Inlet annually over the course of the last 19 years. Based on a preliminary evaluation of nesting intervals per section on PINWR compared to Bodie Island, it is apparent that sea turtle nesting habitat is more readily available on PINWR versus Bodie Island. Due to the consistently low annual nesting densities and the high frequencies of both storm and renourishment events, no relationships between nesting densities and storm or renourishment events are readily apparent.

Monitoring results showed mole crab and coquina numbers were significantly reduced following shoreline placement of Oregon Inlet maintenance dredged material and that the underlying effects on the infaunal communities within a terminal groin fillet is directly related to the fill material size, the volume of material placed, and the seasonal material placement. There is also very limited information on the invertebrate communities at inlets and how inlet stabilization impacts these communities. Although there are conflicting opinions on the magnitude of impact, there is valid concern that construction of groin structures would prevent some portion of ocean-spawned larvae from reaching estuarine nursery areas (USACE 1999a).

2. Fort Macon, Beaufort Inlet, North Carolina

a) General Site Description

Beaufort Inlet is one of the most managed inlets in North Carolina (Figure III-15). When discussing environmental resources and potential effects, the number of ongoing projects in this area should be considered. As shown in Figure III-16, a late 1970's photograph looking east to west towards Beaufort Inlet depicts a historical rock structure on Shackleford Banks. The structure is landlocked as the inlet migrated to the west in the last 50 years (Moslow and Heron 1994). The State Port at Morehead City has a navigational channel approximately 45 feet deep through Beaufort Inlet. The beaches along Fort Macon State Park periodically receive dredged material disposal from maintenance dredging of the navigation channels, most recently during 2007 (Personal communication, R. Rudolph, Carteret County Shoreline Protection Office, March 2009). The US Coast Guard has a base on the north side of Fort Macon State Park; the shoreline of this base is stabilized with riprap, groins, and bulkheads.



Figure III-15. Beaufort Inlet



Figure III-16. Hard Structure Located on Western End of Shackelford Banks

Source: Cape Lookout National Seashore, Michael Rikard

As described by the Carteret County Shore Protection Office (2002), the Morehead City Harbor Federal Navigation Project involves maintenance dredging of Beaufort Inlet that separates Shackelford and Bogue Banks, located to the east and west of the inlet, respectively. There have been several prior studies in the study area and adjacent waters by the USACE Wilmington District (USACE 1976b, 2003).

(1) Aesthetics

Aesthetic effects of the terminal groin and subsequent placement of dredged material have been both positive and negative. Beach placement temporarily affects aesthetics due to the presence of heavy equipment, pipelines, and incompatible material on the beach. The placement of poor quality material resulted in elevated turbidity in the surf zone. Noise and combustion exhaust created by the operation of the dredge and other equipment resulted in minor increases in noise and air pollution (USACE 2003). However, not all placement events were of questionable quality, the terminal groin has protected Fort Macon as designed; and upon completion of most beneficial placement events, the aesthetics and recreational use of the beach have been enhanced due to the wider beach.

(2) Recreation/Public Access

Fort Macon State Park is located at the east end of Bogue Banks overlooking Beaufort Inlet, just south of Brandt Island. This park is North Carolina's most visited park, with approximately 1.4 million visitors each year (Fort Macon State Park 2000). Fort Macon



State Park was opened in 1936 as the state's first functioning park. Facilities include a seaside bathhouse, restrooms, refreshment stand, designated fishing and swimming areas, picnic tables, outdoor grills, and a short nature trail. Bird and wildlife viewing are popular activities at the park. Recreational resources of statewide significance are centered on Fort Macon and the beach (Fort Macon State Park 2000). The restored 19th-century fort provides historical educational opportunities that are not available elsewhere in North Carolina, and the park's diverse coastal environment also provides a broad range of educational opportunities. These areas are utilized by tourists and local residents throughout the year.

b) Natural Resources

As described by USFWS (2002), the Beaufort Inlet area has been characterized as a significant resource. The NCNHP has delineated several SNHA within the area, including the Rachel Carson National Estuarine Research Reserve (NERR) to the northeast and Shackleford Banks to the east. Shackleford Banks forms the southernmost portion of Cape Lookout National Seashore (CALO), administered by the National Park Service (NPS), and has been designated a Wilderness Area. CALO contains nationally significant natural and cultural resources and values that play a vital role in the state's ecosystem and local economies. Many of the federally protected species that depend upon inlet shoreline habitat utilize habitat within the CALO (NPS 2009).

The Fort Macon Registered Natural Heritage Area covers 350 acres and encompasses the entire park with the exception of the areas that are developed with recreational facilities or the fort itself (Fort Macon State Park 2000). The natural area provides a good example of a typical sea-to-sound barrier island community developed over the various geological and topographical features of the island.

The Fort Macon State Park profile (2000) consists of a continuous line of dunes which in turn supports a dune grass natural community dominated by sea oats (*Uniola paniculata*) and seaside little bluestem (*Schizachyrium littorale*). The interior portion supports a maritime shrub natural community which is a dense thicket of coastal red cedar (*Juniperus virginiana*), stunted live oak (*Quercus virginiana*) and loblolly pine (*Pinus taeda*), yaupon (*Ilex vomitoria*) and wax myrtle (*Myrica cerifera*). There are small pockets of maritime forest with similar species but a taller canopy. The sound side of the park has a salt marsh dominated by saltmarsh cordgrass.

Tidal inlets including Beaufort Inlet have also been designated as Habitat Areas of Particular Concern (HAPC) for red drum, penaeid shrimp and the snapper-grouper complex by the SAFMC (NCDMF 2000). The USFWS has designated critical habitat for overwintering piping plovers at the Rachel Carson NERR and Shackleford Banks (2002). The United States Congress has designated Fort Macon State Park and portions of Beaufort Inlet as covered by the Coastal Barrier Resources Act (CBRA) or within a CBRA zone, coincident with the boundaries of the NERR and CALO. Figure III-17 depicts the numerous coastal resources present within the vicinity of Beaufort Inlet and the Fort Macon terminal groin.



Figure III-17. Coastal Classification of Habitat for Beaufort Inlet, NC

(1) *Seabeach Amaranth*

Seabeach amaranth on Fort Macon/Atlantic Beach has been monitored since 1991 (Figure III-18). The number of plants observed on Fort Macon/Atlantic Beach declined steadily from 490 plants in 1991 to 106 plants in 1994. The population increased sharply in 1995, with a total of 8,382 plants observed. No plants were observed in 1996, and only 74 were observed in 1997. The population increased to 525 plants in 1998, followed by a decline to four plants in 1999. Over the next four years, the population increased steadily, reaching a high of 479 plants in 2003. Since 2003, the annual number of plants has ranged from 4 to 142.

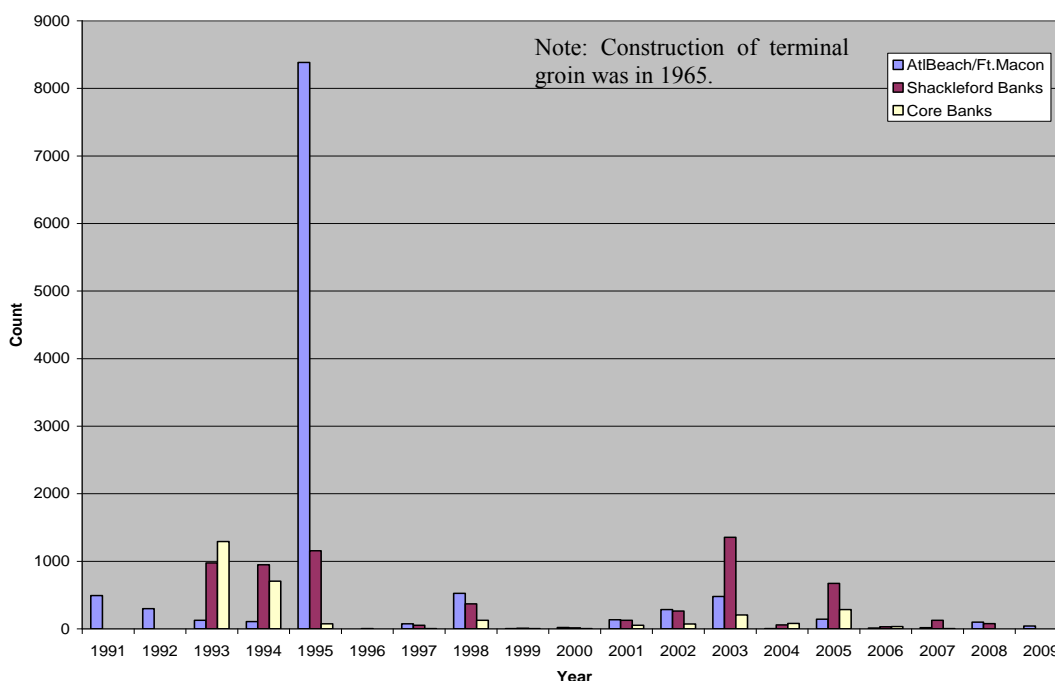


Figure III-18. Seabeach Amaranth Plants for the Beaufort Inlet Area

Seabeach amaranth plants on Shackleford Banks have been monitored since 1993. A total of 975 plants were observed in 1993. Numbers remained relatively high over the next two years, with 948 plants observed in 1994 and 1,155 plants observed in 1995. The population declined to three plants in 1996, and only 51 plants were observed in 1997. The population increased to 369 plants in 1998, followed by a decline to nine plants in 1999. Over the next four years, the population increased steadily, reaching a high of 1,354 plants in 2003. Since 2003, the annual number of plants has ranged from 30 to 671.

As a comparison to an unmanaged barrier island, Core Banks survey data was included in this evaluation. Seabeach amaranth at Core Banks has been monitored since 1993. A total of 1,290 plants were observed in 1993. Numbers remained relatively high in 1994, with a total of 704 plants observed. The population declined sharply over the next three years, with 75 plants observed in 1995, one plant observed in 1996, and two plants observed in 1997. The population increased to 125 plants in 1998, followed by a decline



to two plants in 1999. Over the next four years, the population increased steadily, reaching a high of 206 plants in 2003. Since 2003, the annual number of plants has ranged from zero to 284. Fluctuations among the three populations, shown in Figure III-18, exhibit similar patterns over the course of the monitoring period. All of the populations experienced significant declines between 1995 and 1996, and the number of plants in all three populations remained low in 1997. All three populations experienced significant increases in 1998 while there was then a sharp decline in 1999, and increased steadily over the course of the following three years (2001-2003). All three populations experienced sharp declines in 2004, followed by significant increases in 2005 and subsequent declines in 2006.

As seen by the data shown in Figure III-18, seabeach amaranth experiences a great deal of natural population variability from one year to the next. These natural fluctuations can be attributed to a number of factors; such as erosion, storms, and seed dispersal. Habitat loss due to hurricanes may have contributed to the dramatic decline in seabeach amaranth numbers from 1997 to 2000 as evidenced by the post-hurricane data from Hurricane Fran (1996) and Hurricane Floyd (1999) (USACE 2006). Seabeach amaranth habitat on Fort Macon and CALO is subject to the effects of frequent tropical storms. Since 1991, Fort Macon and CALO have experienced tropical storms and/or hurricanes each year with the exception of 1994, 2001, 2003, and 2005. Due to the high frequency of storm events and the lack of information regarding specific effects of individual storms on seabeach amaranth habitat, no relationship between seabeach amaranth numbers and storm events is readily apparent. Seabeach amaranth habitat on Fort Macon is also subject to the effects of periodic beach renourishment projects. Since 1991, Fort Macon beaches have been nourished four times. Seabeach amaranth numbers increased following renourishment projects in 2002 and 2007, whereas numbers decreased following renourishment projects in 1993 and 2004. Based on these data, no consistent relationship between seabeach amaranth numbers and renourishment projects is readily apparent.

(2) Seagrass

In 1981, visible SAV in Core and Bogue sounds covered 19,458 acres [8.4 million square feet (ft²)] within a total water area of 104,840 acres (19 percent SAV coverage; Carraway and Priddy 1983). However, acreage for these areas may be underestimated, particularly in low salinity riverine areas, since aerial photography at the scale utilized (1:24,000) may not be able to detect some SAV due to the relatively small patch size and high turbidity of the water (Street et al. 2005). In contrast, considerable SAV loss may have occurred in Morehead City when the port access channels were originally dredged, given that nearby, similar yet undredged areas within Bogue Sound support SAV. As indicated by Street et al. (2005), because almost all of the eastern shoreline of Core Sound and the southern shoreline of Back Sound are undeveloped (Shackleford and Core Banks), the seagrass beds in that area have not been highly effected by channel dredging, marinas, or docks. As seen in Figure III-19, seagrass is not present in Beaufort Inlet; however, it is present on the sound side of Fort Macon and within the inner part of Carrot Island, approximately 1.2 miles away from the inlet (Personal communication, D. Field, NOAA, February 2010; Personal communication, S. Chappell, NCDMF, February 2010).



Figure III-19. Seagrass Habitat for Beaufort Inlet, NC

(3) Sea Turtles

The Sea Turtle Monitoring Project, initiated in 2002 by NCWRC, was designed to observe and record sea turtle nesting activity on the island of Bogue Banks (Hollowman and Godfrey 2006). The project area included the ocean-facing beaches on Bogue Banks with the Atlantic Beach/Fort Macon State Park area evaluated in this study (Figure III-20). As a comparison to an ocean-facing beach that has not been nourished, Shackelford Banks and Core Banks sea turtle nesting data were also included in the analysis. Sea turtle nesting activities on Bogue Banks included research data relative to the effects of beach nourishment on sea turtle nesting: sand compaction, sand temperature, and nest temperature throughout the sea turtle nesting seasons.

The study of the effects of beach renourishment on sea turtle nesting was initiated following concern that the material placed on the beach during nourishment may be different from what originally existed on the nesting beaches (Holloman and Godfrey 2006). The differences in sediment may have negative effects on sea turtle reproduction. For instance, characteristics such as sand compaction and sand temperature directly affect sea turtle nests. Sex determination in hatchlings is dependent upon the temperature at which nests incubate: higher temperatures yield greater numbers of females while cooler temperatures result in more male hatchlings (Wibbels 2003). Although, as discussed by Street et al. (2005), soft stabilization offers an alternative to hard stabilization that has less severe habitat effects and some positive effects. For example, wider beaches from properly constructed beach nourishment projects can enhance sea turtle nesting habitat.

Given that darker colors absorb more solar radiation, sediment used as beach fill could result in warmer nests if turtles lay their eggs in darker nourished sand (Hays et al. 2001). North Carolina is roughly the northern boundary of sea turtle nesting in the southeastern United States. North Carolina sand temperatures are cooler than those of more southerly states, thereby producing relatively more male hatchlings than more southerly states (Mrosovsky et al. 1984; Mrosovsky and Provanha 1992). Other potential effects include the possibility that dark sediment could create nest temperatures that are too hot for successful incubation or that the nourished material is too compact for successful nest construction. Although Fort Macon was not included in the study initiated in 2000 by the NCWRC (Personal communication, M. Godfrey, NCWRC, November 2009), it was concluded that sand temperatures in nourished areas were warmer than non-nourished areas (Hollowman and Godfrey 2006). Regular monitoring of sea turtle nesting activity has been conducted on Shackelford Banks since 1990 (Figure III-21). On average, 10 nests have been recorded annually over the course of the last 19 years. No obvious trends in nesting activity are evident over the course of the 19 year monitoring period. Highly productive years include 1993 (20 nests), 1995 (16 nests), 1997 (13 nests), 1998 (21 nests), 2003 (16 nests), 2005 (16 nests), and 2008 (15 nests). Regular monitoring of sea turtle nesting activity at Fort Macon State Park has been conducted since 1985 (Figure III-21). On average, 3.5 nests have been recorded annually over the course of the last 24 years. During the period of 1985 through 1993, the number of annual nests ranged from one to 13, with an annual average of five nests. No nests were recorded in 1994, 1995, or 1996.



Figure III-20. Species Occurrence for Beaufort Inlet, NC

During the period of 1997 through 2008, the annual number of nests ranged from zero to six, with an annual average of three nests. As depicted in Figure III-21, other than the lack of nesting activity from 1994 through 1996, no obvious trends in nesting activity are evident over the course of the 24-year monitoring period.

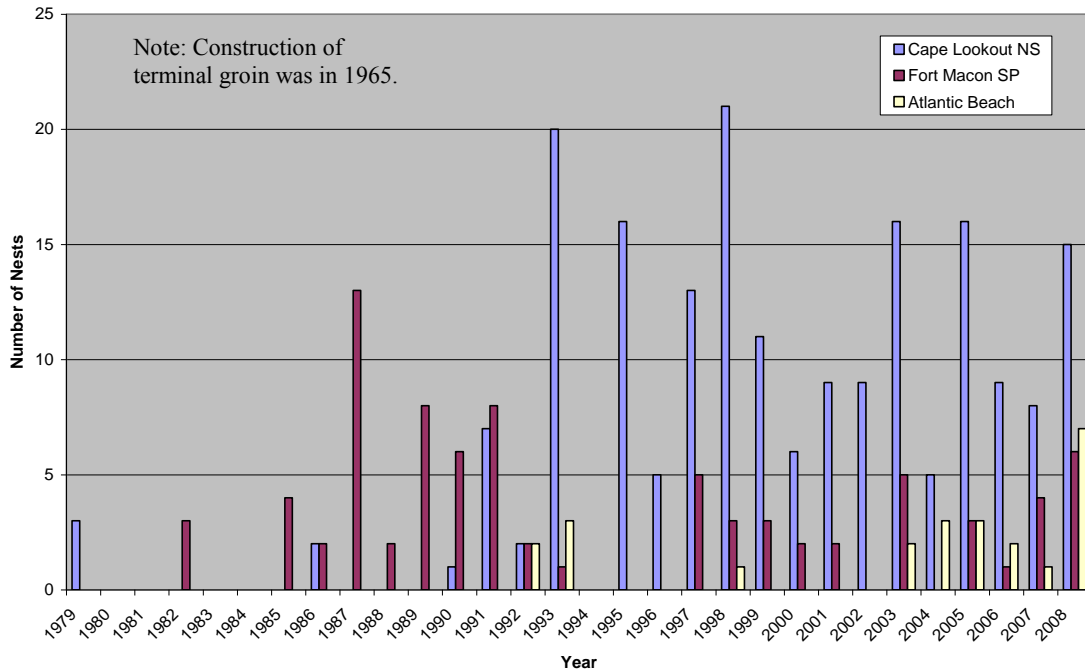


Figure III-21. Sea Turtle Nesting Activity for the Beaufort Inlet Area

Although historical data for sea turtle nesting was obtained, it is difficult to analyze as Fort Macon State Park relocates most of the nests due to the high number of tourists (Personal communication, M. Godfrey, NCWRC, November 2009). However, in the case of Fort Macon State Park, the high number of visitors has likely had little effect on whether or not a female sea turtle will nest, since the park is closed to the public after sunset. On the other hand, human presence may be disturbing female nesting sea turtles in Atlantic Beach, which tends to be rather “busy” at night during the nesting season (Personal communication, M. Godfrey, NCWRC, November 2009).

Sea turtle nesting habitat on Fort Macon and CALO is subject to the effects of frequent tropical storms. Since 1991, Fort Macon and CALO have experienced tropical storms and/or hurricanes each year with the exception of 1994, 2001, 2003, and 2005. Due to the high frequency of storm events and the lack of information regarding specific effects of individual storms on sea turtle nesting habitat, no relationship between nesting densities and storm events is readily apparent. Sea turtle nesting habitat on Fort Macon is also subject to the effects of periodic beach renourishment projects. Since 1973, Fort Macon beaches have been nourished seven times. Sea turtle nesting densities increased following renourishment projects in 1986, 2002, 2004, and 2007; whereas nesting density decreased following renourishment in 1993. These data indicate that renourishment may have a positive effect on sea turtle nesting.

(4) *Shorebirds and Waterbirds*

Tidal shoals that are sub-aerial during low tides are valuable foraging and roosting habitat for migratory shorebirds and colonial waterbirds (USFWS 2002). Some of these shoals are supra-tidal even at high tide and provide additional habitat to numerous species of shorebirds and colonial waterbirds species. In 1998, the Beaufort Inlet system encompassed approximately 463 acres of shoals and inlet shoulders available to shorebirds and colonial waterbirds (Figure III-22). This was the fifth largest flood tidal shoal system in North Carolina with only Cape Fear River, New Drum, Oregon, and Ocracoke Inlets exceeding it. Overall, Beaufort Inlet provided the sixth largest inlet complex in North Carolina in terms of habitat available to migratory shorebirds and waterbirds in 1998 (USFWS 2002).

The inlet shorelines on both Beaufort Inlet and Shackleford Banks have supported bird nesting habitat for black skimmer, common tern, gull-billed tern, and least tern (Figure III-22); NCWRC, unpublished data). During migratory periods, thousands of birds are commonly found in and around Beaufort Inlet. Birds commonly seen in Beaufort Inlet during the winter months include common loon (*Gavia immer*), double-crested cormorants (*Phalacrocorax auritus*), red-breasted mergansers (*Mergus serrator*), northern gannets (*Morus bassanus*), Bonaparte's gulls (*Larus philadelphia*), great blue heron (*Ardea herodias*), and black-crowned night-herons (*Nycticorax nycticorax*). Willets (*Tringa semipalmata*), ruddy turnstone (*Arenaria interpres*), sanderlings (*Calidris alba*) and various gull species are often found along the beaches of Fort Macon State Park during the winter (Personal communication, R. Newman, Fort Macon State Park, October 2009). Avian use of the inlet shoreline at Fort Macon State Park can attract birds not regularly seen at North Carolina inlets [e.g., purple sandpiper (*Calidris maritima*), scoters (Anatidae sp.), eiders (Anatidae sp.), and ducks] because of several rock structures (USFWS 2002). Most commonly during the summer, the Fort Macon State Park area supports willets, ruddy turnstone, black-bellied plover (*Pluvialis squatarola*), sanderlings, gulls, and terns. Spring and fall migratory periods bring red knot, whimbrel (*Numenius phaeopus*), western sandpiper (*Calidris mauri*), scoters, common loon, red-throated loon, heron, egret, and white ibis (*Eudocimus albus*) (Fussell 1985). Gull-billed terns, black skimmers, and terns have nested in the past at Beaufort Inlet (Personal communication, D. Allen, NCWRC, October 2009). Waterbirds regularly seen at the Rachel Carson NERR are black tern, common tern, sandwich tern, black skimmer, cormorant (Family Phalacrocoracidae), glaucous gull (*Larus hyperboreus*), Iceland gull (*Larus glaucooides*), lesser black-backed gull (*Larus fuscus*), Bonaparte's gull, little gull (*Hydrocoloeus minutus*), brown pelican (*Pelecanus occidentalis carolinensis*), black-crowned night-heron, and white ibis (Fussell 1985). Within the inlet itself, Radio Island and the Rachel Carson NERR both generate diverse bird watching. At the Rachel Carson NERR, which Fussell (1985) refers to as the Bird Shoal Complex for its avian diversity, common shorebird species include American oystercatcher, semipalmated plover (*Charadrius semipalmatus*), ruddy turnstone, willet, whimbrel, greater yellowlegs (*Tringa melanoleuca*), short-billed dowitcher (*Limnodromus griseus*), marbled godwit (*Limosa fedoa*), dunlin (*Calidris alpina*), red knot, western sandpiper, semipalmated sandpiper, sanderling, piping plover, black-bellied plover, and Wilson's plover.

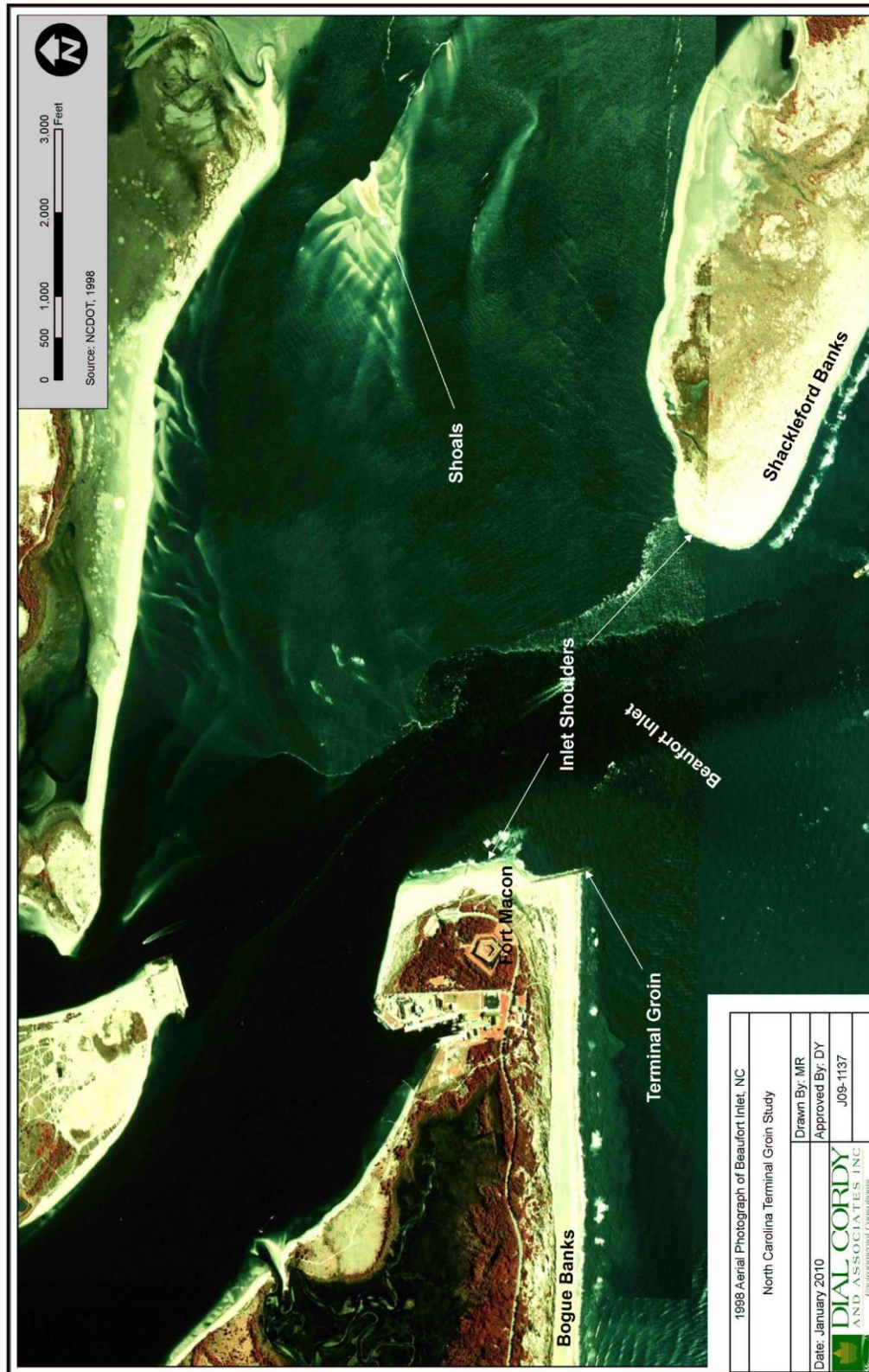


Figure III-22. 1998 Aerial Photograph of Beaufort Inlet, NC



Wilson's plover nesting surveys were conducted by Park Service personnel on CALO from 2006 through 2009 (Figure III-23). The annual number of nesting pairs on Shackleford Banks ranged from 14 to 32. The number of nesting pairs increased from 14 in 2006 to 32 in 2008, followed by a decrease to 18 nesting pairs in 2009. During this same period, the number of nesting pairs on North and South Core Banks were generally two to three times greater than the number of pairs on Shackleford Banks. The number of nesting pairs on North and South Core Banks increased steadily from 28 in 2006 to 64 in 2009. However, given the lack of long-term data and the unavailability of data specifically for western Shackleford Banks, no discernible trends can be concluded.

Nesting surveys for the least tern, black skimmer, common tern, and gull-billed tern were conducted by Park Service personnel on Shackleford Point in 1992, 1993, and 1995 (Figure III-24). The total number of nests for all species increased from 277 in 1992 to 592 in 1993, followed by a decrease to 60 nests in 1995. Common terns, gull-billed terns, and black skimmers are formerly known to have nested at Shackleford Point; however, they have not been observed nesting there for several years (Personal communication, J. Fussell, bird expert and author, February 2010). It is believed that the decline in nesting birds at Shackleford Point is likely associated with the degradation of habitat related to the fact that the inlet shorelines have been relatively stable for decades.

Lack of historic natural resource data hinders drawing conclusions on the effects of the construction and operation of the terminal groin on natural resources. However, the inlet shoreline adjacent to the Fort Macon terminal groin does not appear to be suitable for either colonial nesters or shorebirds based on preliminary analysis of historical aerial photographs and available historical shorebird and colonial waterbird data. Colonial waterbirds and shorebirds depend on ephemeral habitats while stabilization of inlet shoreline causes vegetation growth that results in unsuitable habitat (Personal communication, D. Allen, NCWRC, October 2009), and not having historical pre-construction bird surveys makes it difficult to conclusively say the terminal groin alone is the cause of loss of suitable habitat.

Annual least tern and Wilson's plover observations at Fort Macon State Park were recorded by the park ranger between 1994 and 2009 (Figure III-25). The numbers of annual observations were highly variable over the course of this period. An annual average of 44 least terns were observed from 1994 through 2000. No least tern observations were recorded in 2001 and 2002. Least tern observations declined steadily from 168 in 2003 to 5 in 2008, followed by a sharp increase to 281 in 2009. Wilson's plover observations remained low throughout the period of record. An annual average of three Wilson's plovers was observed between 1996 and 2000. No Wilson's plover observations were recorded in 2001 and 2002, and an annual average of 11 Wilson's plovers were observed between 2003 and 2009. It is significant to note that some years, Wilson's plovers were absent along the ocean and inlet beach of Fort Macon State Park (Personal communication, J. Fussell, bird expert and author, February 2010).



Shorebird habitats on Fort Macon and CALO are subject to the effects of frequent tropical storms. Since 1991, Fort Macon and CALO have experienced tropical storms and/or hurricanes each year with the exception of 1994, 2001, 2003, and 2005. Due to the high frequency of storm events and the lack of information regarding specific effects of individual storms on shorebird habitats, no relationship between shorebird numbers and storm events is readily apparent. Shorebird habitat on Fort Macon is also subject to the effects of periodic beach renourishment projects. Since 1973, Fort Macon beaches have been nourished seven times. Least tern and Wilson’s plover observations at Fort Macon increased following renourishment projects in 2002, 2004, and 2007. These data indicate that renourishment may have a positive effect on habitat utilization by these species.

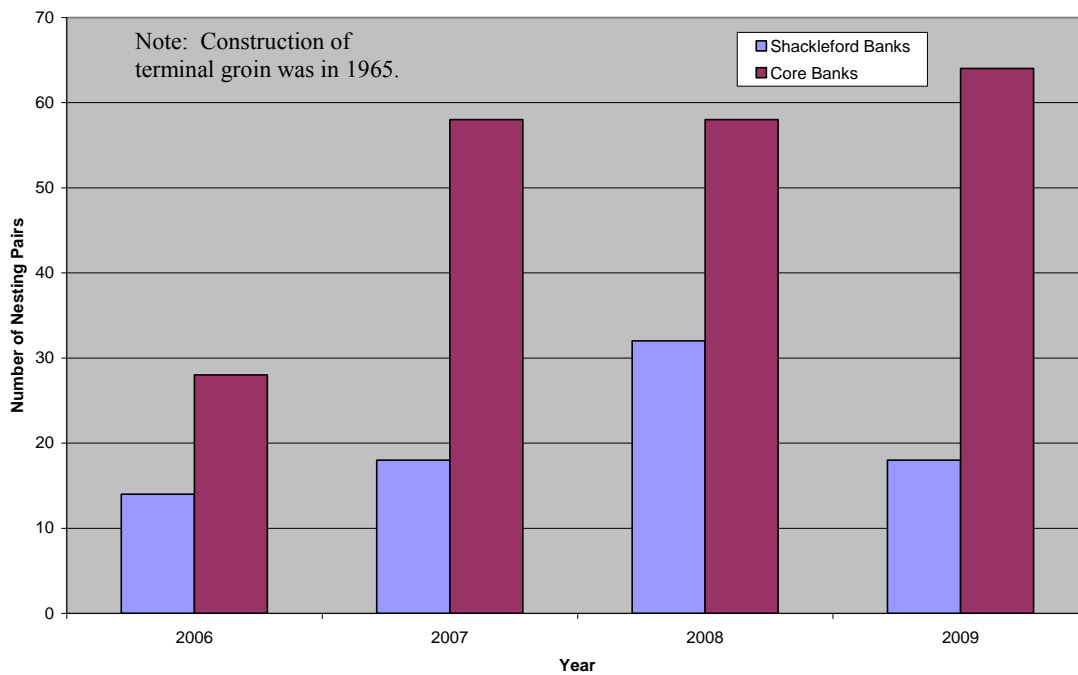


Figure III-23. Wilson’s Plover Nesting Survey Data (CALO)

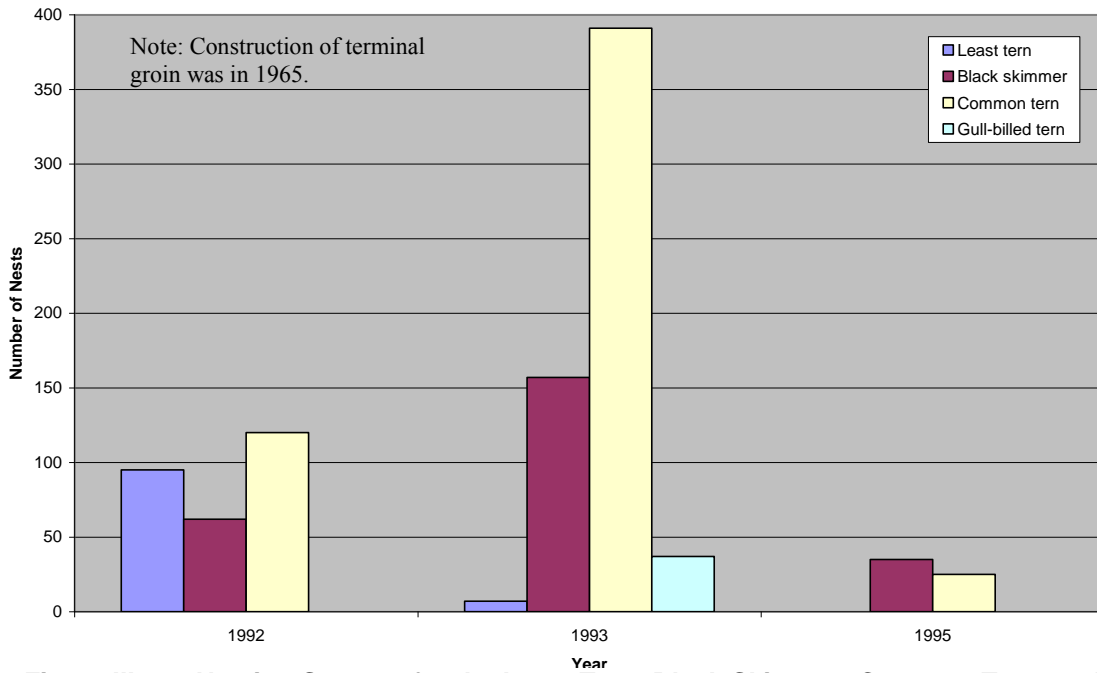


Figure III-24. Nesting Surveys for the Least Tern, Black Skimmer, Common Tern, and Gull-Billed Tern (Shackleford Point)

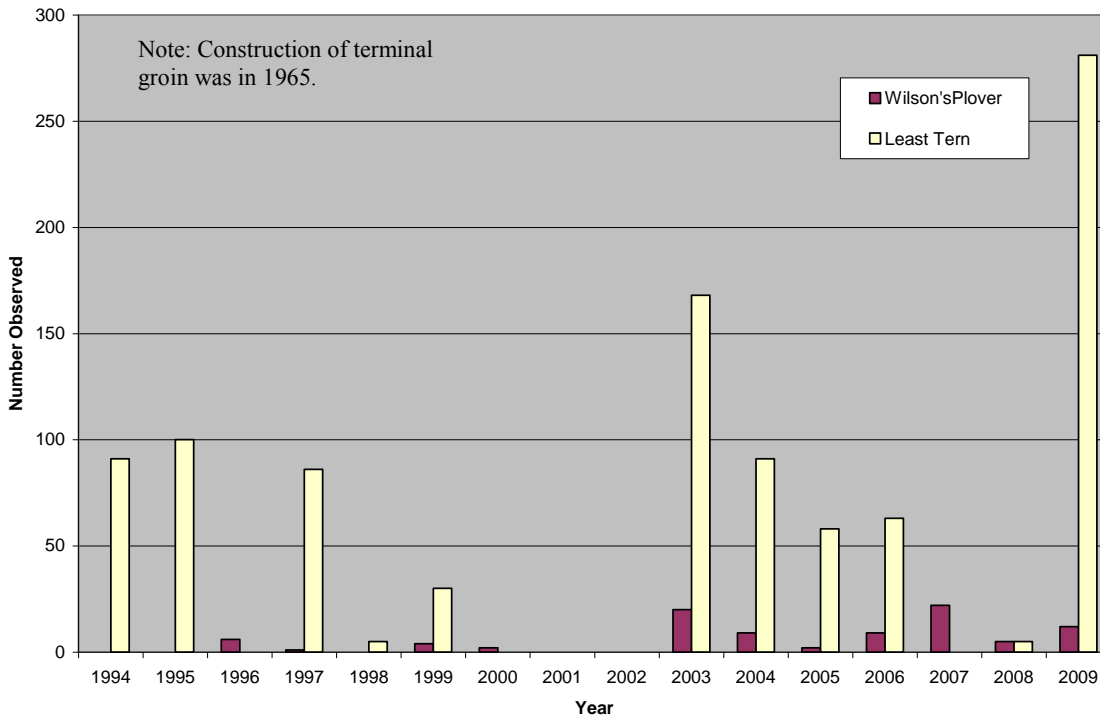


Figure III-25. Annual Least Tern and Wilson's Plover Observations (Fort Macon State Park)

Federally Threatened Species

Piping Plover

Annual piping plover data were obtained from NCWRC for Shackleford Banks West, Fort Macon, and North/South Core Banks (Figure III-26 and Figure III-27). The earliest records for Shackleford Banks West date to 1970; however, pre-2000 records are limited to 3 individuals in 1970, 4 individuals in 1980, 1 individual in 1989, and 1 individual in 1996. It is significant to note that the individuals in 1970 and 1980 represent breeding records. In 2000, a total of 25 individuals were observed on Shackleford Banks West. The number of observations subsequently increased to 72 individuals in 2001. Over the next 5 years, the number of annual observations on Shackleford Banks West steadily declined, culminating with a low of 6 individuals in 2006. The number of observations increased to 38 individuals in 2007 and subsequently declined to 14 individuals in 2008. There have been few recorded observations of piping plovers at Fort Macon. Fort Macon records are limited to one individual in 1996 and 3 individuals in 2006.

In order to compare to a regionally local control site, piping plover records for North and South Core Banks were evaluated from 1983 (Figure III-27). Prior to 2000, annual piping plover observations on the Core Banks were relatively low, with an annual average of 19 individuals observed during the period of 1983 through 1999. The period of 2000 through 2008 was marked by a steady increase in piping plover observations. Annual observations on the Core Banks increased from 57 individuals in 2000 to 241 individuals in 2008. On average, 125 individuals were observed on the Core Banks during the period of 2000 through 2008. In comparison, an average of 33 individuals was observed on Shackleford Banks West during the period of 2000 through 2008.

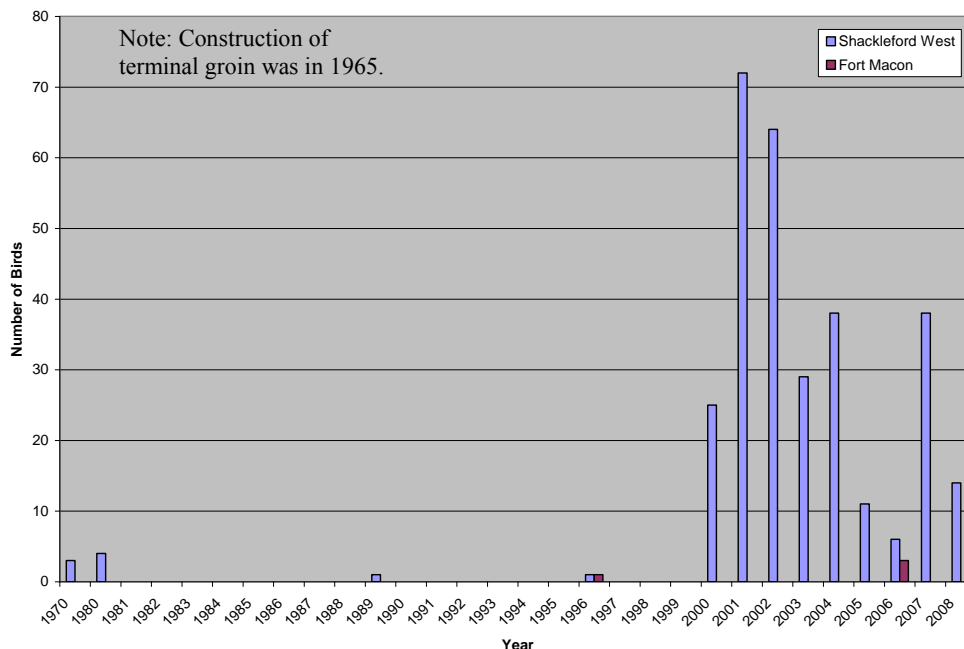


Figure III-26. Annual Piping Plover Observations for Fort Macon and Shackleford Banks, NC

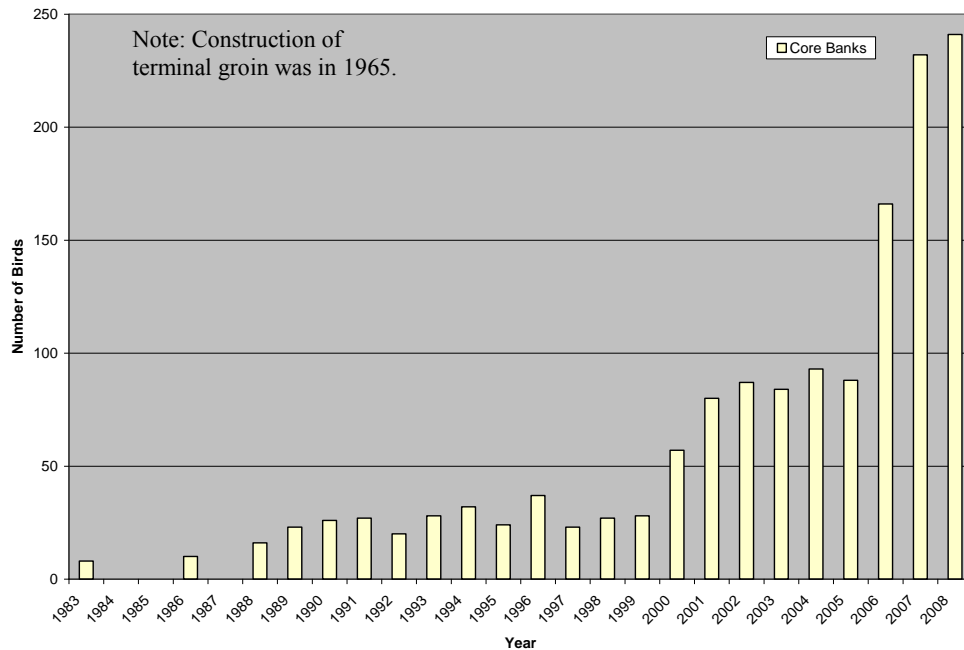


Figure III-27. Annual Piping Plover Observations for Core Banks, NC

The apparent increase in Figure III-26 is in sharp contrast to Christmas Bird Count data which show a significant decline in the numbers of piping plovers using the Beaufort Inlet system from the 1970’s until the present (Personal communication, J. Fussell, bird expert and author, February 2010). The Morehead City Christmas Bird Count circle includes all of the Rachel Carson Reserve, the westernmost two miles of Shackleford Banks, and the easternmost seven miles of Bogue Banks. Thus, it includes all of the major piping plover habitat associated with Beaufort Inlet (i.e. the flats at the western end of Shackleford Banks and the flats within the Rachel Carson Reserve), as well as the shorelines of Fort Macon State Park, which are occasionally visited by the piping plovers from Rachel Carson Preserve/Shackleford Banks. Christmas Bird Count data are not typically obtained by any rigorous scientific methodologies, and the results from year to year certainly vary due to the level of coverage as well as the weather conditions, which can vary considerably from year to year at this season.



Table III-5. Piping plover counts--results of Morehead City Audubon Christmas Bird Count, for 1971 through 2008

1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983
<u>70</u>	22	20	<u>81</u>	<u>54</u>	25	<u>57</u>	20	32	<u>64</u>	<u>54</u>	7	<u>40</u>
1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996
<u>35</u>	24	1	25	17	9	7	8	6	7	13	12	9
1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	
18	16	11	1	1	18	5	25	8	11	NC	19	

Source: John Fussell, compiler for Morehead City Christmas Count from 1971 to present.

NC = Because of severe weather, no count was held in 2007.

All counts of 35 birds or greater are boldfaced and underlined.

The below discussion has been provided by John Fussell, the Morehead City Christmas Bird Count coordinator and compiler since 1971, regarding the results of Table III-5:

- In most cases, the lowest annual counts are due largely to severe weather or other factors that inhibited the level of coverage. In general, it might be best to make conclusions about trends after dropping the two lowest counts for each five-year period;
- The Fort Macon area was covered on all counts;
- The Rachel Carson Reserve was covered every year except 1986 when boat transportation to the Reserve became unavailable. On most years, the coverage of this area was good to very good (this area always gets priority coverage on counts, because it harbors large numbers of shorebirds);
- For most of the years prior to 1984, Shackleford Banks was not covered on the count. For the majority of years from 1984 on, Shackleford Banks has been covered on the count. Coverage of Shackleford Banks has generally been better during the more recent years; and
- Thus, for the count overall it can be inferred that coverage has generally been better during recent years and was less thorough during the earlier years, especially prior to 1984.

The general results of piping plover observations can be summarized as:

- Throughout the count's history, the Rachel Carson area has been a very important piping plover wintering area. Every year that Rachel Carson was covered on the count, piping plovers were found there, and more have always been found there than at other locations within the count circle except for two years;



- Although the western end of Shackleford Banks is also a major wintering site for piping plovers, they are not found there as reliably as at Rachel Carson. However, since 1984 piping plovers have been identified there on more than half of the counts; and
- During the 37 years that the count has been conducted, piping plovers have been found on the beaches of Fort Macon State Park on five occasions. The largest counts were in 1974 and 1975, when 11 and 29 plovers were observed. The last piping plover observed at Fort Macon on the Christmas Bird Count was one in 1989.

Population trends of piping plovers in the Beaufort Inlet area based on these Christmas count data include the following:

- The series of single-digit counts from 1989 through 1993 represents a true population low. Survey coverage was good on all these counts. This period may correspond, at least to some extent, to an overall population low of the species (i.e. prior to recent intensive measures to restore the population beginning to take effect). However, it is probably likely that this series of low counts is at least equally related to the severe snowstorm/wind of 23-24 December 1989 (and subsequent severe cold). This weather event was observed to cause marked mortality of water birds along the North Carolina coast, especially of shorebirds. Because shorebirds often return to the same wintering site each year, a loss of piping plovers at a site one year could result in a lower wintering population for a number of subsequent years;
- The overall pattern from 1971 until present is of a population high in the 1970's followed by a decline until about the early 1990's, followed by some degree of population recovery from about the mid-1990's until the present. The period of recovery of the Beaufort Inlet winter population is certainly related to some degree to the increase of the overall population increase of the species in recent years, an increase related to intensive recovery efforts, particularly of breeding areas on public lands; and
- However, it would seem to be the case that the overall population of the species in the Beaufort Inlet area should now be similar to what it was in the 1970's. Thus, it is probably the case that the decline (from the 1970's to the present) in the population of wintering piping plovers at Beaufort Inlet is due in part to factors within the immediate Beaufort Inlet area.

Some possible reasons for the long-term decline in the number of wintering piping plovers in the Beaufort Inlet system are:

- Based on aerial photography, it appears that there has been a loss in the extent of suitable habitat within the Beaufort Inlet system (comparing aerial photography from the 1960's through 1980 as compared to aerial photography from the period after 1980). This loss of habitat is certainly related to the fact that the shorelines



of the inlet are now largely “anchored” in place, largely the result of the fact that the channel location is stabilized to a major degree.

- The shorelines of the inlet at Fort Macon State Park, which have moved little from year to year, have never been very good habitat for piping plovers.
- Based on aerial photography, there appears to have been a loss of intertidal feeding habitat for piping plovers at both Shackleford Banks and Rachel Carson from the 1970’s until the present. At Shackleford Banks, much of this loss has been due to plant succession. At Rachel Carson, much intertidal habitat has been lost as the outer beach of Bird Shoal has migrated inland (northward). This has resulted in formerly suitable habitat being replaced with subtidal habitat, and other areas of formerly suitable habitat building in elevation such that they are no longer intertidal, or are flooded only during the highest tides.
- Based on aerial photography, there has been loss and degradation of prime roosting/loafing habitat for piping plovers in the Beaufort Inlet system. On Shackleford Banks, plant succession and dune development have caused declines in roosting habitat, i.e. expansive above-tidal flats (and with shorelines being relatively stable since 1980, there has been little to no re-creation of such habitat). At Rachel Carson, there have also been declines in such habitat. The long barrier spit (that forms the outer beach of Bird Shoal) has migrated inland, such that it is not insulated during high tides to the degree it once was. Further, much of this strip has built up into vegetated dunes. At both Shackleford Banks and Rachel Carson, there is still some good roosting habitat, but less of it than formerly, and the fact that there is less makes it harder for birds to find alternative roosting sites when subjected to human disturbance at particular sites.
- There is more human disturbance at both Rachel Carson and Shackleford Banks nowadays as compared to the 1970’s. Further, the decreased extent of suitable roosting sites makes human disturbance more of a problem than it would be otherwise; and
- It is likely that human disturbance has its greatest impact on the wintering population from about late July to Labor Day, when most wintering birds are arriving. It is likely that at this time of the year disturbance and lack of roosting sites causes some birds that might otherwise overwinter here to abandon the area and continue migrating further southward.

As indicated above, piping plover habitats on Fort Macon and CALO are subject to the effects of frequent tropical storms and periodic beach renourishment projects. Since 1991, Fort Macon and CALO have experienced tropical storms and/or hurricanes each year with the exception of 1994, 2001, 2003, and 2005. Due to the high frequency of storm events and the lack of information regarding specific effects of individual storms on piping plover habitats, no relationship between piping plover observations and storm events is readily apparent. Piping plover habitat on Fort Macon is also subject to the effects of periodic beach renourishment projects. Since 1973, Fort Macon beaches have been nourished seven times. Due to the low number of piping plover observations on Fort Macon, and considering the higher number of piping plovers observed on Shackleford Banks West, it can be concluded that appropriate habitat for piping plovers



does not exist on Fort Macon due to multiple factors including beach nourishment and maintenance, the stabilization of the inlet shoreline by the terminal groin, and ongoing maintenance dredging in Beaufort Inlet which disrupts the formation of intertidal shoals, preferred foraging habitat for piping plovers.

Based on discussions with NCWRC, it is difficult to draw many conclusions from available data with respect to the terminal groin at Fort Macon considering pre-construction data is unavailable. It is known that these inlet shoreline dependent birds depend on ephemeral habitats, and stabilization of these areas typically causes vegetation to grow which makes these sites unsuitable for these birds (Personal communication, D. Allen, NCWRC, October 2009).

(5) Fish and Fisheries

The Newport River Estuary is an important nursery area for larval fish, and Beaufort Inlet serves as a passageway for the larvae as they migrate inshore [North Carolina State Ports Authority (NCSPA) 2001]. Patterns of larval transport seem to be tied to the inlet’s flow characteristics. In other words, the majority of incoming larvae are transported to the east toward the estuaries behind Shackleford Banks and to the center toward Beaufort and the Beaufort channel. Approximately 90 percent of incoming larvae are entrained and directed up estuary to either Shackleford Banks or Beaufort Channel (Bulkhead Channel), while 10 percent of larvae are transported through the Morehead City Channel into Bogue Sound and the Newport River Estuary (Blanton et al. 1999; Churchill et al. 1999; NCSPA 2001).

Research conducted by scientists at the NOAA laboratory in Beaufort has documented 129 different species of larval fish in and around Beaufort Inlet to date, finding larvae present during every month of the year. Peters et al. (1995) and Peters and Settle (1994) documented species’ utilization and temporal trends of larval fish transport through Beaufort Inlet. Table III-6 depicts the time periods during which various larval species immigrated through the inlet. Over 52 taxa that included 29 species were identified. Menhaden (*Brevoortia* sp.), spot, Atlantic croaker, and pinfish dominated the majority of the samples. Darkened boxes indicate higher larval abundance.

Table III-6. Peak larval abundance of seven important fish species near Beaufort Inlet

Species	Month						
	Sep	Oct	Nov	Dec	Jan	Feb	Mar
Menhaden						Darkened	Darkened
Summer flounder						Darkened	Darkened
Southern flounder						Darkened	Darkened
Spot					Darkened	Darkened	Darkened
Pinfish				Darkened	Darkened	Darkened	Darkened
Gulf flounder			Darkened	Darkened	Darkened	Darkened	Darkened
Atlantic croaker	Darkened	Darkened	Darkened	Darkened	Darkened	Darkened	Darkened

Source: Peters et al. 1995



Larvae passing downwind and outside the narrow withdrawal zone pass seaward of the inlet shoals and, given the right conditions, will be transported into the next available inlet downstream. The strong asymmetrical tidal flow within Beaufort Inlet also creates cross-channel salinity and temperature gradients during flood tide periods, when larvae are most apt to migrate to estuarine waters (Churchill et al. 1999). As described by NCSPA (2001), salinity and temperature levels measured with *in situ* current meters in the eastern and central sections of the inlet resembled those of shelf water, providing relatively stable water conditions for incoming larvae. However, salinity and temperature measurements in the western section of Beaufort Inlet fluctuate more than those of the eastern and central sections. These fluctuations are a result of the relatively high amount of freshwater input coming from the Newport River which passes through the channel and moves toward the inlet mouth (Kirby-Smith and Costlow 1989). This input creates a mixture of continental shelf and estuarine plume water moving through the channel out of Beaufort Inlet and into the Atlantic Ocean (Churchill et al. 1999a; Luettich et al. 1999). The mixed water could potentially result in unfavorable conditions for larvae migrating through the western section of the inlet. Larvae may attempt to avoid the flow along the western section reducing the amount of larvae transported into the channel.

Hardened structures can potentially interfere with the passage of larvae and early juveniles from offshore spawning grounds into estuarine nursery areas (Street et al. 2005; Kapolnai et al. 1996; Churchill et al. 1997; Blanton et al. 1999) however, based on Physical Assessment Section, terminal groins continue to allow sand to bypass into the adjacent tidal inlet and therefore bypasses larvae into the estuary. Approximately 60 species of larval fish and 34 species of juvenile and adult fish have been documented moving through Beaufort Inlet, Ocracoke Inlet, and Oregon Inlet in the winter and an even greater number of species during the summer months (Hettler and Barker 1993; Peters et al. 1995). Successful transport of larvae from fish spawning on the continental shelf through the inlet occurred within a narrow zone parallel to the shoreline and was highly dependent on along-shore transport processes (Blanton et al. 1999; Churchill et al. 1999; Hare et al. 1999).

Effects may be greatest in coastal areas like the Outer Banks, where there are few inlets. Offshore spawning, estuarine-dependent species that might be effected by hardened structures include many of North Carolina's most important commercial and recreational fish species such as menhaden, spot, Atlantic croaker, shrimp, gag grouper (*Myceteroperca microlepis*), black sea bass, and flounders. Moreover, the areal loss of beach at hardened shorelines is often managed by implementing nourishment projects, possibly having additional effects on the subtidal bottom and potentially obstructing fish passage through adjacent inlets (Blanton et al. 1999).

Commercial fishery landings from the Newport River/Beaufort Inlet area is a million dollar industry, with an average of 683,550 pounds for an annual value of \$1,065,455 from 1994 to 2001 (Street et al. 2005). Over two dozen fishery species have been commercially harvested each year from this system. Blue crab, shrimp, hard clams,



Eastern oyster (*Crassostrea virginica*), mullet, and southern flounder (*Paralichthys lethostigma*) are the largest annual catches by weight from the Newport River and Beaufort Inlet area (NCDMF, unpublished data). The tidal shoal system within Beaufort Inlet also provides spawning habitat for blue crab and red drum.

(6) Benthic Resources

The noticeable differences between the natural and artificial beaches of the project area persist in the wet beach, or the area subject to daily tidal flux. This ecological niche is subject to wave action, which creates alternating periods of subaqueous and subaerial conditions. The fauna adapted to this environment are concentrated in the top 2 to 4 inches [Personal communication, Dr. C.H. Peterson, University of North Carolina (UNC) Chapel Hill, October 2009] and are sensitive to the grain size, geomorphology, and swash energy of the intertidal zone (Alexander et al. 1993; Donoghue 1999). Therefore, the fauna are patchily distributed depending upon the specific physical and hydrologic characteristics at any given location along and across the beach (Bowman and Dolan 1985; Donoghue 1999; Lindquist and Manning 2001). Along Bogue Banks, the wet beach infauna is dominated by polychaete worms, coquina clams, and mole crabs (Diaz 1980; Lindquist and Manning 2001; Peterson et al. 2000a; Peterson and Manning 2001; Reilly and Bellis 1978). Predators foraging on the infauna include shorebirds such as sanderlings and willets and surf zone fish including Florida pompano (*Trachinotus carolinus*) and Gulf kingfish (*Menticirrhus littoralis*) (Lindquist and Manning 2001; Peterson et al. 2000a; Peterson and Manning 2001). The native wet beaches of Bogue Banks often have depressed infaunal populations due to beach scraping and beach fill activities relative to pre-project levels (Peterson et al. 2000a; Peterson and Manning 2001; Reilly and Bellis 1978). The dune face adjacent to the beach provides habitat for ghost crabs and other invertebrate species. This ecological community has been disrupted by beach scraping, or bulldozing, along the majority of the island's beaches. The scraping has degraded the biological community naturally found in the dune scarp and dune toe, suppressing the abundance and distribution of fauna such as ghost crabs (Conaway 2000; Peterson et al. 2000a; Peterson and Manning 2001).

In 1994, quantitative sampling of benthic invertebrates was conducted within the Beaufort Inlet ebb tidal delta (Peterson et al. 1995). Sampling was conducted within a planned dredged material disposal area on the west side of Beaufort Inlet and in a control area on the east side of the inlet. In order of abundance, the most common organisms in the core samples were polychaetous annelids, bivalve molluscs, crustaceans (amphipods), echinoderms, and nematodes. Sampling results indicate a strong association between polychaete/amphipod density and water depth. Polychaete density increased with depth, whereas the density of amphipods decreased with depth. Core sample densities were similar to those found in other North Carolina estuaries and lagoons where demersal predation is a dominant ecological factor. Larger epifauna and infauna represented in the scrape samples included sand dollars, olive shells, brown shrimp, and other taxa. The densities of larger epifauna and infauna were generally lower at the deepest depth stratum; however, the relationship between depth and patterns of abundance varied in a complex fashion among transects. Variation in sampling results between the treatment and control



areas indicate that the two sides of the inlet are not symmetrical with regard to environmental processes or benthic community composition. Peterson et al. (1995) postulate that the differences are due to differences in water circulation patterns and sedimentation.

Additional baseline sampling of benthic invertebrates was conducted in the same areas in 1996 (Peterson et al. 1996). In order of abundance the most common benthic organisms in the core samples were polychaetous annelids, bivalve molluscs, and crustaceans (amphipods). Core sample densities were again similar to those found in other North Carolina estuaries and lagoons where demersal predation is a dominant ecological factor. Sampling again indicated that the two sides of the inlet are not symmetrical with regard to environmental processes or benthic community composition.

In conjunction with the development of the Morehead City Harbor Dredged Material Management Plan (DMMP), Wilmington District USACE is investigating opportunities to expand the existing nearshore ocean disposal area off Bogue Banks (west of Beaufort Inlet) and create a new nearshore ocean disposal area off Shackleford Banks (east of Beaufort Inlet). Prior to the placement of any maintenance material into the existing/expanded nearshore ocean disposal area off Bogue Banks and the new nearshore area off Shackleford Banks; the characterization of the marine benthic macroinvertebrate community and associated sediment particle size, followed by analysis of community parameters via statistical treatment was required. The results of this 2009 characterization study will be available in early 2010 (Personal communication, D. Piatkowski, USACE Wilmington District, February 2010). The deposition of dredge material from navigational channel maintenance on estuarine or coastal dredge disposal sites, ebb tidal deltas, or other areas of subtidal bottom results in increased turbidity, temporary reduction in and slow recovery of the abundance and diversity of benthic invertebrates (SAFMC 1998).

(7) Cultural and Hardbottom Resources

Fort Macon State Park is managed by the state and contains high archaeological value as an historic military defense site in coastal North Carolina. Beaufort Inlet has more recently received scientific attention as a shipwreck believed to be Blackbeard's Queen Anne's Revenge has been discovered on the southwestern portion of the inlet's ebb tidal delta. Other shipwrecks adjacent to Beaufort Inlet are currently being investigated for archaeological significance and recovery.

A recent hardbottom and cultural resources survey was conducted by the USACE in the fall of 2009 within the vicinity of the nearshore disposal area offshore of Fort Macon as well as the proposed offshore site near Shackleford Banks' western end. The surveys were conducted as part of on-going efforts by the USACE to expand nearshore disposal options associated with maintenance dredging of Beaufort Inlet (Figure III-28). The purpose of this work is to assess the presence and/or absence of both cultural and hardbottom resources within the USACE's proposed nearshore disposal areas (i.e. off Bogue Banks and Shackleford Banks) for the Morehead City Harbor DMMP.



Preliminary results indicate no hardbottom resources are present within the investigation areas shown in Figure III-28 (Personal communication, D. Piatkowski, USACE Wilmington District, February 2010). Other studies by Moser and Taylor (1995), including data on hardbottom locations in North Carolina waters (i.e., within 3 nautical miles of shore), have confirmed no hardbottom resources within the nearshore area of the Fort Macon terminal groin.

In the 2009 cultural resources survey, the USACE confirmed through magnetometer, side-scan sonar, and sub-bottom profile surveys significant magnetic and/or sonar anomalies that might represent cultural resources; however, the sources and exact locations have not been identified as of yet.

c) Summary of Findings

As described by USFWS (2002), the Beaufort Inlet area has been characterized as a significant resource. The NCNHP has delineated several SNHA within the area, including the Rachel Carson National Estuarine Research Reserve (NERR) to the northeast and Shackleford Banks to the east. Beaufort Inlet's tidal dynamics and dredging maintenance processes are the chief factors affecting the sedimentation patterns and sand distribution in and out of Beaufort Inlet.

Seabeach amaranth has experienced a great deal of natural population variability from one year to the next. These natural fluctuations can be attributed to a number of factors; such as erosion, storms, and seed dispersal. Since 1991, Fort Macon beaches have been nourished four times. Seabeach amaranth numbers increased following renourishment projects in 2002 and 2007, whereas numbers decreased following renourishment projects in 1993 and 2004. Based on these data, no consistent relationship between seabeach amaranth numbers and renourishment projects is readily apparent.

Since 1973, Fort Macon beaches have been nourished seven times. Sea turtle nesting densities increased following renourishment projects in 1986, 2002, 2004, and 2007; whereas nesting density decreased following renourishment in 1993. These data indicate that renourishment may have a positive effect on sea turtle nesting. Although historical data for sea turtle nesting was obtained, it is difficult to analyze as Fort Macon State Park relocates most of the nests due to the high number of tourists.

In 1998, the Beaufort Inlet system encompassed approximately 463 acres of shoals and inlet shoulders available to shorebirds and colonial waterbirds (Figure IV-20). This was the fifth largest flood tidal shoal system in North Carolina with only Cape Fear River, New Drum, Oregon, and Ocracoke Inlets exceeding it. Overall, Beaufort Inlet provided the sixth largest inlet complex in North Carolina in terms of habitat available to migratory shorebirds and waterbirds in 1998 (USFWS 2002). Lack of historic natural resource data hinders drawing conclusions on the effects of the construction and operation of the terminal groin on natural resources. However, the inlet shoreline adjacent to the Fort



Macon terminal groin does not appear to be suitable for either colonial nesters or shorebirds based on preliminary analysis of historical aerial photographs and available historical shorebird and colonial waterbird data. Colonial waterbirds and shorebirds depend on ephemeral habitats while stabilization of inlet shoreline usually causes vegetation growth that results in unsuitable habitat and not having historical pre-construction bird surveys makes it difficult to conclusively say whether suitable habitat existed prior to terminal groin construction or if the terminal groin may have caused the loss of suitable habitat. Shorebird habitat on Fort Macon is also subject to the effects of periodic beach renourishment projects. Since 1973, Fort Macon beaches have been nourished seven times. Least tern and Wilson's plover observations at Fort Macon increased following renourishment projects in 2002, 2004, and 2007. These data indicate that renourishment may have a positive effect on habitat utilization by these species.

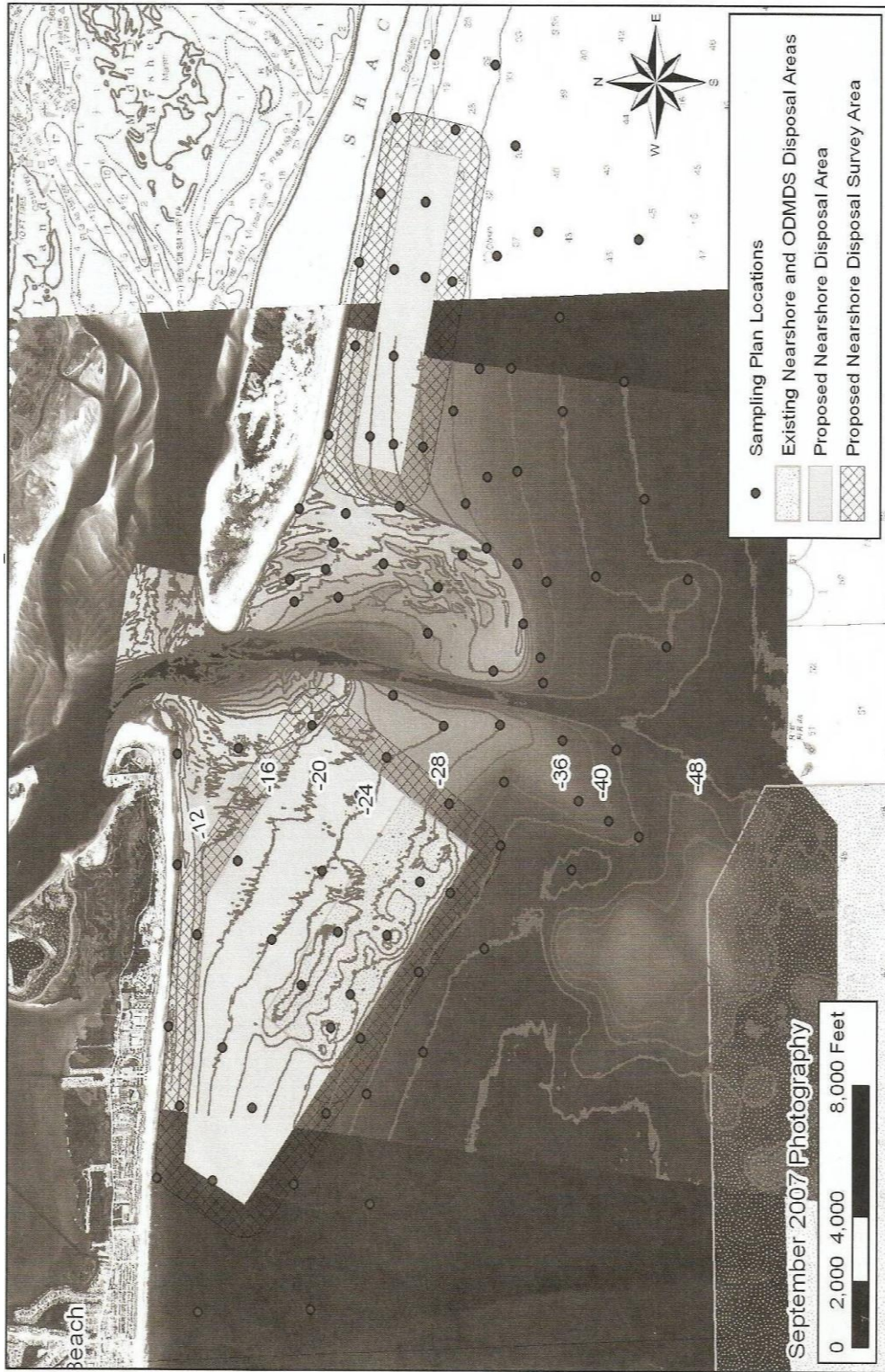


Figure III-28. Location of Hardbottom and Cultural Resource Surveys Offshore of Beaufort Inlet, Source USACE 2007



Piping plover habitat on Fort Macon is also subject to the effects of periodic beach renourishment projects. Due to the low number of piping plover observations on Fort Macon, no conclusions can be drawn regarding the effects of renourishment on piping plovers. However, considering the higher number of piping plovers observed on Shackelford Banks West, it can be concluded that appropriate habitat for piping plovers does not exist on Fort Macon.

The native beaches of Bogue Banks often have depressed infaunal populations due to beach scraping and beach fill activities relative to pre-project levels (Peterson et al. 2000a; Peterson and Manning 2001; Reilly and Bellis 1978). The deposition of dredge material from navigational channel maintenance on estuarine or coastal dredge disposal sites, ebb tidal deltas, or other areas of subtidal bottom results in increased turbidity. The cumulative modifications in Beaufort Inlet results in a temporary reduction and slow recovery of the abundance and diversity of benthic invertebrates (SAFMC 1998).

The Newport River Estuary is an important nursery area for larval fish, and Beaufort Inlet serves as a passageway for the larvae as they migrate inshore [North Carolina State Ports Authority (NCSPA) 2001]. Patterns of larval transport seem to be tied to the inlet's flow characteristics. In other words, the majority of incoming larvae are transported to the east toward the estuaries behind Shackelford Banks and to the center toward Beaufort and the Beaufort channel. Hardened structures can potentially interfere with the passage of larvae and early juveniles from offshore spawning grounds into estuarine nursery areas (Street et al. 2005; Kopolnai et al. 1996; Churchill et al. 1997; Blanton et al. 1999) however; terminal groins continue to allow sand to bypass into the adjacent tidal inlet and therefore are likely bypassing larvae into the estuary.

A recent hardbottom and cultural resources survey was conducted by the USACE in the fall of 2009 within the vicinity of the nearshore disposal area offshore of Fort Macon as well as the proposed offshore site near Shackelford Banks' western end. Preliminary results indicate no hardbottom resources are present within the investigation areas and the sources and exact locations of potential cultural findings have not been identified as of yet.

3. Amelia Island, Nassau Sound, Florida

a) General Site Description

As described by Olsen (1993); Nassau Sound is a natural, unmaintained entrance connecting the Nassau River, South Amelia River, and the Atlantic Intracoastal Waterway (AIWW) with the Atlantic Ocean. Nassau Sound separates Amelia Island to the north from Little Talbot Island to the south (Figure III-29).

From 1993 to 2003, the southern terminus of Amelia Island had receded to such a degree that the historical sandy spit formation associated with the Amelia Island State Park (AISP) had been completely lost. The AISP is located in northeast Florida, in eastern Nassau County. In order to stabilize south Amelia Island, a two phase construction



project plan was formulated. An EA performed for Phase I was completed in September 2001 (DC&A 2001a). Phase I, constructed in the summer of 2002, stabilized the beach area by dredging and placing approximately two million cubic yards of material within the eroded area (Olsen Associates, Inc. 2003). Phase II of the stabilization plan involved the construction of terminal structures at the south end of Amelia Island to provide a physical “template” which would preclude the nourished shoreline from receding back to its 2002 pre-nourishment configuration. As described in DC&A (2003), the synthesis of these two projects would provide long-term benefits that otherwise would not be accomplished with just one or the other.

The long-term benefits of these two projects include the erosion reduction of Amelia Island’s south end and the continued protection of the recreational beach, wildlife nesting areas, and landward natural communities.

Inlet migration had placed increased erosion pressure on the southern end of Amelia Island prompting coastal engineering actions intended to protect valuable resources along the AISP and adjacent to privately held lands northward. Without the Phase I renourishment project, the sandy beach would have experienced further effects not only to public recreational use, but would continue to degrade both the shoreline and the maritime forest to a point that wildlife species would not have been able to utilize the area for nesting, foraging, and roosting. Long-range beach management decisions by both public and private interests were implemented to help resolve the erosion problem. Phase II was proposed to increase the longevity of the restored beach area and surrounding communities (DC&A 2003).

The principal objectives of this project were to ensure the long-time maintenance of a suitably wide shoreline and the protection of adjacent maritime forest from erosion and inundation caused by typical (seasonal) wave conditions and high frequency storm events (DC&A 2003). Phase I of the south Amelia Island stabilization project was necessary to address an emergency condition; whereby, chronic inlet-related shoreline erosion was threatening the upland maritime forest and associated environmental resources located predominately within AISP. Phase I provided a reliable template to secure the project site while awaiting the second construction phase. The goal of Phase II was to supplement Phase I renourishment efforts with structures that would provide continued stability of the project site. Deemed successful, the project has adequate nesting/foraging/roosting areas for sea turtle and least tern use, while at the same time increasing the shoreline width for continued reliable, public recreational use (Olsen Associates, Inc. 2008).

(1) Aesthetics

Although aesthetics were not evaluated by DC&A (2003), based on a general review of aerial photography, the visual environment of AISP did not significantly change from pre-construction to post-construction of Phase II.

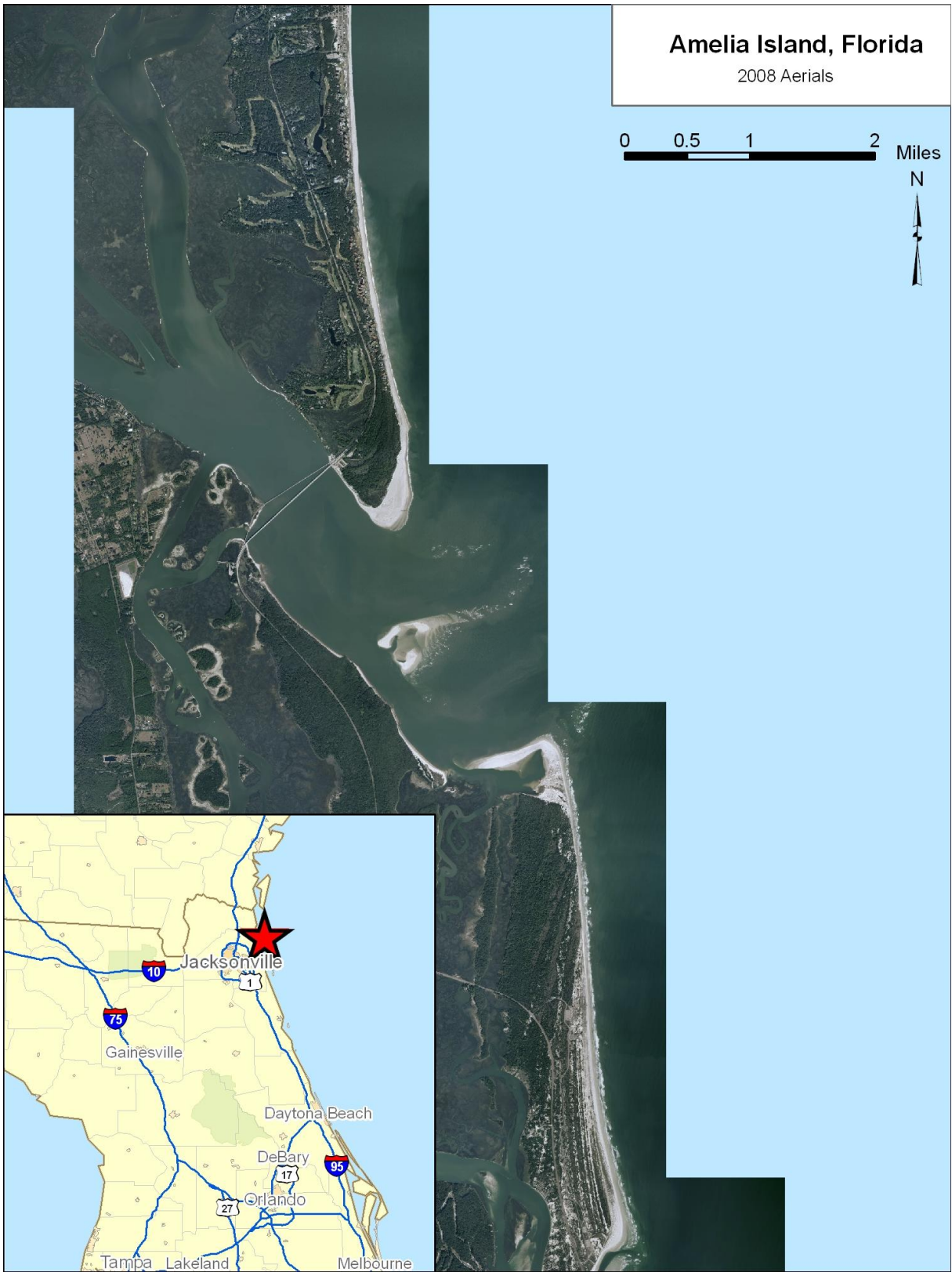


Figure III-29. Amelia Island, Florida



(2) Recreation

Within the AISP, all upland uses are either recreational or for conservation purposes. Northward of the AISP and within the Phase II project area, all upland uses are residential (single-family or multi-family). The shoreline immediately adjacent to the terminal structure is open to the public. In the AISP, a small attendance fee is collected (generally on the honor system). That fee did not change due to the project, and is applied to costs associated with maintaining the Park facilities.

The AISP is an important fishing destination for citizens of both Nassau and Duval Counties. The waters offshore of the project site and surrounding areas are used primarily by recreational boating traffic (DC&A 2003). Small recreational boats comprise the majority of crafts within Nassau Sound. Commercial boat traffic does traverse the area, but generally occurs outside of the immediate project area in order to avoid the Nassau Sound shoals. Recreational diving in the immediate area is extremely limited due to the strong currents, shallow depths and dark water/limited visibility (Olsen Associates, Inc. 2002).

Effects to navigation associated with the terminal groin were proposed to be minimal (DC&A 2003). Small craft utilizing the area would need to avoid the terminal structures and breakwater. Design plans indicate that the structures would be visible above the mean high water line. Therefore, the structures would be seen by boaters and avoided. Since commercial boat traffic does not utilize the near-shore area within the project boundaries, navigation for these vessels does not pose a problem.

(3) Public Access

Amelia Island contains a total of 14 miles of oceanfront beach. The majority of the beach contains private, residential houses west of the primary dune. However, AISP and Fort Clinch State Park (Fort Clinch) provide public access for recreational use of the shoreline. Additionally, public access to the South Amelia beaches is provided at several designated areas. All of the publicly owned access areas, especially the AISP and Fort Clinch are popular destinations for local citizens and visitors to use for multi-purpose recreation.

During Phase II shoreline stabilization activities, the use of the beach was restricted temporarily. The restrictions were implemented to protect the public's safety from the machinery, equipment and equipment staging areas. As soon as construction was completed, the beach was reopened to the public.

b) Natural Resources

Nassau Sound has existed as a natural inlet system for at least as long as historic charts indicate (Olsen Associates, Inc. 2001). Natural forces such as tides, currents, and waves continually interact within the project area, as well as the surrounding landscapes. These events continue to help characterize physical features of the Nassau Sound area. Although unstabilized, Nassau Sound has been affected over the last century as a direct



result of man-induced activities that include two Department of Transportation bridges, the excavation of the Atlantic Intracoastal Waterway, and the construction of navigation projects at the Saint (St.) Mary's River entrance and the St. Johns River entrance (Figure III-30). The Physical Assessment Section describes the partially permeable and low groin structures that were designed to reduce the alongshore transport rate of sand without adversely affecting various land forms in nearby Nassau Sound. The groin and breakwater were built leaky enough to permit some sand to continue to pass into the sound and along the downdrift shoreline.

(1) Vegetation

The Florida Department of Transportation's Florida Land Use, Cover and Forms Classification System (FLUCCS) was utilized to describe the natural communities within the Phase II project boundaries. Three major communities identified include: coastal scrub, live oak, and saltwater marsh (Figure III-30). An additional community, the nearshore open sand/benthic habitat, is described under Benthic Resources.

As described by DC&A (2003), construction of the stabilization structures would provide increased protection of the vegetative communities. Completion of the Phase I beach renourishment provided initial protection of the coastal scrub and live oak communities. The stabilization structures furthered the measures being taken to protect the vegetative communities.

Accumulation of sand at the landward end of the terminal structure was proposed to stabilize the existing dune and vegetation by significantly reducing the erosion and overwash that occurs in existing conditions. Expansion of the vegetation across the new sand accumulation was expected, and is consistent with that observed along the accretionary, inboard end of structures such as is observed at the north sides of St. Lucie Inlet, Port Canaveral, St. Augustine, and St. Johns River Entrance (Olsen Associates, Inc. 2003).

The terminal groin located west of the A1A bridge was proposed to help protect salt marsh and therefore, provide habitat protection for the diamondback terrapin (*Malaclemys terrapin*) and other species that utilize that habitat (DC&A 2003). Based on a preliminary evaluation of aerial photographs pre- and post-construction of the terminal groin, no significant changes have been observed in vegetation communities (Olsen Associates, Inc. 2008).

(2) Sea Turtles

Loggerhead sea turtles use the habitats offshore of Nassau County to varying degrees during different stages of their life cycle. During the summer months, hatchlings utilize this habitat as a corridor to deeper waters farther off the coast. Juvenile and sub-adult sea turtles may utilize the offshore habitats as a foraging area, while adult sea turtles are present year-round with seasonally high abundances during the breeding season. The green sea turtle follows similar life cycles as the loggerhead sea turtle, although their abundance in the project area is greatly reduced or rare. Green sea turtles utilize the



habitats offshore of Nassau County to varying degrees during different stages of their life cycle. During the summer months, hatchlings utilize this habitat as a corridor to deeper waters farther off the coast. Juvenile and sub-adult green sea turtles may utilize the offshore habitats as a foraging area, while adults are sporadically present year-round with their greatest occurrence during the breeding season.

The loggerhead sea turtle is the most common sea turtle nesting on Amelia Island (Figure III-31). Loggerhead sea turtles nest on ocean beaches, with nests typically positioned between the high tide line and the dune front. Relatively narrow, steeply sloped, coarse-grained beaches are the preferred nesting habitat (NMFS and USFWS 2008). The green sea turtle nesting habits are similar to the loggerhead sea turtle, although green sea turtle nesting is uncommon within Nassau County. Over the course of 12 years, the nest records ranged from 0 to 4 per year (average = 0.8) [Florida Marine Research Institute (FMRI) 2000]. According to USFWS (2001b), a total of 10 nests were recorded for green sea turtles on Amelia Island between 1988 and 1999 with 2 nests occurring within the area that received nourishment. There are no records of green sea turtles nesting within the Phase II project area (USFWS 2004). The leatherback sea turtle, a relatively uncommon visitor to Amelia Island, was recorded to nest three times on Amelia Island, with one (1) nest occurring within the re-nourished area between 1988 and 1999. There are no records of leatherback sea turtles nesting within the project area of Phase II (USFWS 2004).

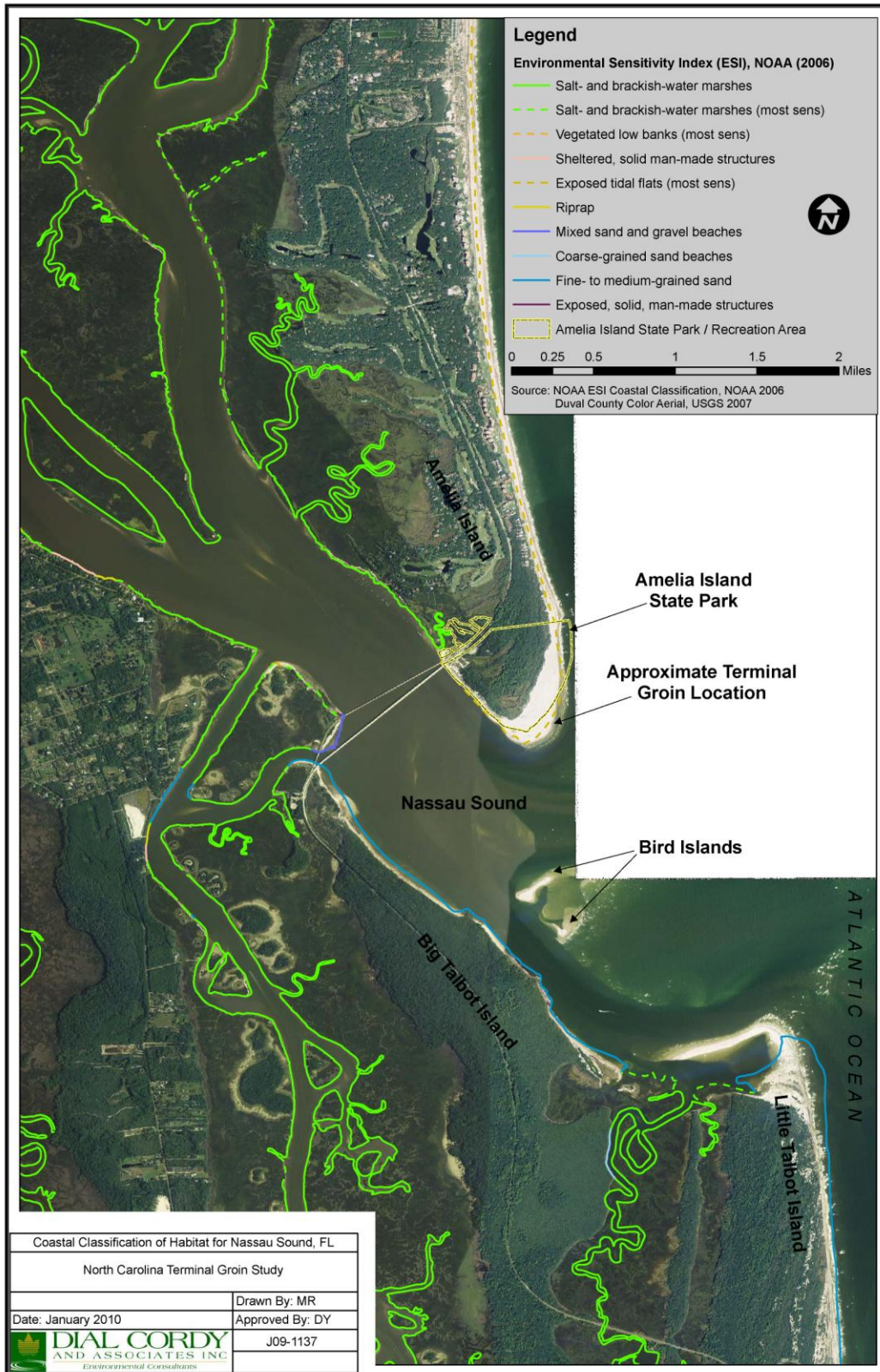


Figure III-30. Coastal Classification of Habitat for Nassau Sound, FL

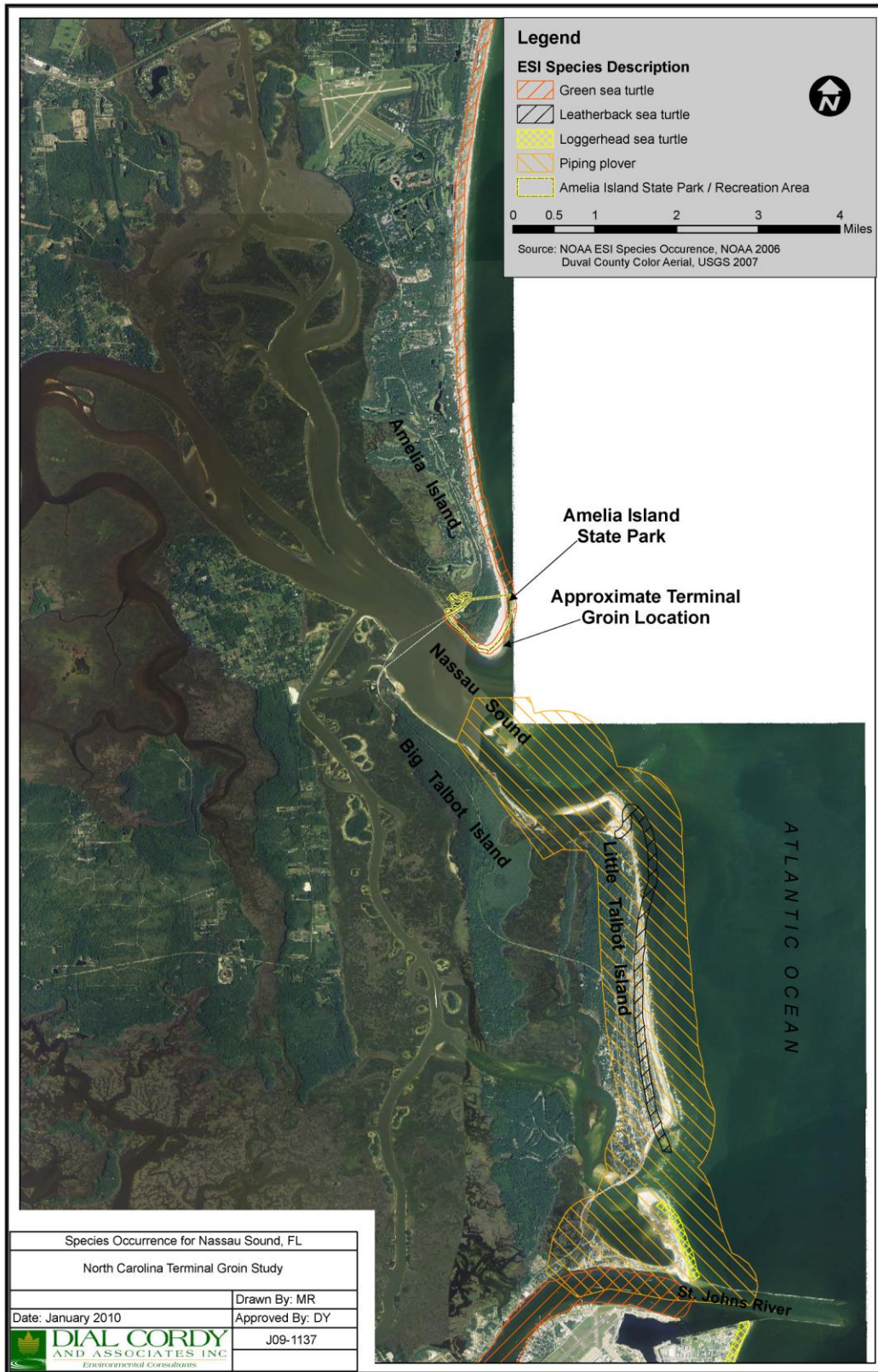


Figure III-31. Species Occurrence for Nassau Sound, FL



Sea turtle nesting data for Amelia Island, AISP, and Little Talbot Island State Park were obtained from the FFWCC (Personal Communication, B. Brost, FFWCC, February 2010), the Fish and Wildlife Research Institute (http://research.myfwc.com/features/category_sub.asp?id=2309), the USACE Sea Turtle Data Warehouse (<http://el.erdc.usace.army.mil/seaturtles/>), and the Florida Shore Protection and Sea Turtle Management System: (<http://el.erdc.usace.army.mil/flshore/refs.cfm?County=None>).

Sea turtle nesting data for Amelia Island dates back to 1986 (Figure III-32). On average, 74 nests were recorded annually from 1986 through 2005. The annual number of nests was relatively low from 1986 through 1989, with a range of 31 to 57 nests. Numbers fluctuated widely from 1990 through 1999, with a low of 30 nests recorded during 1993 and a peak of 120 nests recorded during 1999. The number of nests declined steadily over the next three years, reaching a low of 51 in 2002. There was a resurgence of nesting activity in 2003, when an all-time high of 121 nests was recorded.

The number of nests declined sharply to 46 in 2004, followed by an increase to 70 in 2005. Other than the steady decline between 1999 and 2003, no obvious trends in nesting activity are evident over the course of the monitoring period. Additional data specific to AISP spans the period of 2004 through 2008 (Figure III-32). On average, three nests have been recorded annually over the course of the five-year monitoring period. Nesting data for Little Talbot Island State Park spans the period of 2004 through 2008 (Figure III-32). On average, 26 nests have been recorded annually over the course of the five-year monitoring period. The number of nests recorded ranged from 2 to 43. Due to inconsistent monitoring protocols and the lack of historical monitoring data for AISP, it is difficult to draw conclusions regarding the effects of the terminal groin on sea turtle nesting (Personal Communication, M. Simmons, Biologist, AISP, February 2010).

Sea turtle nesting habitat on Amelia Island is subject to the effects of tropical storms. Sea turtle nesting densities on Amelia Island declined following storm events in 1988, 1996, and 2000; whereas nesting densities increased following storm events in 2002 and 2004. Based on these data, there does not appear to be a consistent relationship between Amelia Island nesting densities and storm events. Due to the limited data set for Little Talbot State Park and AISP (2004 – 2008), conclusions regarding the effects of tropical storms on nesting at these sites are not possible. Sea turtle habitats on Amelia Island are also subject to the effects of periodic beach renourishment projects. Amelia Island beaches were nourished nine times between 1986 and 2005. Sea turtle nesting densities declined following renourishment in 1988, 1991, 1994, and 2001; whereas nesting densities increased following renourishment in 1987, 1989, 1993, 1997, and 2002. Based on these data, there does not appear to be a consistent relationship between Amelia Island nesting densities and renourishment events.

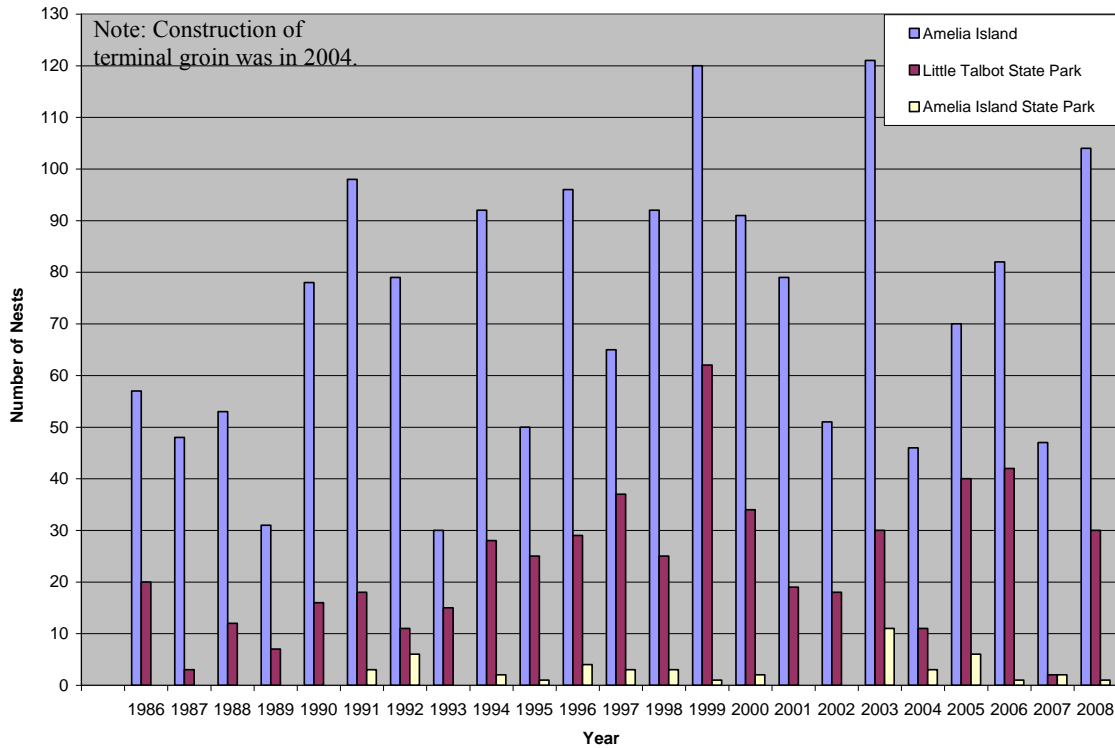


Figure III-32. Sea Turtle Nesting Data from Amelia Island and Little Talbot State Park

Based on the Biological Opinion of the USFWS (2001a and 2004), the Shoreline Stabilization project affected only one mile of the approximately 1,400 miles of available sea turtle nesting habitat in the southeastern United States. Research has shown that the principal effect of such shoreline stabilization projects on sea turtle reproduction is a reduction in nesting success, and this reduction is most often limited to the first year following project construction (USFWS 2004). Research has also shown that the effects of a shoreline stabilization project on sea turtle nesting habitat are typically short-term because an affected beach will be reworked by natural processes in subsequent years, and beach compaction will decline.

Nests laid on nourished beaches generally hatch successfully (Nelson and Dickerson 1988) as Herren (1999) found no significant difference in hatching success in the nourished area in the first or second season after the Sebastian Inlet, Florida, sand transfer nourishment. Although Ecological Associates, Inc. (EAI) (1999) found lower overall hatch success on nourished beaches following construction compared to controls; the differences were not statistically different. The EAI study did show changes in incubation environment, but these changes did not affect the hatching success. These changes, along with changes in beach sediment composition did not affect hatching success in the EAI study. Both the Herren (1999) and EAI (1999) studies point to erosional losses of nests laid low on the newly constructed berms as the primary source of effect. A proper relocation program, if needed, could largely eliminate this source of effect.



(3) Shorebirds and Waterbirds

The permit for Phase II construction of this South Amelia Island Shore Stabilization Structures Project was issued 27 August 2003. Because of concerns raised during the evaluation of the permit application, an extensive monitoring program and the Shorebird Management Plan (SMP) were included as requirements in the permit. The primary concern raised was the potential effects the structure might have on the sediment transport system, which affects the sediment balance of the islands and shoals in Nassau Sound, collectively known as the “Bird Islands.” These islands and shoals have historically provided critical nesting, resting, and feeding habitat for a variety of shorebird and seabird species. Based on pre- and post-survey data within Nassau Sound, the Bird Islands have not experienced a change in total acreage (Personal communication, A. Browder, Sr. Engineer, Olsen Associates).

As described in the SMP (DC&A 2003), no significant adverse effects to shorebird or seabird populations were expected to occur during the construction phase of the project. Although, based on the Biological Opinions of USFWS (2001a, 2004), construction of the terminal structure was expected to have a minor affect; i.e., reduction in the amount of littoral sand transport into Nassau Sound, until the system stabilizes six months following construction. This project was expected to have the potential to result in the temporary loss of a minor, possibly insignificant portion of the Nassau Sound/Bird Island shoal and spit complex.

Historical Shorebird Use—Pre-Construction Survey Results

A total of ten species of shorebirds have been documented nesting within the area (Table III-7). The FDEP - Division of Recreation and Parks staff has systematically surveyed known shorebird nesting areas to document breeding activities since 1988. Historically, nesting by shorebirds on south Amelia Island occurred almost entirely at the southern tip of the island, within the boundary of AISP. Nesting on Little Talbot Island has been largely restricted to nesting by least terns, concentrated on the north end, though some nesting by other species has occurred on both the north and south ends. As described in the SMP (2004), Wilson’s plovers have consistently nested on both islands, but their nests may be harder to detect since they form loose, less visible, colonies. American oystercatchers, another more solitary nester, have more commonly nested on Little Talbot Island, though in low numbers.

The FDEP records for other shorebird species date back to 1997; however, there are few records prior to 2003 for Amelia Island and few records prior to 2002 for Little Talbot Island and the Bird Islands. Due to the lack of data, the evaluation of non-nesting shorebird records for Amelia Island was limited to 2003 onwards, and the evaluation of non-nesting shorebird records for Little Talbot Island and the Bird Islands was limited to 2002 onwards. Selected species that were evaluated included the American oystercatcher, black skimmer, Caspian tern, common tern, gull-billed tern, least tern, red knot, roseate tern, and Wilson’s plover.

Table III-7. Shorebird species confirmed to nest in the Nassau Sound area, with known nesting locations indicated

Common Name	Scientific Names	Locations		
		Little Talbot Island	Nassau Sound Shoals	Amelia Island
Wilson's plover	<i>(Charadrius Wilsonia)</i>	X	X	X
Killdeer	<i>(Charadrius vociferus)</i>			X
American oystercatcher	<i>(Haematopus palliates)</i>	X	X	X
Willet	<i>(Catoptrophorus semipalmatus)</i>		X	
Laughing gull	<i>(Larus atricilla)</i>		X	
Gull-billed tern	<i>(Sterna nilotica)</i>		X	
Royal tern	<i>(Sterna maxima)</i>		X	
Sandwich tern	<i>(Sterna sandvicensis)</i>		X	
Least tern	<i>(Sterna antillarum)</i>	X	X	X
Black skimmer	<i>(Rynchops niger)</i>		X	X

Source: Amelia Island State Park Shorebird Management Plan

On Amelia Island, the total number of individuals representing all of the selected species increased from 783 in 2003 to 1,828 in 2004 (Figure III-33). The total number of individuals declined to 952 in 2005 and 540 in 2006. Numbers remained steady at 571 in 2007, followed by an increase to 1,251 individuals during 2008. Least terns were the most abundant species, with an average of 315 individuals observed annually over the course of the six-year monitoring period (2003 through 2008). Other abundant species included black skimmers (annual average of 288), Caspian terns (annual average of 158), and red knots (annual average of 99). Of the selected species, nesting by least terns, Wilson's plovers, and black skimmers has been documented on Amelia Island (Figure III-34). Since 2002, a total of 706 nests have been recorded on Amelia Island. Least terns account for the majority of the nests, with a total of 581 nests recorded from 2002 through 2007. Records for other species include 100 black skimmer nests in 2006 and 25 Wilson's plover nests from 2003 through 2007.

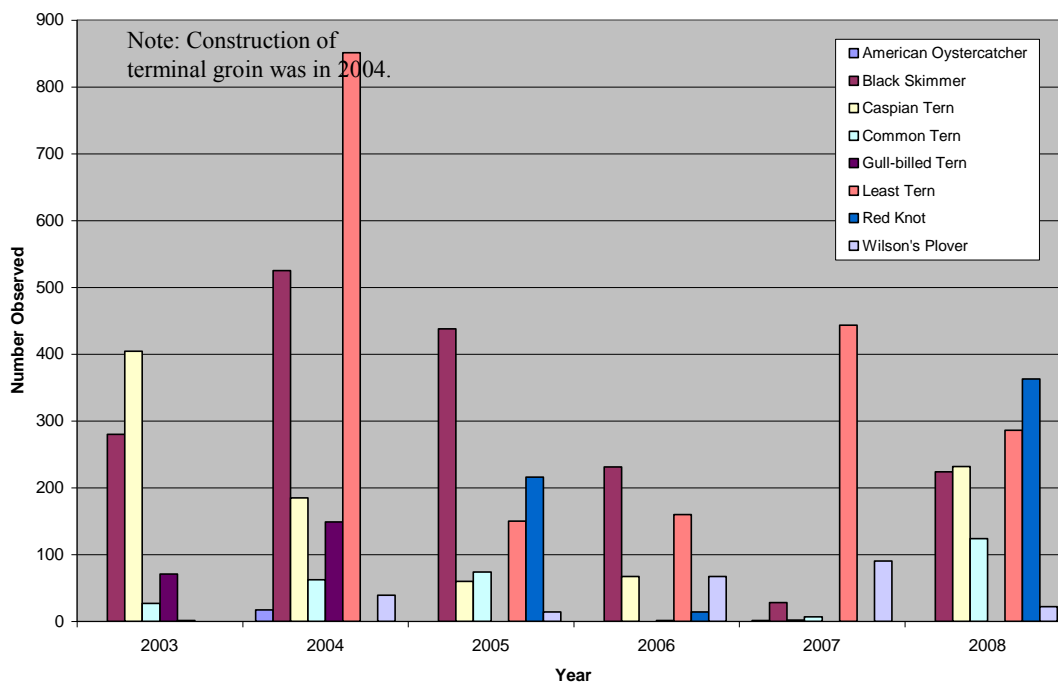


Figure III-33. Amelia Island State Park Non-Nesting Shorebird Observations

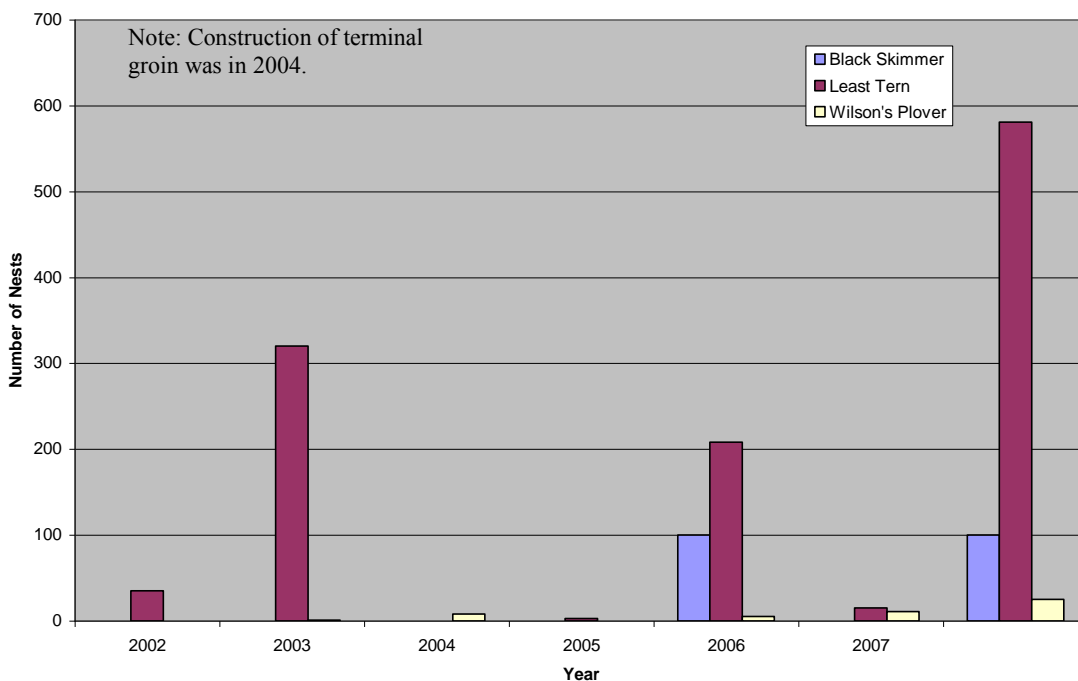


Figure III-34. Amelia Island Nesting Shorebird Observations

On the Bird Islands, the total number of individuals representing all of the selected species increased from 3,261 in 2002 to 15,697 in 2003 (Figure III-35). The total number of individuals declined to 2,150 in 2004, increased to 5,579 in 2005, and declined to 2,765 in 2006. Total numbers declined further to 396 in 2007 and remained relatively low at 937 in 2008. Red knots were the most abundant species, with an average of 1,861

individuals observed annually over the course of the seven-year monitoring period (2002 through 2008). Other abundant species included common terns (annual average of 1,193), black skimmers (annual average of 537), Caspian terns (annual average of 334), and least terns (annual average of 174). Nesting records for the Bird Islands include 185 black skimmer nests in 2003, four gull-billed tern nests in 2003, one Wilson’s plover nest in 2003, and 38 black skimmer nests in 2005 (Figure III-36).

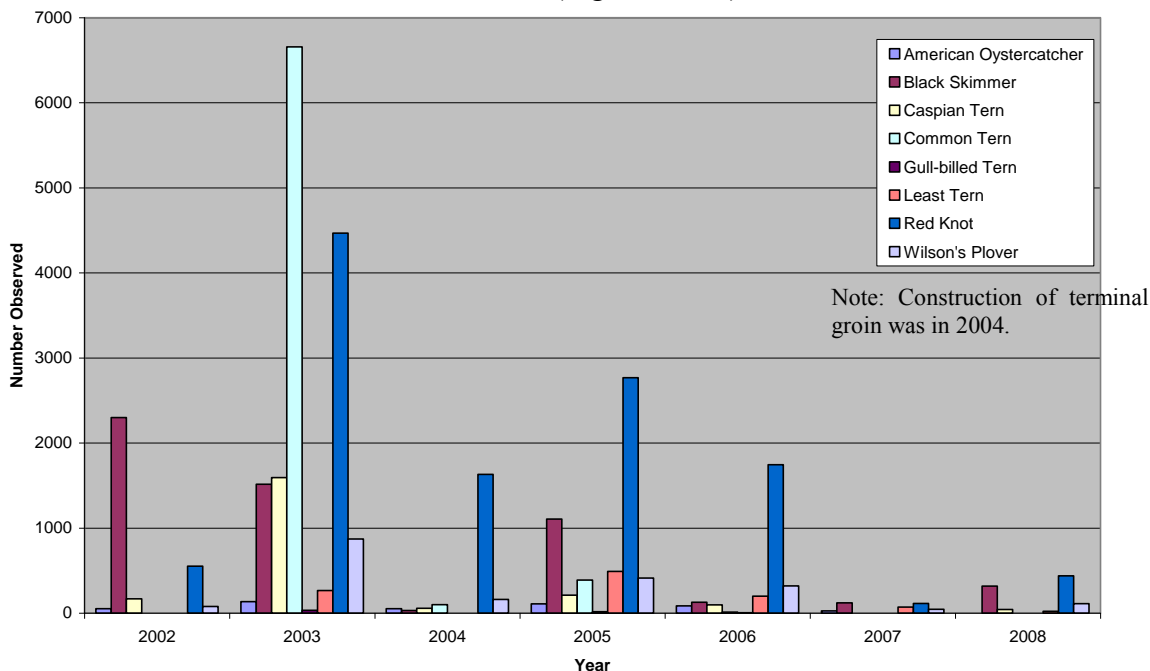


Figure III-35. Bird Islands Non-Nesting Shorebird Observations

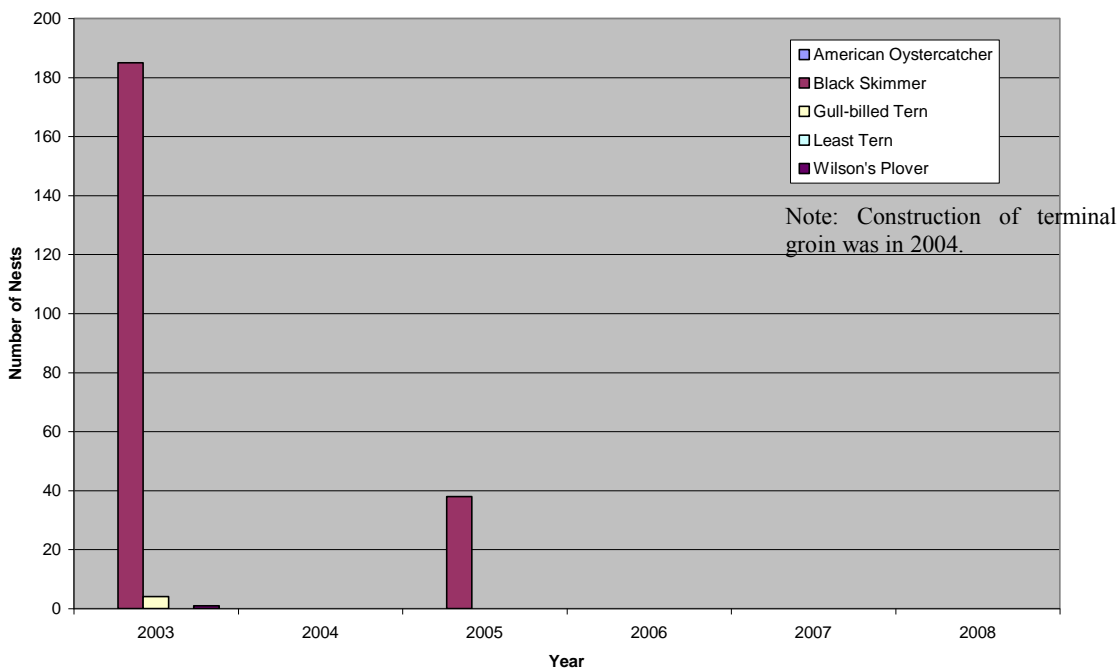


Figure III-36. Bird Islands Nesting Shorebird Observations

On Little Talbot Island, the total number of individuals representing all of the selected species increased from 1,015 individuals in 2002 to 1,259 individuals in 2003 (Figure III-37). The total number of individuals declined to 421 in 2004, increased to 1,463 in 2005, and declined to 927 in 2006. Total numbers declined further to 314 in 2007, followed by an increase to 1,262 in 2008. Red knots were the most abundant species, with an average on 409 individuals observed annually over the course of the seven year monitoring period (2002 through 2008). Other abundant species included roseate terns (annual average of 121), black skimmers (annual average of 80), common terns (annual average of 52), and Caspian terns (annual average of 48). Of the selected species; nesting by least terns, Wilson’s plovers, and American oystercatchers has been documented on Little Talbot Island (Figure III-38). Since 1997, a total of 95 nests have been recorded on Little Talbot Island. A total of 57 least tern nests were recorded from 1997 through 2002; however, no additional least tern nests have been observed since 2002. Of the 57 least tern nests, 31 were recorded in 1997 and 21 were recorded in 2002. A total of 36 Wilson’s plover nests were observed from 1997 through 2007. Of the 36 Wilson’s plover nests, 20 were recorded in 2002 and nine were recorded in 2007.

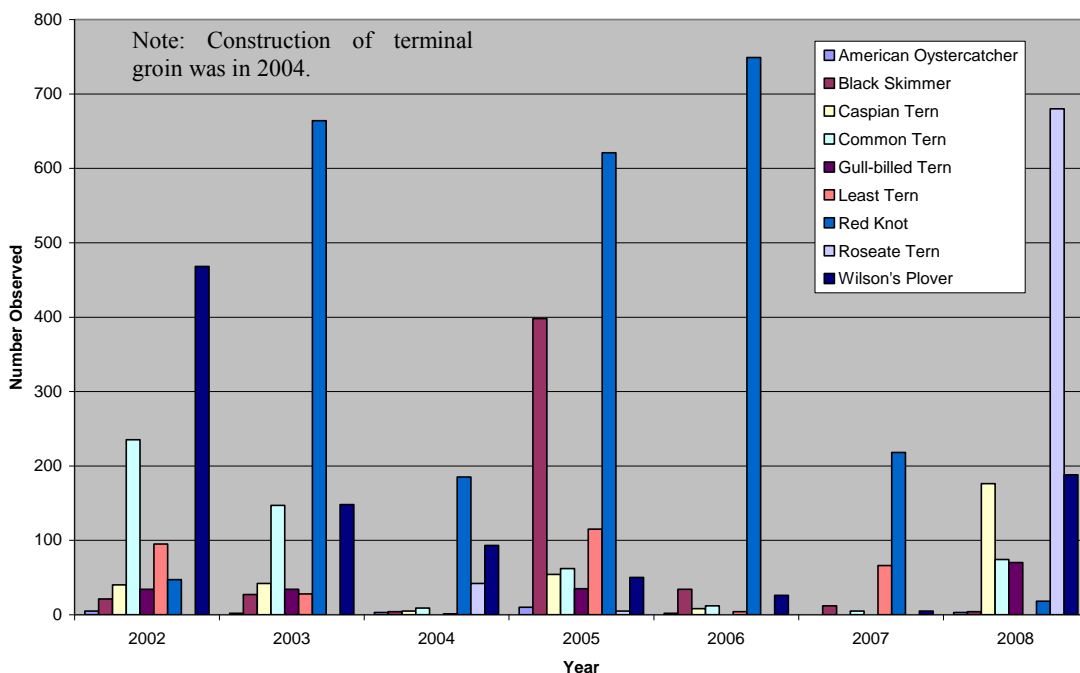


Figure III-37. Little Talbot Island State Park Non-Nesting Shorebird Observations

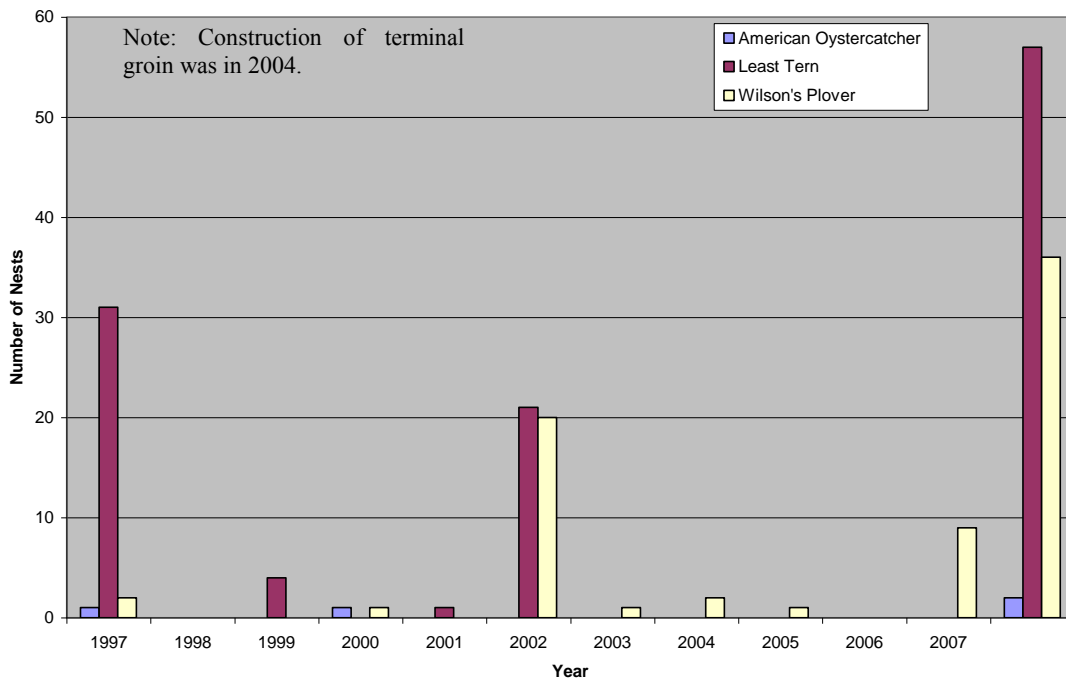


Figure III-38. Little Talbot Island State Park Nesting Shorebird Observations

Shorebird habitats on Amelia Island, Little Talbot Island State Park, and the Bird Islands are subject to the effects of tropical storms. On Amelia Island, the total number of individuals representing all of the selected species declined following tropical storm events in 2004 and 2005. On Little Talbot Island State Park and the Bird Islands, the total number of individuals representing all of the selected species increased following the tropical storm event in 2004 and decreased following the tropical storm event in 2005. Based on the limited shorebird data set (2003 – 2008 for Amelia Island and 2002 – 2008 for AISP and Little Talbot Island State Park), it is not possible to draw conclusions regarding the effects of tropical storms on shorebird populations at these sites. Shorebird habitats on Amelia Island are also subject to the effects of periodic beach renourishment projects. The total number of shorebirds on Amelia Island increased slightly following beach renourishment in 2006. Based on the limited shorebird data set for Amelia Island (2003 – 2008), it is not possible to draw conclusions regarding the effects of renourishment projects on shorebird populations.



Federally Threatened Species

Least Tern

The least tern is listed by the state of Florida as a threatened species and is protected federally under the Migratory Bird Treaty Act [Florida Game and Freshwater Fish Commission (FGFWFC) 1997]. The AISP is designated by the state as Critical Wildlife Habitat for least terns (Personal communication, M. Simmons, AISP, November 2009; DC&A 2003). However, prior to Phase I renourishment efforts, lack of suitable beach habitat precluded this species from utilizing this protected area. The southern portion of Little Talbot Island State Park contains a least tern nesting area (Personal communication, M. Simmons, AISP, November 2009). Least terns attempted to nest along the beach at the northern end of Little Talbot Island State Park in 2001, but nest inundation from higher than normal tide events destroyed nests and nest contents (Lach 2001). Continued above-average tides hindered successful re-nesting efforts in those areas during that year's nesting season. These failures typify that lack of suitable, expansive beach habitat can greatly reduce nest success.

Since 1988, least terns have rarely succeeded in fledging offspring in their traditional colony sites on the north end of Little Talbot Island and the south end of Amelia Island. However, in 2002 beach renourishment activities resulted in a widened beach profile at the south end of Amelia Island and least terns attempted to establish a nesting colony there, though that attempt was abandoned. In 2003, least terns returned to that site and formed a large and very successful colony for the first time since the 1980s; an estimated 125 pairs nested and produced approximately 75 fledglings.

Piping Plover

Although Little Talbot Island is designated by the state as Critical Wintering Habitat for the piping plover, AISP, including the northern limits of project boundaries, does not have this designation (Figure III-31). The piping plover has not been reported within the AISP, although a few sightings of this species have been made south of the project area (DC&A 2003). Activities on-site may cause some birds to shift preferred nesting sites. Because FL-Unit 35 extends further south to the St. Johns River, and the birds are also known to utilize that area, the unit's size and the documentation of birds using other unaffected areas within the unit helps reduce those potential effects (USFWS 2004).

Annual piping plover observations on Little Talbot Island and the Bird Islands have been recorded by the FDEP since 2001 (Figure III-39). On average, 153 piping plovers have been observed annually since 2001. The number of annual observations increased from three in 2001 to 181 in 2002 and 329 in 2003. Annual piping plover observations subsequently declined to 200 in 2004, and remained steady in 2005 and 2006. The annual average for the period of 2004 through 2006 was 218 individuals. Piping plover observations subsequently declined to 28 in 2007 and remained low at 53 individuals in 2008. FDEP data do not include any records of piping plovers on Amelia Island.

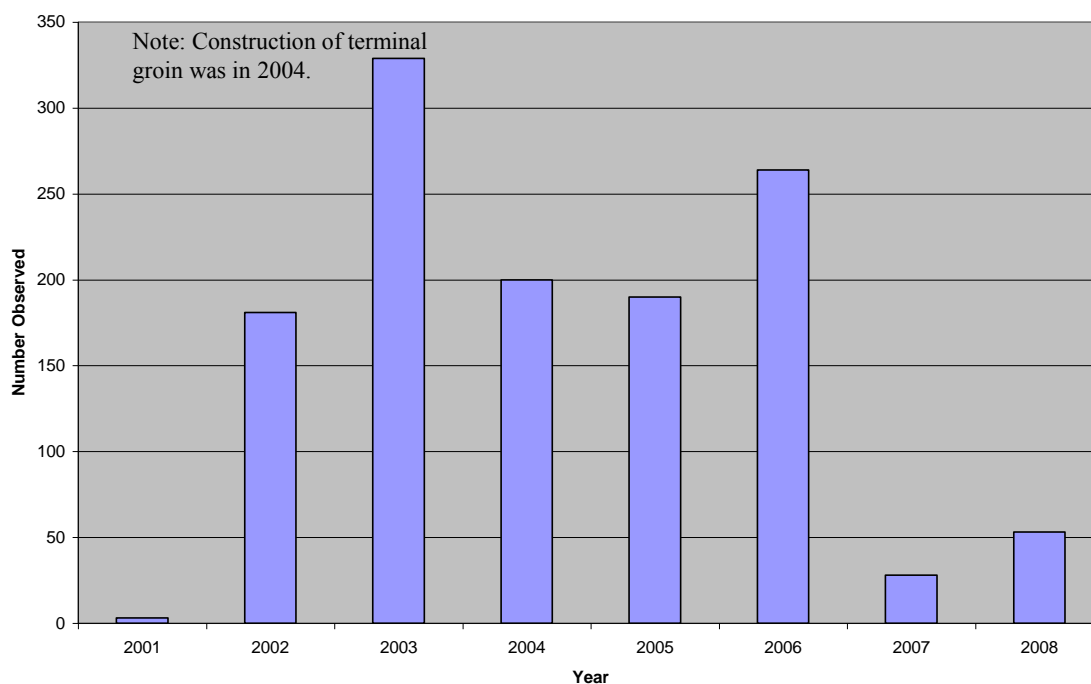


Figure III-39. Piping Plover Observations for Little Talbot Island and Bird Islands, Nassau Sound

Piping plover habitat on Little Talbot Island and the Bird Islands is subject to the effects of tropical storms. Piping plover observations on Little Talbot Island and the Bird Islands increased following a tropical storm event in 2002, decreased following a tropical storm event in 2004, and increased following a tropical storm event in 2005. Based on the limited piping plover data set (2001 – 2008), it is not possible to draw conclusions regarding the effects of tropical storms on piping plover populations at these sites.

Nesting on the Nassau Sound Islands

The Nassau Sound islands have historically supported some of the largest and most diverse shorebird nesting colonies in northeast Florida. Shorebird nesting efforts were highest in the 1970s and 1980s when thousands of black skimmers, gull-billed terns, royal terns (*Thalasseus maximus*), least terns, and sandwich terns (*Thalasseus sandvicensis*) nested on the islands. Smaller numbers of American oystercatchers, Wilson’s plovers, and laughing gulls (*Leucophaeus atricilla*) have also been recorded nesting on the islands. Monitoring of shorebird nesting on the Nassau Sound islands has occurred on and off for at least the past 30 years (Loftin 1978).

Nesting data from 2000 through 2004 indicate that black skimmers and gull-billed terns successfully nested and produced chicks on Nassau Sound islands, though at reduced numbers compared to the 1970s and 1980s. Estimating the number of nesting pairs has been difficult since the colonies were not physically entered during the surveys to prevent disturbance (Personal communication, M. Simmons, AISP, November 2009). Typically about 200 black skimmers and a dozen gull-billed terns nested on the Nassau Sound



islands each year during this period (SMP). However, overwash of the nesting areas during storm events and spring tides has been a persistent problem for nesting colonies on the islands. Based on pre- and post-survey data within Nassau Sound, the Bird Islands have not experienced a change in total acreage (Personal communication, A. Browder, Sr. Engineer, Olsen Associates).

Nesting on Amelia Island, North of the State Park

In 1994, a beach nourishment project was carried out along southern Amelia Island. Sand was pumped onto approximately three miles of the beach from just south of American Beach southward to about the northern border of the state park. In 1995, least terns first nested on that re-nourished beach, at the southern end near the south Amelia public beach access. Numbers of nests increased each year until 1999, when approximately 150 pairs nested there. In 2000, no least terns attempted to nest in any part of the re-nourished area of the Amelia Island beach until June/July. Then, only about 50 pairs began nesting in the southern area, probably as a second nesting attempt. Numbers of least terns nesting in this area remained low through 2004, when it was estimated that 50 to 75 least terns nested there (Personal communication, M. Simmons, AISP, November 2009). Observations have indicated that least terns nesting in this area have been successful incubating eggs to hatching and rearing the young to fledging, but fledging rates are not known.

Permit provisions were expected to provide suitable nesting sites outside the construction area. To ensure no adverse effects occurred, the permit for Phase II of the South Amelia Island Stabilization Project required post-construction surveys and monitoring and an annual report discussing the performance of the beach fill and the structures, especially any adverse effects that might be attributable to the structures. Due to inconsistent monitoring protocols and the lack of historical monitoring data for Amelia Island State Park, it is difficult to draw conclusions regarding the effects of the terminal groin on shorebird use (Personal communication, M. Simmons, Biologist, AISP, February 2010).

(4) Fish and Fisheries

The SAFMC (1998) has designated the water column and intertidal flats within the project area as EFH. The nearshore bottom area has also been designated as Essential Fish Habitat-Habitat Areas of Particular Concern (EFH-HAPC) (SAFMC 1998).

Several different species inhabit the intertidal flats and water column. As reported by USACE (1984), species that inhabit these habitats include red drum, spotted seatrout, bluefish, Atlantic croaker, kingfish, and mullet (*Mugil* sp.). Continental Shelf Associates (1993) conducted trawls in the region and identified bay anchovy (*Anchoa mitchilli*) as the dominant species collected. Drum (Family Sciaenidae) were the second most abundant fish collected. Table III-8 represents species that were identified within the project area or could potentially be observed in and around the project area.

Table III-8. Fish species within and adjacent to the Nassau Sound

Common Name	Scientific Name
Bay anchovy	<i>Anchoa mitchilli</i>
Black drum	<i>Pozonias cromis</i>
Bluefish	<i>Pomatomus saltatrix</i>
Croaker	<i>Micropogon undulates</i>
Mullet	<i>Mugil sp.</i>
Pompano	<i>Trachinotus carolinus</i>
Southern flounder	<i>Paralichthyr lethostigma</i>
Spanish mackerel	<i>Scomberomorus maculates</i>
Spotted seatrout	<i>Cynoscion nebulosus</i>
Red drum	<i>Scianenops ocellata</i>
Kingfish	<i>Menticirrhus americanus</i>

As discussed in the EA, temporary effects that were projected to occur include displacement of fish during placement of rock associated with the construction of the terminal groin as well as temporary elevation in turbidity levels (DC&A 2003). Long-term effects of the structure would be beneficial to fish by providing significant structure currently absent within the project area.

c) Benthic Resources

Based on a review of available literature for this site, biologically active hardbottom habitat does not exist within the project area. The benthic communities present on or near the beaches and in the offshore borrow area are associated with sandy sediments.

Biological communities in the highly dynamic intertidal swash zone must cope with being aerially exposed during normal tidal cycles as well as being subjected to the high energy of the ocean waves. Typically, these organisms have low species diversity because of the harshness of the environmental conditions present. However, animals that are able to successfully adapt to these dynamic conditions are faced with very little competition from other organisms. Because of this lack of competition and adaptability to the dynamic conditions found along the project area, coquina clams are able to numerically dominate the biological community (Edgren 1959).

Receding waves tend to wash amphipods and isopods out of their burrows and suspend these organisms into the water column where they serve as an important food source for a variety of nearshore fish. A variety of polychaete worms that are also adapted to this highly dynamic and stressful environment can be found within the intertidal zone of the Nassau County beaches. These intertidal organisms also provide an important food source for foraging shore and wading birds. Highly visible decapod crustaceans of the Nassau County supralittoral zone include the ghost crab, mole crab, and Atlantic fiddler crab (*Uca pugilator*). These organisms are highly mobile and burrow into the moist sand to retard water evaporation from their bodies during aerial exposure (Barnes 1974). As described in DC&A (2003), the nearshore benthic community was comprised of



approximately 59 acres. Post-construction monitoring was not a permit requisite for this resource.

d) Summary of Findings

Increased erosion pressure on the southern end of Amelia Island has prompted coastal engineering actions intended to protect valuable resources along the AISP and adjacent to privately held lands northward.

Sea turtle nesting data for Amelia Island dates back to 1986 and on average, 74 nests were recorded annually from 1986 through 2005. The number of nests declined sharply to 46 in 2004, followed by an increase to 70 in 2005. Other than the steady decline between 1999 and 2003, no obvious trends in nesting activity are evident over the course of the monitoring period. Additional data specific to AISP spans the period of 2004 through 2008 and on average 26 nests have been recorded annually over the course of the five-year monitoring period. The number of nests recorded ranged from 2 to 43. Due to inconsistent monitoring protocols and the lack of historical monitoring data for AISP, it is difficult to draw conclusions regarding the effects of the terminal groin and beach nourishment on sea turtle nesting.

Because of concerns raised during the evaluation of the permit application, an extensive shoal acreage monitoring program and the Shorebird Management Plan (SMP) were included as requirements in the permit. The primary concern raised was the potential effects the structure might have on the sediment transport system, which affects the sediment balance of the islands and shoals in Nassau Sound, collectively known as the “Bird Islands.” These islands and shoals have historically provided critical nesting, resting, and feeding habitat for a variety of shorebird and seabird species. Based on pre- and post-survey data within Nassau Sound, the Bird Islands have not experienced a change in total acreage. Shorebird habitats on Amelia Island are subject to the effects of periodic beach renourishment projects. The total number of shorebirds on Amelia Island increased slightly following beach renourishment in 2006. Based on the limited shorebird data set for Amelia Island (2003 – 2008), it is not possible to draw conclusions regarding the effects of renourishment projects on shorebird populations.

The AISP is designated by the state as Critical Wildlife Habitat for least terns. Although Little Talbot Island is designated by the state as Critical Wintering Habitat for the piping plover, AISP, including the northern limits of project boundaries, does not have this designation. FDEP data do not include any records of piping plovers on Amelia Island. Due to inconsistent monitoring protocols and the lack of historical monitoring data for Amelia Island State Park, it is difficult to draw conclusions regarding the effects of the terminal groin on shorebird or piping plover use.

The lack of raw data resulted in non-discernable trends in potential effects on benthic and fisheries resources from the terminal groin and associated fillet.

4. Captiva Island

a) General Site Description

Redfish Pass is a relatively young, hydraulically stable tidal inlet (CEPD 2002). The pass separates North Captiva Island from Captiva Island and connects Pine Island Sound to the Gulf of Mexico. Redfish Pass is reported to have cut through the barrier island during a severe tropical storm in 1921. The pass is about 900 feet wide and recent surveys indicate depths up to 20 feet (CEPD 2002) (Figure III-40).

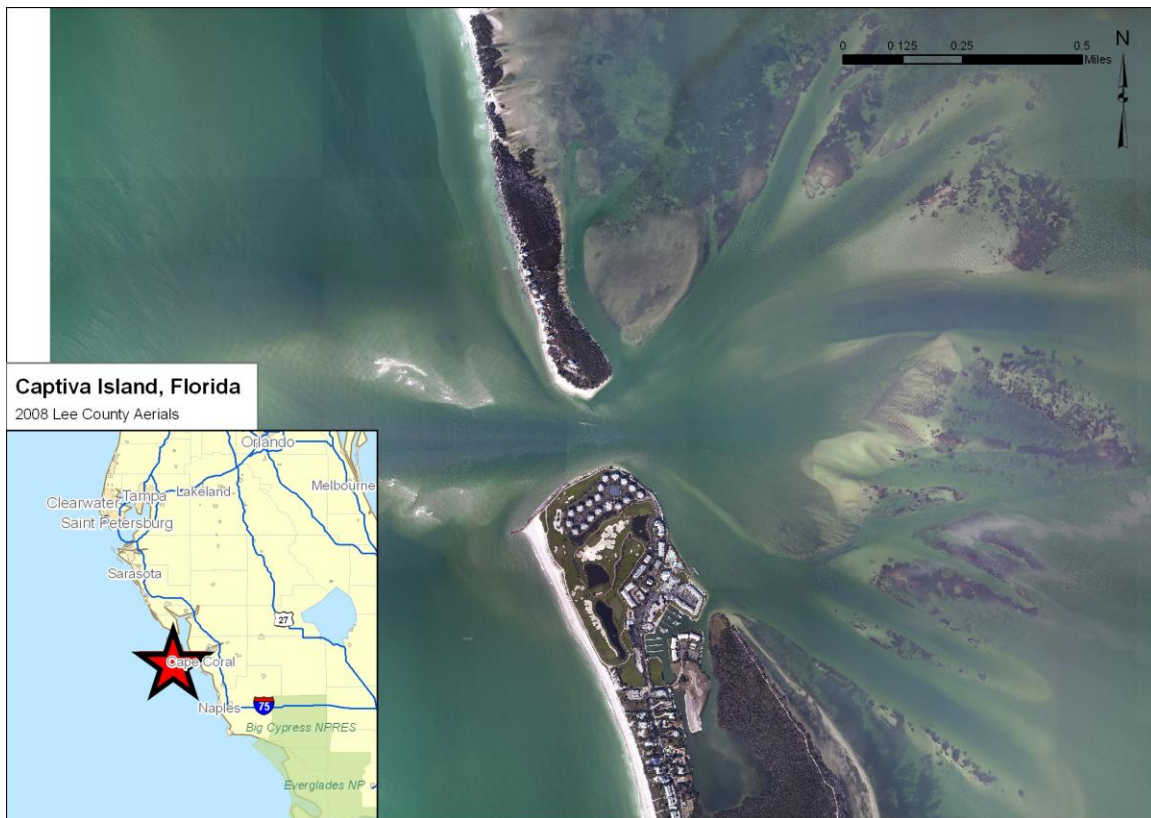


Figure III-40. Captiva Island, Florida

The extensive shoal system (ebb and flood tidal shoals) that has formed as a result of the pass contains about eight million cubic yards of material. This material has been trapped from the longshore transport between adjacent shores. The Redfish Pass Inlet Management Plan (IMP) investigated the effect of the pass on Captiva Island and found it to be approximately 32,000 cubic yards per year (CPE 1995). Studies since then have indicated higher estimated effects.



(1) Aesthetics

Captiva Island possesses visually pleasing attributes including the waters of the Gulf of Mexico and the existing natural appearing beach. The white sand contains fragments of shells, which tend to give the beach a golden tint (CPE 1995). The beaches of Captiva, although eroded, are famous for the shells that are sought by visitors. The island is developed residentially along the majority of its length. Hotels and condominiums are present in some areas of South Seas Plantation and intermittently along the rest of Captiva Island. There is a vegetated dune along the entire length of Captiva Island in which some sections are adjacent to the Captiva-Sanibel Road, which is the only route to mainland Florida (CPE 1995).

(2) Recreation

Common water related activities in southwest Florida include fishing, sailing, kayaking, snorkeling, and recreational diving. In Lee County, listed dive shops and dive boat operations are concentrated in the Ft. Myers area. Based on 1999 data provided by the Bureau of Marine Fisheries Management, there are more than 40 artificial reefs in Lee County (CEPD 2002).

FMRI reported 39,000 registered vessels for Lee County in 2000. There were over 3,500 personal pleasure watercraft boats registered and more than 300 personal watercraft rentals in 2000. Sailing, kayaking, and canoeing are popular water activities on Captiva and Sanibel Islands with guided tours or private rentals available.

(3) Public Access

As described in the Joint Coastal Permit Application for the Captiva and Sanibel Islands Renourishment Project (CEPD 2002), the project area consisted of both publicly and privately owned property. Of the 4.9-mile project length on Captiva Island, 5,562 linear feet provide direct public benefit. The largest Gulf front parcel on Captiva Island is the 5,010-foot segment of public road that traverses adjacent to the beach and is the main Hurricane evacuation route.

Public access is available at seven access points on Captiva Island with two public parking lots. The entire project area has been developed. Resort and beach recreation development is prevalent in the northern segment of Captiva Island with the remainder being primarily single-family residences. State Road 867 parallels the shoreline for a distance of approximately one mile and a rubble revetment was constructed to protect the roadway.



b) Natural Resources

Redfish Pass, which has a history of slow migration and tidal shoaling, greatly influences the surrounding estuarine and marine environment (CPE 1993). The presence of the pass allows for the mixing of gulf and estuarine waters. The tides that occur at the pass greatly influence the currents, water quality, salinity, and temperature regimes within the pass and the surrounding estuarine waters. The pass also provides migratory marine-estuarine species with ready access to their spawning and nursery grounds (Figure III-41).

Captiva is in an area of overlap between subtropical marine species and temperate marine species (CEPD 1995). Many of the sessile tropical species are at the northern limit of their range and are under some natural stress during the winter months because of lowered temperatures and the increased turbidities brought on by storms. Many motile forms, such as fish, migrate in and out of the area with the seasons. During the warmer summer months, tropical species predominate, while during the cooler winter months, temperate species are relatively more abundant.

The natural resources surrounding Redfish Pass are comprised of three major resource classifications (CPE 1993). These include the beach and dune system, and upland areas; the estuarine wetlands; and the nearshore Gulf of Mexico. As depicted in Figure III-42 (1991 snapshot) and Figure III-43 (2006 snapshot), the estuarine habitats in the vicinity of Redfish Pass has remained relatively stable.



Figure III-41. Coastal Classification of Habitat for Redfish Pass, FL

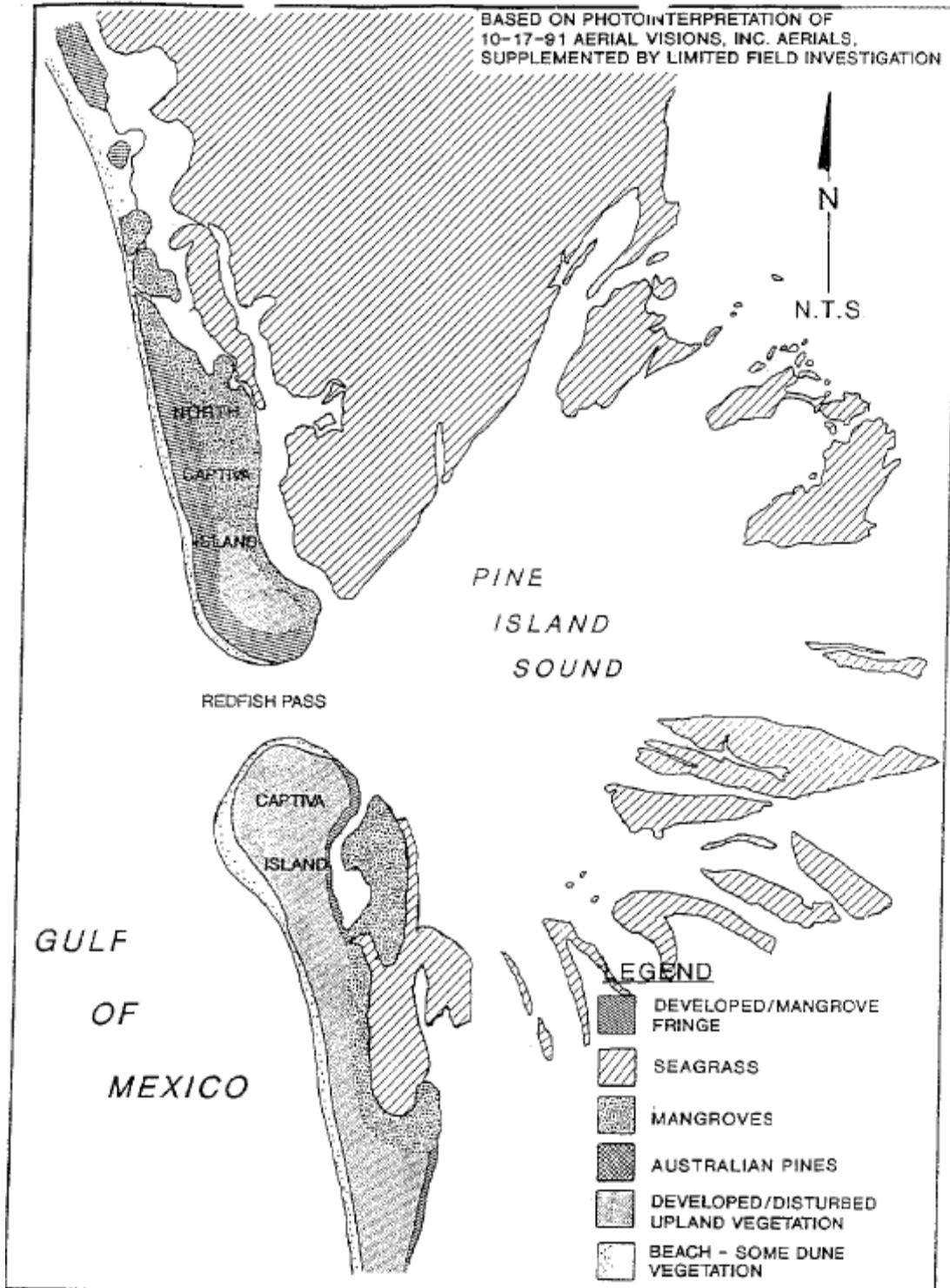


Figure III-42. Coastal Habitats of Redfish Pass (1991)



Figure III-43. Seagrass and Mangrove Habitat for Redfish Pass, FL



Based on discussions with Lee County's Operations Manager for Marine Services, shoreline protection efforts alone may have possibly worked; however, the additional sand placement events needed to maintain the shoreline would have likely had adverse indirect effects on fisheries and SAV within Redfish Pass as a result of sand transport. Additionally, without the construction of the terminal groin, there would have been a significant increase in cost to shoreline protection efforts due to an increase in the frequency of sand placement events. Without both the terminal groin and fill project elements, the degrading habitat would have lessened the opportunity for nesting birds and sea turtles (Personal communication, S. Boutella, Operations Manager for Marine Services, Lee County, February 2010). As confirmed by the Sanibel-Captiva Conservation Wildlife Habitat Management Office, the groin and fill area at Redfish Pass does not appear to be of an immediate concern to the local resource agencies (Personal communication, B. Smith, Director, February 2010).

(1) Sea Turtles

The beaches in proximity to Redfish Pass provide nesting habitat for the Atlantic loggerhead sea turtle (Figure III-44). Other sea turtles reported to occur in the vicinity of Redfish Pass include the green, hawksbill, Kemp's ridley, and the leatherback sea turtles. Prior to the 1988 Captiva Island beach restoration project, continuing beach erosion and the construction of shoreline protection structures had resulted in the loss of most of the sea turtle nesting habitat south of Redfish Pass (LeBuff 1990). Following the 1988 Captiva Island beach restoration project, LeBuff (1990) confirmed both the number of nests and nesting success increased. Studies prior to the beach project documented an average of 19 nests/year for the five-mile beach, with an average nesting success of 36.5 percent. In contrast, according to CPE (1993), the average number of nests from 1988 to 1991 was 57 nests or a 199 percent increase over pre-restoration averages.

Sea turtle nesting data for Captiva Island, an approximate 5 mile shoreline from Redfish Pass to Blind Pass, dates back to 1986 (Figure III-45). On average, 94 nests were recorded annually from 1986 through 2009. The number of nests on Captiva Island increased steadily from 28 nests in 1986 to 141 nests in 1995. The number of nests declined over the next two years, before increasing sharply to 177 nests in 1998. The number of nests remained high over the next two years, with 142 nests in 1999 and 179 nests in 2000. The number of nests generally declined over the course of the next seven years, reaching a low of 54 nests in 2007. However, the 2008 nesting period resulted in a sharp increase to 137 nests and then decrease to 80 nests in 2009.

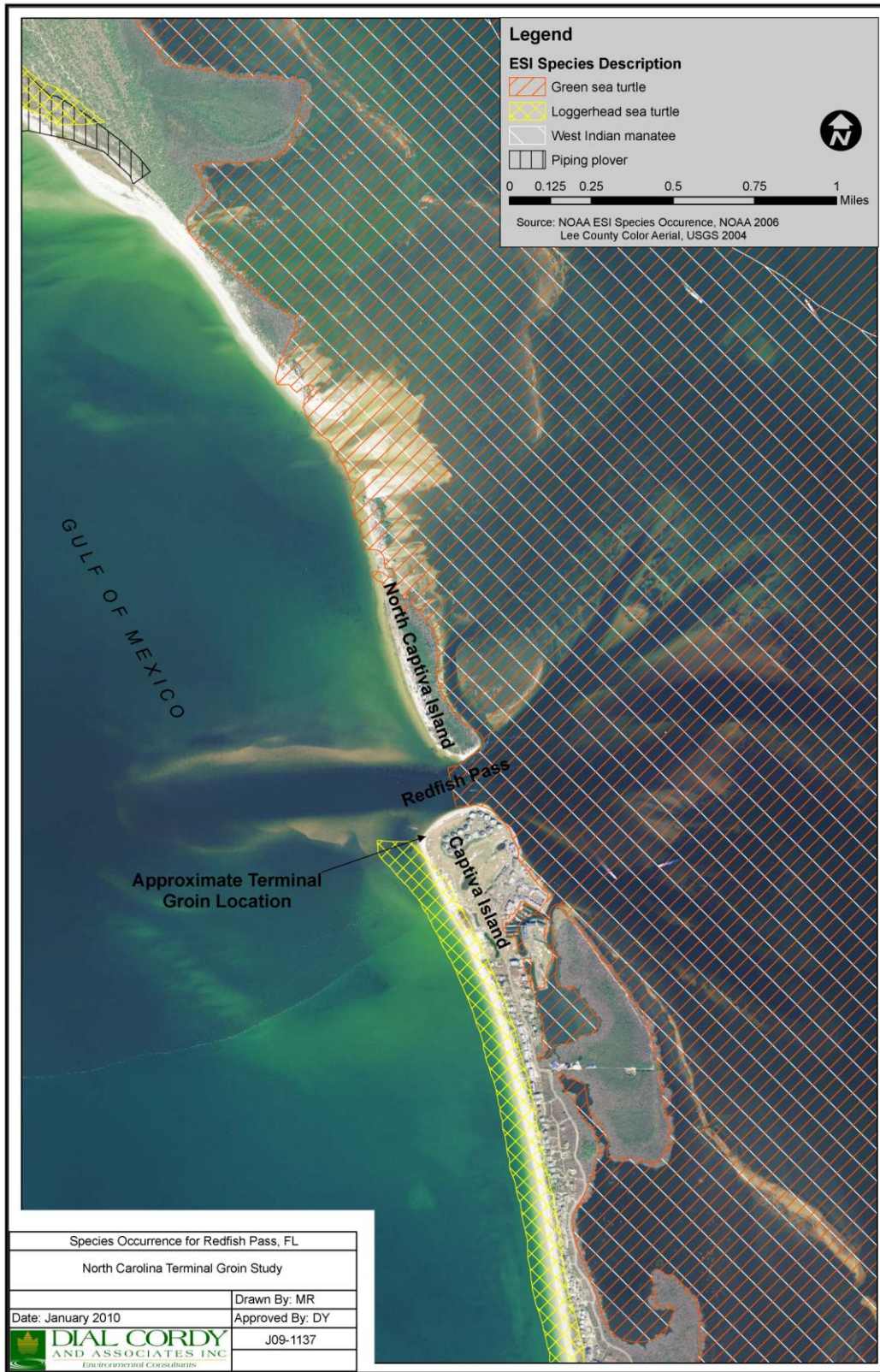


Figure III-44. Species Occurrence for Redfish Pass, FL

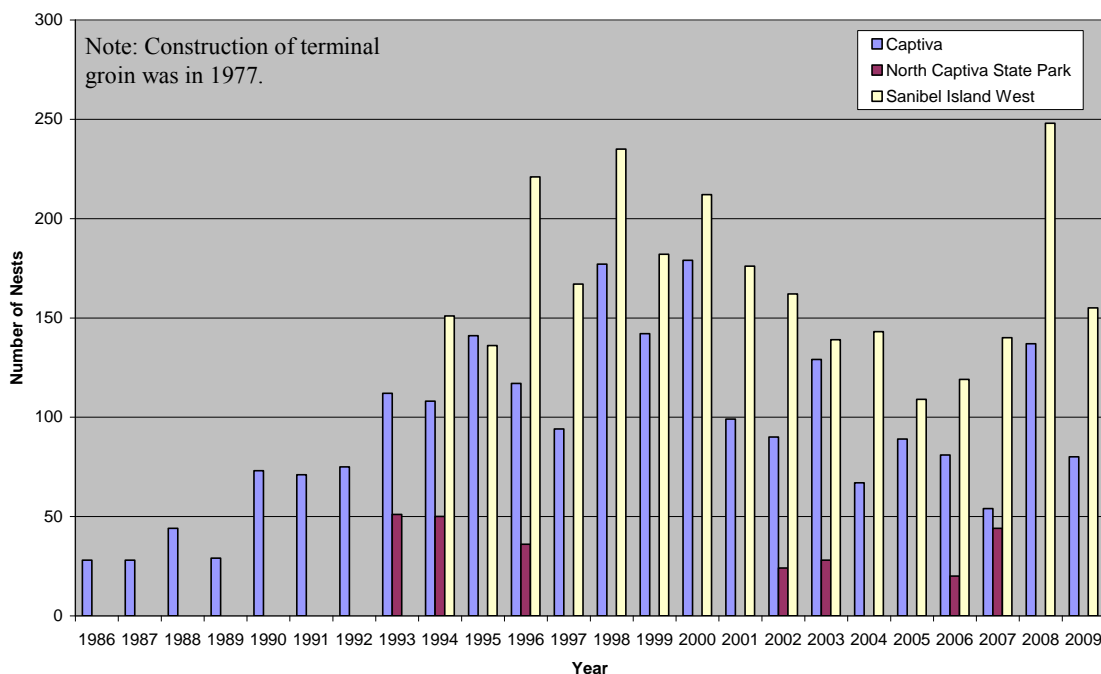


Figure III-45. Sea Turtle Nesting Data from Captiva Island, North Captiva State Park, and Sanibel Island West

Sea turtle nesting data for Sanibel Island West, an approximate 6.5 mile shoreline from Blind Pass to Tarpon Bay Road, dates back to 1994 (Figure III-45). On average, 168 nests have been recorded annually over the course of the last 16 years. A total of 151 nests were recorded during 1994. The number of nests declined slightly to 136 nests in 1995, followed by an increase to 221 nests in 1996. The number of nests reached a peak in 1998, when a total of 235 nests were recorded. The number of nests gradually declined over the next seven years, reaching a low of 109 nests in 2005. The number of nests increased over the next three years, reaching an all-time high of 248 nests in 2008.

Nesting data for North Captiva Island State Park, an approximate 3 mile shoreline, is intermittent. The available data set includes 1993, 1994, 1996, 2002, 2003, 2006, and 2007 (Figure III-45). The number of nests recorded ranged from 20 to 51. The average number of nests recorded was 36.

Sea turtle nesting habitats on Captiva Island, North Captiva Island State Park, and Sanibel Island West are subject to the effects of tropical storms. Sea turtle nesting densities on Captiva Island increased following storm events in 1992, 1994, 1999, and 2004; whereas nesting densities decreased following storm events in 1988, 1990, 1998, 2001, 2005, 2006, and 2008. Sea turtle nesting densities on Sanibel West increased following storm events in 1999, 2005, and 2006; whereas nesting densities decreased following storm events in 1994, 1998, 2001, 2004, and 2008. Due to the limited data set for North Captiva Island State Park, trends following storm events are not apparent. Based on these data, there does not appear to be a consistent relationship between nesting density and storm events. Sea turtle nesting habitat on Captiva Island is also subject to



the effects of periodic beach renourishment projects. Captiva Island beaches were nourished 5 times between 1988 and 2009. Sea turtle nesting densities on Captiva Island increased following renourishment in 1991; whereas nesting densities decreased following renourishment in 1988, 1996, 2005, and 2008. These data indicate that renourishment may have had an adverse effect on sea turtle nesting.

To date there is little available data regarding sea turtle hatchling reactions/interactions with offshore emergent breakwaters or shoreline T-groins, such as the three T-groin structures located on the north side of Redfish Pass (North Captiva Island). There are currently few similar structures along the west Florida shoreline. These Gulf coast structures can be found at 1) at Marco Island in Collier County, 2) in Naples, north of Gordon Pass, Collier County, and 3) at North Captiva Island, at the north side of Redfish Pass in Lee County. No adverse effects, except for one female sea turtle becoming entrapped in the Redfish Pass terminal groin, have been documented. Only limited nesting has occurred near the existing structures. Additionally there has been minimal monitoring effort to evaluate the failure or success of the hatchling migration from the shoreline to and/or beyond these structures. Sea turtle nesting on Captiva Island has historically been very low. Consequently, it is not possible to detect changes associated with the terminal groin [Personal communication, A. Bryant, Sanibel Captiva Conservation Foundation (SCCF), February 2010]. As described by Foote (2003), erosion control structures are proposed to absorb wave energy and minimize sand scouring thus providing a sandy beach for humans, for property protection, and for sea turtle nesting habitat. If the structures perform successfully and adequate sand remains within the project area it is probable that sea turtles will nest near the erosion control structures.

(2) Shorebirds and Waterbirds

Many species of birds are known to forage in the project area, particularly on North Captiva Island (CPE 1993). Shorebirds, including gulls, terns, sandpipers, plovers and stilts, use the intertidal beach for foraging; while other birds, such as the eastern brown pelican and the double-crested cormorant, forage in the nearshore waters (Continental Shelf Associates 1987). Table III-9 lists some of the most common bird species reported in the vicinity of Redfish Pass.

In 2009, a USACE sponsored bird survey for Lee County was conducted (Lott et al. 2009). Redfish Pass between North Captiva Island and Captiva Island was included within the survey area. The north and south sides of the pass were surveyed separately. Captiva Island has an elevated area on the inlet beach that larids and shorebirds use for roosting. Species diversity was low as only nine species were observed over three visits: the great egret, snowy egret, black-bellied plover, willet, ruddy turnstone, sanderling, laughing gull, royal tern, and sandwich tern. All observations were either on intertidal or shallow-water substrates, and no wrack line was present. The disturbances were low at this site relative to other surveyed areas. During the three surveys; no vehicles, no dogs, and no parked boats were observed.



Based on irregular surveys, Captiva Island has less shorebird diversity and abundance as compared to Sanibel (Personal communication, B. Smith, Director of Sanibel-Captiva Conservation Wildlife Habitat Management Office, February 2010). Although shorebirds and waterbirds are not regularly surveyed on Captiva in the vicinity of Redfish Pass, there is a monitoring program associated with Blind Pass on Sanibel Island, approximately five miles south of Redfish Pass. There are four species of listed shorebirds that have been historically known to nest on Sanibel Island, approximately five miles from Redfish Pass, which include: least tern, snowy plover (*Charadrius alexandrinus*), Wilson's plover, and black skimmer (Loflin 2005). In the last eight years, the previously small nesting population of black skimmers has, for an unknown reason, ceased nesting activities on Sanibel Island. A small historical nesting colony that included all four species nested in the dunes landward of part of the nourishment area (just west of Silver Key), but none of these species returned to nest at this site in recent years; probably due to a steadily increasing density of native coastal vegetation including sea oats, salt grass, marsh elder, sea blight, railroad vine, and inkberry at this former tidal pass location.

Table III-10 presents the number of nesting pairs of each species found during monitoring by the SCCF on all Sanibel Island beaches in 2002 through 2003. SCCF has the only comprehensive shorebird monitoring and protection program for the island.

No shorebird nesting is known to have occurred within or immediately adjacent to the proposed nourishment project locations from 2002 through 2005 (Loflin 2005). A recently active colony of approximately 15 pairs of least terns and seven pairs of snowy plovers was located approximately 1,200 feet from the east end of the proposed project location.

Table III-9. Common bird species within the vicinity of Redfish Pass

Common Name	Scientific Name
American robin	<i>Turdus migratorius</i>
Black skimmer	<i>Rynchops niger</i>
Blue jay	<i>Cyanocitta cristata</i>
Boat-tailed grackle	<i>Quiscalus major</i>
Carolina wren	<i>Thyrothorus ludovicianus</i>
Common barn-owl	<i>Tyto alba</i>
Common flicker	<i>Colaptes auratus</i>
Common grackle	<i>Quiscalus quiscula</i>
Common ground-dove	<i>Columbina passerina</i>
Common yellowthroat	<i>Geothlypis trichas</i>
Eastern screech-owl	<i>Otus asio</i>
European starling	<i>Sturnus vulgaris</i>
Fish crow	<i>Corvus ossifragus</i>
Gray catbird	<i>Dumetella carolinensis</i>
Gray kingbird	<i>Tyrannus dominicensis</i>
Great crested flycatcher	<i>Myiarchus crinitus</i>
Great horned owl	<i>Bubo virginianus</i>
House sparrow	<i>Passer domesticus</i>
Laughing gull	<i>Larus atricilla</i>
Mangrove cuckoo	<i>Coccyzus minor</i>
Mourning dove	<i>Zenaida macroura</i>
Northern cardinal	<i>Cardinalis cardinalis</i>
Northern mockingbird	<i>Mimus polyglottos</i>
Pileated woodpecker	<i>Dryocopus pileatus</i>
Prairie warbler	<i>Dendroica discolor</i>
Red-bellied woodpecker	<i>Melanerpes carolinus</i>
Red-winged blackbird	<i>Agelaius phoeniceus</i>
Ring-billed gull	<i>Larus delawarensis</i>
Royal tern	<i>Sterna maxima</i>
Rufous-sided towhee	<i>Pipilo erythrophthalmus</i>
Sanderling	<i>Calidris alba</i>
Sandwich tern	<i>Sterna sandvicensis</i>
Short-billed dowitcher	<i>Limnodromus griseus</i>
Smooth-billed ani	<i>Crotophaga ani</i>
White-eyed vireo	<i>Vireo griseus</i>
White-winged dove	<i>Zenaida asiatica</i>
Willet	<i>Catoptrophorus semipalmatus</i>



Table III-10. Number of shorebird nests on Sanibel Island in 2002 and 2003

Species	2002	2003
Snowy plover	27	31
Least tern	50	50
Wilson’s plover	6	8
Black skimmer	0	0

In addition to the nesters, numerous resident or itinerant shorebirds have been recorded as utilizing Sanibel's beaches for feeding, resting, or overnight accommodations on a year-round basis. These species are joined by numerous additional ones during spring and fall migration and a subset of these use the beaches as over-wintering habitat. The piping plover is occasionally observed among the migrants and over-wintering species, although Sanibel and Captiva Islands were not designated as critical habitat for this species during a recent evaluation by the USFWS (Figure III-44). There was a proposed critical overwintering habitat for piping plovers covering Captiva Island and Sanibel Island; however, due to the lack of use by piping plover in this specific area, this unit has been deleted from the finalized Federal Register (USFWS 2001b).

The CEPD received a Joint Coastal Permit from the FDEP in 2002 and a dredge and fill permit from the USACE to undertake a beach nourishment project on both Captiva and Sanibel Islands. As the areas to be nourished were undergoing moderate to severe erosion and did not support shorebird nesting, the project was expected to enhance and benefit shorebird foraging, resting, and nesting habitat. It was anticipated by Loflin (2005), should any shorebirds unexpectedly begin nesting activities before or during construction within the project area; construction activities, especially heavy equipment operation, would disturb the birds. In addition, shorebirds that utilized the shoreline in the project area or immediately adjacent to it during construction for foraging, resting, and nesting would be disturbed and forced to utilize other shorelines. In addition to natural coastal processes, the distribution and quality of bird habitat on Florida’s coasts are strongly affected by human disturbance or coastal engineering (Lamonte et al. 2006).

(3) Water Quality

Redfish Pass falls within a coastal waterbody segment [Waterbody Identification (ID) 2092D] that has been assessed under Florida’s Impaired Waters Rule (Chapter 62-303, F.A.C) and determined to not be in violation of any water quality standards except for mercury in fish tissue (most marine waters in Florida are impaired for mercury) and dissolved oxygen (Personal communication, J. Nelson, FDEP South District Office, October 2009). An important caveat is that no causative pollutant has been established for dissolved oxygen and the water quality stations reporting the impairment are not located in the vicinity of the terminal groin at Redfish Pass. No long-term water quality station exists within the vicinity of Redfish Pass (Personal communication, J. Nelson, FDEP South District Office, October 2009); however, as described by the CEPD (2002) the placement of dredged material on the beach would have no long-term effect on water quality. A temporary localized increase in turbidity was expected as fine-grained



material present in the nourishment sands was washed from the sediments. However, no significant increase was expected in nutrients, contaminants, or other parameters since the dredged material was primarily sand that would settle quickly through the water column.

(4) Fish and Fisheries

The offshore gulf waters provide habitat for adult and juvenile fishes (CPE 1993). Estuarine-dependent species which use the offshore and pass waters for spawning include red drum, spotted seatrout, snook (*Centropomus undecimalis*), Atlantic croaker, southern flounder, Florida pompano, striped mullet, Gulf menhaden (*Brevoortia patronus*), tarpon (*Megalops atlanticus*), and bonefish (*Albula vulpes*) (Continental Shelf Associates, Inc. 1987). Reef fishes in the area include red grouper (*Epinephelus morio*), jewfish (*Epinephelus itajara*), gag grouper, scamp (*Mycteroperca phenax*), red snapper (*Lutjanus campechanus*), and mangrove snapper (*Lutjanus griseus*) (Continental Shelf Associates, Inc. 1987).

The coastal waters offshore of Captiva and North Captiva Islands also contain a wide variety of commercial and sport fishes. A review of recent marine fishes annual landings' summaries indicates that significant commercial fisheries for mullet, red grouper, spotted sea trout, blue crab and pink shrimp (*Farfantepenaeus duorarum*) exist in Lee County (CPE 1993). Although some commercially valuable fishes do frequent the waters adjacent to Redfish Pass, commercial fisheries in the vicinity of Redfish Pass are generally limited to seasonal mullet fisheries (CPE 1993). No known commercial concentrations of scallops or shrimp exist in the immediate area of Redfish Pass.

Many commercial fishermen utilize Lee County coastal waters, fishing a wide array of gear for various economically important species. Table III-11 summarizes commercial values of several species harvested in Lee County for the period between 1992 through 1998 (Lee County 2005).

Tarpon, grouper, red drum, and snook are among the many popular fish caught in Lee County. Local fishing guides provide full-day or half-day fishing tours for several of these species. Snook are caught off the local beaches; whereas, redfish are abundant on the grass flats, inlets, and in the backwaters of Pine Island Sound accessible through Redfish Pass. Most of the fish associated with the nearshore littoral zone offshore Captiva and Sanibel Islands are highly mobile and capable of escaping temporary effects. In January of 2006, 1,000,000 cubic meters of sand was added to Captiva Island, which substantially widened the beach and rebuilt the beach inside the inlet. By the end of 2007, the beach had mostly disappeared which may have been the result of less sand bypassing the longer terminal groin or the passage of Tropical Storm Barry that made landfall north of this region in June 2007. The inlet beach losses may also reflect in a potential loss of larval transport around the extended groin.



(5) Benthic Resources

As evaluated by CPE (1993, 1995), aerial photographs and field investigations of the project area shoreline confirmed no significant hardbottom formations exist in proximity to Redfish Pass. Because there were no hardbottom formations in this location, there were no post-construction monitoring required for biological resources (Personal communication, V. George, FDEP, January 2010).

The gulf floor surrounding Redfish Pass consists of unconsolidated sediments, primarily sand. According to CEPD (2002), the extension and refurbishing of the terminal groin at Redfish Pass created new areas of nearshore habitat. The original groin covered approximately 0.15 acre of land in vicinity of the intertidal zone and was to be increased to 0.65 acre upon refurbishment. The area to be covered was characterized by sandy bottom with no known hardbottom or seagrass beds. The groin extension provided an additional 0.5 acre of substrate available for habitation by nearshore communities such as crabs, sea urchins, and numerous other gastropod species. During the data collection phase of the study, post-construction monitoring data regarding potential hardbottom and/or seagrass effects due to the extension of the groin at Redfish Pass were not ascertained.

Table III-11. Commercial values of fish species harvested in Lee County for the period between 1992 through 1998.

Species	1992	1993	1994	1995	1996	1997	1998
Grouper	\$1,028,430	\$1,007,230	\$938,472	\$797,017	\$927,747	No Data	No Data
Lobster, Spiny	\$29,634	\$20,564	\$27,293	\$39,328	\$6,288	\$13,982	\$14,835
Shrimp	\$4,291,249	\$8,286,381	\$8,233,486	\$11,524,218	\$12,958,319	\$12,802,009	\$15,940,420
Snapper	\$242,723	\$232,057	\$178,324	\$104,331	\$71,728	\$46,760	\$60,164
Stone Crabs	\$243,230	\$466,080	\$500,786	\$1,105,251	\$1,953,834	\$603,951	\$739,452
Blue Crabs					\$1,941,168	\$1,118,088	\$1,554,594
TOTALS	\$5,835,266	\$10,012,312	\$9,878,361	\$13,570,145	\$17,859,084	\$14,584,790	\$18,309,465

Source: Data from FDEP-FMRI

As described by the CEPD (2002), the placement of dredged material on the beach was proposed to have no long-term effect on water quality. A temporary localized increase in turbidity was expected as fine-grained material present in the nourishment sands was washed from the sediments. However, no significant increase was expected in nutrients, contaminants or other parameters since the dredged material was primarily sand which would settle quickly through the water column to the bottom.

The placement of dredged material on the beach and in the littoral zone was proposed to effect benthic communities occupying the project areas. However, populations of benthic organisms were anticipated to reestablish within six to 12 months after placement occurred (CEPD 2002). Beach nourishment, borrow area dredging, and rehabilitation of marine structures were anticipated to temporarily disrupt some phytoplankton and zooplankton populations. Increased turbidity in the water column was expected to temporarily reduce light penetration, which could have affected primary production by the phytoplankton. However, due to the nature of the materials to be utilized, the effects



would have been short-term in nature (Culter and Mahadevan 1982). As concluded by CEPD (2002), no long-term effect on the biological productivity of the nearshore littoral zone was expected.

c) Summary of Findings

A degraded habitat was improved by the use of the terminal groin and associated fill and the project area is not considered an immediate concern of local resource agencies.

Sea turtle nesting data for Captiva Island, an approximate 5 mile shoreline from Redfish Pass to Blind Pass, dates back to 1986. On average, 94 nests were recorded annually from 1986 through 2009. However, the 2008 nesting period resulted in a sharp increase to 137 nests and then decrease to 80 nests in 2009.

In 2009, a USACE sponsored bird survey for Lee County was conducted (Lott et al. 2009). Redfish Pass between North Captiva Island and Captiva Island was included within the survey area. The north and south sides of the pass were surveyed separately. Captiva Island has an elevated area on the inlet beach that larids and shorebirds use for roosting. Species diversity was low as only nine species were observed over three visits: the great egret, snowy egret, black-bellied plover, willet, ruddy turnstone, sanderling, laughing gull, royal tern, and sandwich tern. All observations were either on intertidal or shallow-water substrates, and no wrack line was present. The disturbances were low at this site relative to other surveyed areas. During the three surveys; no vehicles, no dogs, and no parked boats were observed. Based on irregular surveys, Captiva Island has less shorebird diversity and abundance as compared to the adjacent Sanibel Island.

There was a proposed critical overwintering habitat for piping plovers covering Captiva Island and Sanibel Island; however, due to the lack of use by piping plover in this specific area, this unit has been deleted from the finalized Federal Register (USFWS 2001b).

Because there were no live bottoms within the groin construction footprint, FDEP required no post-construction biological resource monitoring. The lack of raw data resulted in non-discernable trends in potential effects on benthic and fisheries resources from the terminal groin and associated fillet.

5. John's Pass, Florida

a) General Site Description

John's Pass, (see Figure III-46 and Figure III-47), approximately 2,100 feet long and 600 feet wide, is located on the west coast of Florida and separates Sand Key on the north from Treasure Island to the south (Vincent 1992). Created by a hurricane in 1848, John's Pass connects Boca Ciega Bay to the Gulf of Mexico. The community immediately to the north is Madeira Beach, which prior to the construction of the terminal structure on the south end of Sand Key was experiencing a chronic erosion problem (Dean 1993). A tide-dominated inlet, John's Pass has extensive ebb- and flood-tidal deltas (Davis and Gibeaut 1990) and a federally maintained navigation channel. The 1958 postcard, Figure III-46, looks north at John's Pass prior to construction of the curved terminal groin. Note the inlet's developed shoreline has been hardened by seawalls.

In 1961, the City of Madeira Beach constructed the 460-ft curved terminal groin on north side of John's Pass and nourished the beach, as shown in the 1965 photo. Federally-authorized dredging of John's Pass began in 1966. In 2000, Pinellas County constructed another terminal groin on the south side of John's Pass.

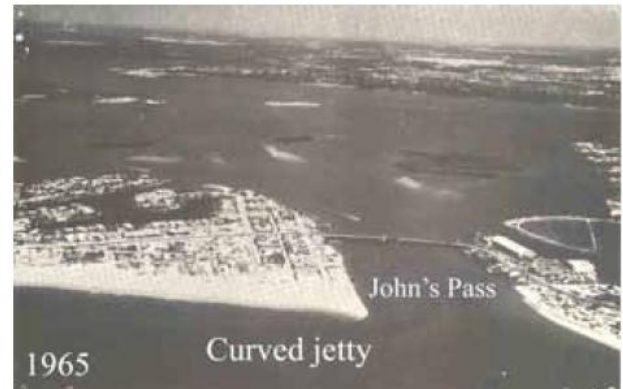
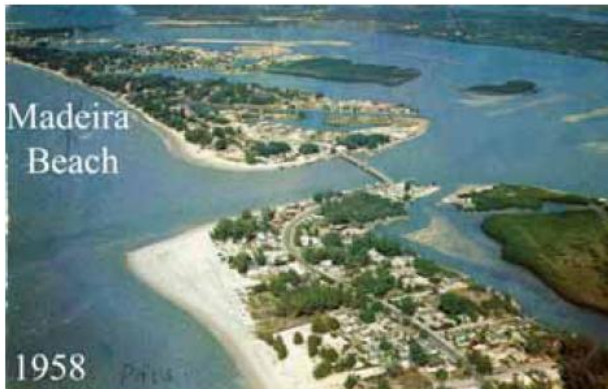


Figure III-46. John's Pass, Florida



Figure III-47. John's Pass, Florida



Treasure Island beaches have been actively managed since 1969, and southern Long Key beaches have been managed since 1980 (CPE 1992). Both beach reaches are on a four-year nourishment cycle (Pinellas County Department of Environmental Management 2008). In 2000, dredge material from John's Pass and Blind Pass were used to renourish Treasure Island and Long Key Beaches. Natural events such as storms and hurricanes act to erode beaches and redistribute sands, contributing to the rate at which beaches erode. Management of these beach resources is a collaborative effort between county, state, and federal entities. Florida's inlet operation and maintenance has altered shoreline sediment transport and deposition necessitating shoreline management of these adjacent beaches.

(1) Aesthetics

Equipment utilized during construction activities are visible on the beaches of Pinellas County and detract from the landward and waterward view shed. These visual and public convenience effects were temporary and move with project progress.

(2) Recreation

According to the FDEP (2008), Florida depends on its 825 miles of sandy beaches fronting the Atlantic Ocean, Gulf of Mexico, and Straits of Florida for the enjoyment of its residents and tourists. Beaches and dunes in Pinellas County are some of the county's most valuable natural resources. These resources provide habitat, storm protection, public access, and the base for the tourism industry. Pinellas County has 35 miles of beaches on the Gulf coast of Florida that are valued for their recreational value. Pinellas County residents as well as tourists utilize these beaches year-round.

(3) Public Access

The county's barrier islands have in most cases been transformed into linear cities and towns with very little undeveloped land remaining. According to the Pinellas County beach access guide, there are 127 parking spaces identified within the Madeira Beach Park located just north of John's Pass (Pinellas County Department of Public Works 2009). The Madeira Beach Park also includes restrooms, showers, and walkovers to the beach. Access to the beach front south of John's Pass is limited, as there are eight parking spaces located approximately 500 feet from the inlet. Treasure Island Park, including 151 parking spaces with numerous facilities, is located south of John's Pass.

b) Natural Resources

John's Pass is located within the Pinellas County Aquatic Preserve, established 21 March 1972 and designated as an Outstanding Florida Water on 1 March 1979. The submerged lands of the preserve include sand and mudflats, seagrass beds, and oyster reefs. The estuarine shoreline is protected by mangroves. As described by FDEP (2006), management concerns with aquatic preserves in highly urbanized areas include recreational issues (boating activities), runoff and dredging, loss of habitat due to shoreline hardening and adjacent upland development, and effects to water quality due to an increased load of nutrients. See Figure III-48 for classification of habitat and development areas.



(1) Sea Turtles

Vertebrate species that utilize the offshore habitats of Pinellas County include many threatened and endangered species. The Gulf of Mexico is within the range of five species of sea turtle, the West Indian manatee, and up to 28 cetacean species. Of these, four species of sea turtle, the manatee, and one cetacean [bottlenose dolphin (*Tursiops truncatus*)] occur within the study area. Four species of sea turtle commonly occur within the area around Pinellas County [Meylan et al. 1999; Environmental Protection Agency (EPA) 1981]. These are the loggerhead, green, Kemp's ridley, and the hawksbill. Loggerhead sea turtles represent most of the sea turtles present in the Tampa Bay area. Data collected on sea turtle nesting in the area shows that the majority are loggerhead sea turtle nests (Figure III-49 and Figure III-50). Stranding records within the Pinellas County area also confirmed that loggerhead sea turtles are the most numerous species.

As shown in Figure III-50, regular monitoring of sea turtle nesting activity has been conducted on north Pinellas County beaches since 1988. The sea turtle survey boundaries of North Pinellas County beaches include Dunedin Pass to the southern boundary of Indian Shores, an approximate 15 mile stretch of oceanfront shoreline. On average, 67 nests have been recorded on the north Pinellas County beaches. The number of nests recorded from 1988 through 1995 was relatively low, with an annual average of 48 nests. Annual nesting records from 1996 through 2005 were significantly higher, with an average of 82 nests.

As recorded by the FFWCC, regular monitoring of sea turtle nesting activity has also been conducted on the middle (mid) region of Pinellas County beaches since 1988 (Personal communication, B. Brost, FFWCC, February 2010). The sea turtle survey boundaries of the Mid Pinellas County beaches include Redington Shores to Blind Pass, an approximate 7 mile stretch of oceanfront shoreline. On average, 50 nests have been recorded annually for this region of Pinellas County beaches. The number of nests recorded from 1988 through 1994 was relatively low, with an annual average of 37 nests. The number of nests recorded from 1995 through 2005 was significantly higher, with an average of 58 nests.

Sea turtle nesting habitat on Pinellas County beaches is subject to the effects of tropical storms and periodic beach renourishment projects. Sea turtle nesting densities on Mid-Pinellas beaches increased following storm events in 1988, 2001, and 2004; whereas nesting densities decreased following storm events in 1990 and 1995. Nesting densities on North Pinellas beaches increased following storm events in 1988, 1990, 1995, and 2001; and decreased following a storm event in 2004. Pinellas County beaches were nourished four times between 1988 and 2004. Sea turtle nesting densities on Mid-Pinellas beaches increased following renourishment in 1988, 1996, and 2004; whereas nesting density decreased following renourishment in 2000. Sea turtle nesting densities on North Pinellas beaches increased following renourishment in 1988 and decreased following renourishment in 1996, 2000, and 2004. Based on these data, there does not appear to be a consistent relationship between nesting density and storm or renourishment events.



Figure III-48. Coastal Classification of Habitat for John's Pass, FL

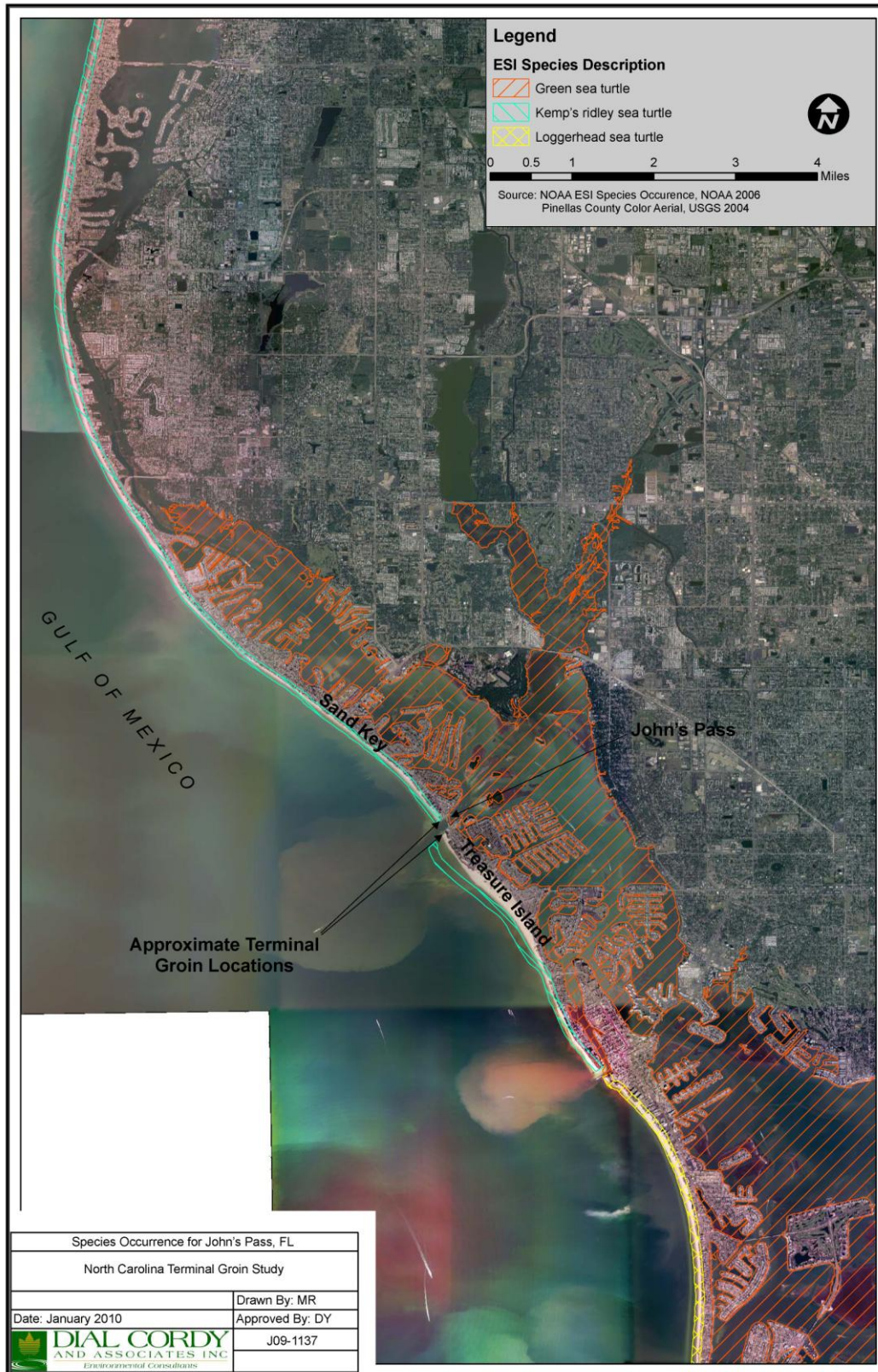


Figure III-49. Species Occurrence for John's Pass, FL

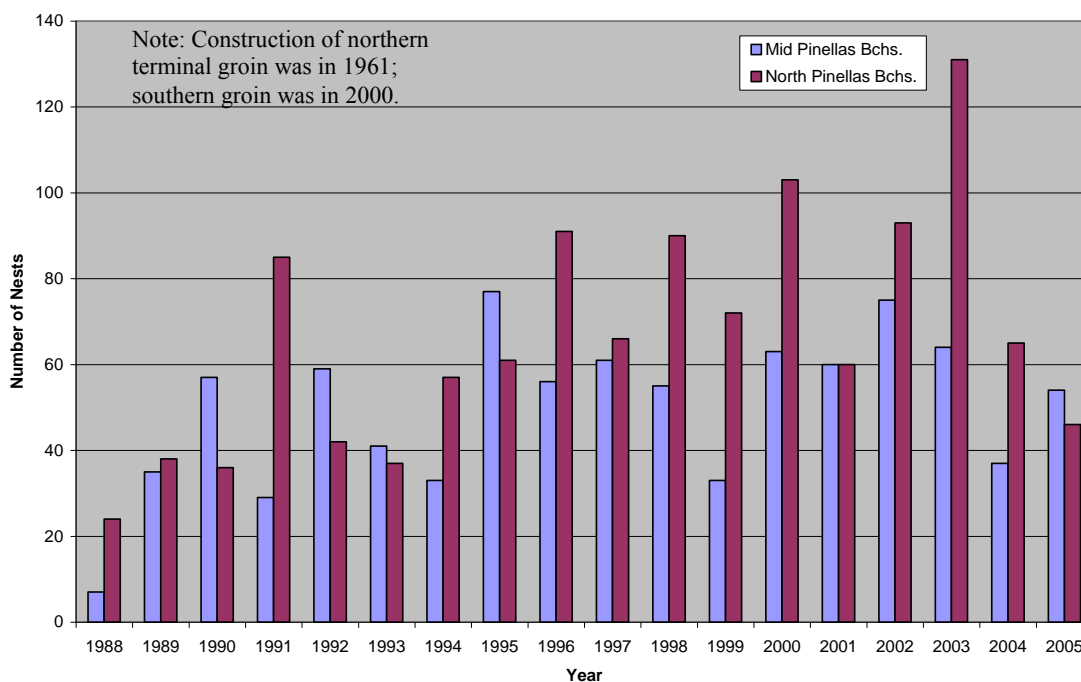


Figure III-50. Sea Turtle Nesting Data for Mid and North Pinellas Beaches

In 2007 and 2008, Audubon of Florida Coastal Islands Sanctuaries Program conducted direct nesting censuses of known colonial waterbird colonies in the Tampa Bay watershed and Pinellas County. Census sites included three sites in John’s Pass: Little Bird Key, Bird Rookery Key, and Eleanor Island (Hodgson et al. 2009).

As described by DC&A (2009), the area evaluated in proximity to John’s Pass consists of suitable habitat for wintering piping plover; however, no piping plover critical habitat is designated within the project area. In addition, this region experiences greater human activity during the winter season. Therefore, the likelihood of piping plover utilizing the beach habitat in the project area is low. Due to limited habitat availability, shorebird data was not accessible for review.

(2) Shorebirds and Waterbirds

Shorebirds that are known to nest on Pinellas County Beaches include American oystercatcher, black skimmer, laughing gull, Caspian tern, least tern, royal tern, sandwich tern, snowy plover, Wilson’s plover, and willet (Hodgson et al. 2009; FFWCC Shorebird/Seabird Monitoring Website <http://myfwc.com/shorebirds/>).

(3) Seagrasses

SAV within Boca Ciega Bay and John’s Pass are associated with tidal flats and shoal areas surrounding mangrove islands or along the shoreline. Figure III-51 depicts the presence of seagrass and unvegetated tidal flats within John’s Pass. Seagrasses are present around the mangrove islands east and south of the channel. Seagrass patches are also associated with the portions of the area’s shoreline and canals. No seagrass is known to occur along the outer pass channel or ebb shoals (DC&A 2009).



Figure III-51. Seagrass and Tidal Flats for John's Pass, FL



Figure III-52. Habitat Change for John's Pass, FL from 1999 to 2006



There appears to be a significant reduction in unvegetated tidal flats along with a significant increase in SAV (Figure III-52) when comparing 1999 to 2006 Southwest Florida Water Management District (SWFWMD) data. The maintained channel dimensions, flow characteristics, meteorological conditions and water quality/water clarity attributes are the likely precursors to the expansion of SAV.

(4) Fish and Fisheries

Assessments of marine resources within the project area were conducted in 2001 and 2002 (DC&A 2001, 2002), and more recently in association with an EA for dredging of the ebb shoal with beach placement (DC&A 2009). Dominant biological community types were documented within and adjacent to the proposed ebb shoal borrow areas, pipeline corridors, and nearshore areas. Surveys of the ebb tidal shoal areas and the Pass-a-Grille channel were also performed (DC&A 2001b, 2002). Marine habitats identified during the offshore surveys included hardbottom, shell hash, and open sand habitat. The biological communities associated with these different bottom types and the water columns have been identified as EFH in accordance with the amendment to the Fishery Management Plans of the [Gulf of Mexico Fishery Management Council (GMFMC) 1998].

Since John's Pass is located within the Pinellas County Aquatic Preserve, turbidity elevation is restricted at the limit of the mixing zone during dredging operations. Therefore turbidity within the mixing zone will be less than 29 nephelometric turbidity units (NTUs) above background. This limits adverse effects to hardbottom.

Fishes off of the Pinellas County coast are comprised of both demersal and pelagic species, many of which utilize the pass for passage between inshore and offshore waters either for foraging or with maturation. Many of the species present within this area are of commercial importance and addressed under the NMFS GMFMC Management Plan (GMFMC 1998). The fish assemblages in the area offshore of Pinellas County Florida and the Gulf of Mexico have been studied many times in the past. These studies have included reports which characterize the offshore and nearshore assemblages of fishes (Moe and Martin 1965; Saloman and Naughton 1979), cold stress of fishes on reef areas (Gilmore et al. 1978), growth and reproduction (Schirripa and Burns 1997; Bullock et. al 1996), and the effects of fishing activities and predation (Pierce et al. 1998; Nelson and Bortone 1996).

Pelagic species also occur throughout the Gulf of Mexico in the nearshore and offshore waters. Major coastal pelagic families include Rachycentridae (cobia), Mugilidae (mulletts), Pomatomidae (bluefish), Caranagidae (jacks), Scombridae (tunas and mackerels), Engraulidae (anchovies), and Carahahinidae (requiem sharks). Many of these pelagic species form large schools (e.g. jacks, mullet, mackerel, etc.), while others travel singly or in small groups (e.g. cobia). Distribution of these species can vary seasonally and usually depends on water column attributes that vary seasonally.



Moe and Martin (1965) collected over 2,300 individual fishes from 41 species during sampling conducted at nine separate locations offshore of Pinellas County. Fishes observed during diver and video surveys on or near hardbottom habitats offshore of Pinellas County (DC&A 2002) include a total of 17 species from 15 families. Most species observed included small demersal species common to hardbottom areas. The most common species observed were wrasses (Labridae); in particular the slippery dick (*Halichoeres bivittatus*). Other common fishes included searobins (*Prionotus* sp.), and menhaden. Anecdotal observations of pelagic fishes during the survey included large schools of baitfish (Engraulidae and Clupeidae), sharks (Carahahinidae), mackerel (Scombridae), and a nurse shark (*Ginglymostoma cirratum*).

In Pinellas County, a gulf sturgeon was most recently documented near Redington Beach in 1992 (USFWS 1995). Gulf sturgeon have not been documented in the vicinity of John's Pass or Blind Pass, possibly because these inlets do not provide access to freshwater rivers required by the gulf sturgeon. Gulf sturgeon may use the project area for foraging during winter months when they are known to be in the Gulf of Mexico.

(5) Benthic Resources

Although John's Pass is not specifically monitored for water quality through the Pinellas County water quality monitoring program (Pinellas County Department of Environmental Management 2009), John's Pass is considered non-impaired coastal waters. An older study (Myers et al. 2000) provided water quality data for the area including south Boca Ciega Bay, which includes John's Pass, and indicated the water quality to be good. The benthic community can serve as an excellent indicator of water quality, and Grabe (1998) describes Boca Ciega Bay as diverse and heterogeneous, and that less than 15 percent of the benthic habitat of the bay is classified as degraded.

Lyons and Collard (1974) characterized the shallow shelf habitat offshore of Pinellas County as an area with sediments dominated by quartz sand and carbonates with exposed rock substrate. This substrate provides habitat for scleractinian, molluscan, crustacean and other invertebrate species. Previous studies have identified species common to habitats offshore of Pinellas County (EPA 1981; CZR 1991; Child 1992; Posey et. al 1996). The species listed in these previous studies compares closely to species observed during the 2002 survey conducted by DC&A (2002). In total, over 40 dominant invertebrate species were observed from the diver and video surveys. According to DC&A (2002), there are many more cryptic and less obvious species present within these complex habitats (Table III-12).

Table III-12. Invertebrates within and adjacent to John's Pass.

Common Name	Scientific Name
Echinoderms	
Beaded Sea Star	<i>Astropecten articulatus</i>
Orange-Ridged Sea Star	<i>Echinaster spinulosus</i>
Rock-boring Urchin	<i>Echinometra lucunter</i>
Common Comet Star	<i>Linckia guildingii</i>
Banded Sea Star	<i>Luidia alternata</i>
Striped Sea Star	<i>Luidia clathara</i>
Sea Star	<i>Luidia</i> sp.
Variegated Urchin	<i>Lytechinus variegates</i>
Mollusks	
Lightning Whelk	<i>Busycon contrarium</i>
Tritons trumpet	<i>Charonia variegata</i>
Penshell	<i>Pinna carnea</i>
Florida Horse Conch	<i>Pleuroploca gigantean</i>
Scleractin Corals	
Tube Coral	<i>Ciadicora arbuscula</i>
Cactus Coral	<i>Isophyllia sinuosa</i>
Rose Coral	<i>Manicina aereolata</i>
Branching Fire Coral	<i>Millepora alcicornis</i>
Boulder Star Coral	<i>Montastrea annularis</i>
Robust Ivory Tree Coral	<i>Oculina robusta</i>
Hidden Cup Coral	<i>Phyllangia americana</i>
Mushroom Coral	<i>Scolymia lacera</i>
Starlet Coral	<i>Siderastrea</i> sp.
Knobby Star Coral	<i>Solenastrea hyades</i>
Blushing Star Coral	<i>Stephanocoenia mitchelinii</i>
Octocorals	
Warty Sea Rod	<i>Eunicea calyculata</i>
Shelf-knob Sea Rod	<i>Eunicea succinea</i>
Colorful Sea Whip	<i>Leptogorgia virgulata</i>
Orange Spiny Sea Rod	<i>Muricea elongata</i>
Delicate Spiny Sea Rod	<i>Muricea laxa</i>
Giant Slit-Pore Sea Rod	<i>Plexaurella nutans</i>
Sea Plume	<i>Pseudotrogorgia</i> sp.
Yellow Sea Whip	<i>Pterogorgia citrina</i>
Sponges	
Erect Rope Sponge	<i>Amphimedon compressa</i>
Brown Variable Sponge	<i>Anthosigmella varians</i>
Dark Volcano Sponge	<i>Calyx podatypa</i>
Brown Bowl Sponge	<i>Cribrochalina vasculum</i>
Ball Sponge	<i>Ircinia</i> sp.
Branching Tube Sponge	<i>Pseudoceratina crassa</i>
Loggerhead Sponge	<i>Sphaciospongia vesparium</i>
Giant Barrel Sponge	<i>Xestospongia muta</i>
Crustaceans	
Florida Stone Crab	<i>Menippe mercenaria</i>
Tunicates	
Colonial tunicates	<i>Clavelina</i> sp.
Condominium Tunicate	<i>Eudistoma</i> sp.
Overgrowing Tunicates	Family Didemnidae

Source: DC&A 2002



The nearshore hardbottom was previously delineated in 2001 by Sea Systems Corp. with side scan sonar and again in August 2005 (DC&A) with towed camera investigations spaced along regular intervals throughout the project area. Comprehensive documentation of the hardbottom resources within 1,000 feet of the shoreline could not be assured with the aforementioned methodology. On 7-10 October 2005, CPE biologists verified and mapped the nearshore hardbottom edge resources within the project area using self contained underwater breathing apparatus (SCUBA).

The most obvious feature of the hardbottom habitats in the eastern Gulf of Mexico includes the octocorals, sponges, and scleractinian corals. Eight species of octocorals, eleven species of scleractinian (hard) corals, and eight species of sponges were identified. Sediments within the area consist of sand to shelly sand that supports benthic invertebrate communities. In an EPA (1981) study, dominant species in these habitats included sand dollars (*Encope emarginata*) and marine worms (*Luidia* sp.). Similar species were observed during the DC&A (2002) study. Benthic sampling conducted during past surveys also shows that polychaetes, oligochaetes, pycnogonids, bivalves, and arthropods are the dominant taxa collected in these habitats (CZR 1991; Child 1992; Posey et al. 1996). Although these species may be found offshore north and south of John's Pass, it was determined that John's Pass ebb tidal shoal (152.1 acres) consisted of primarily sand, with no documentation of seagrass or hardbottom (DC&A 2002).

c) Summary of Findings

John's Pass is located within the Pinellas County Aquatic Preserve. As described by FDEP (2006), management concerns with aquatic preserves in highly urbanized areas include recreational issues (boating activities), runoff and dredging, loss of habitat due to shoreline hardening and adjacent upland development, and effects to water quality due to an increased load of nutrients.

The sea turtle survey boundaries of the Mid Pinellas County beaches include Redington Shores to Blind Pass, an approximate 7 mile stretch of oceanfront shoreline. On average, 50 nests have been recorded annually for this region of Pinellas County beaches. The number of nests recorded from 1988 through 1994 was relatively low, with an annual average of 37 nests. The number of nests recorded from 1995 through 2005 was significantly higher, with an average of 58 nests.

Shorebirds that are known to nest on Pinellas County Beaches include American oystercatcher, black skimmer, laughing gull, Caspian tern, least tern, royal tern, sandwich tern, snowy plover, Wilson's plover, and willet (Hodgson et al. 2009; FFWCC Shorebird/Seabird Monitoring Website <http://myfwc.com/shorebirds/>). The area evaluated in proximity to John's Pass consists of suitable habitat for wintering piping plover; however, no piping plover critical habitat is designated within the project area. In addition, this region experiences greater human activity during the winter season. Therefore, the likelihood of piping plover utilizing the beach habitat in the project area is low. The lack of raw data resulted in non-discernable trends in potential effects on birds, benthic resources, and fisheries from the terminal groins and associated fillets.



C. Overall Findings and Summary of NC and FL Study Sites

Based upon the historical nature of the terminal groins at Fort Macon, John's Pass (northern groin), and Redfish Pass; discernible trends of the effects of these terminal groins on the natural resources is somewhat limited. Lacking pre-construction data makes an empirical determination of post-construction effects at these sites difficult if not impossible. While the use of control and/or regional sites strengthens the ability of a study to infer an impact from a detected change, we cannot infer an impact if there is no statistical evidence for a change (Mapstone 1995); and due to the lack of complete datasets and high levels of confidence in the quality of the data, statistical analysis was precluded. The current development and use of some of the selected sites precludes unrestricted utilization by the site's natural resources. Sea turtles, avian species, and marine species, however, continue to make use of these managed sites, albeit sometimes on a limited basis.

The terminal groins at Oregon Inlet and Amelia Island are more recent construction projects, and pre- and post-construction natural resource data readily available were evaluated (sea turtle and shorebird nesting data). The more recent data collected since construction, indicates an increase in public interest/participation, and funding for monitoring of these resources. Although shorebirds and sea turtles utilize both locations, neither significant trends nor adverse effects were discernable from the available data. The resources present at both the Amelia Island and Fort Macon terminal groin locations were compared to undisturbed neighboring barrier islands where data indicated resources were more prevalent, as expected.

Because of the diversity and commercial importance of hardbottom areas, appropriate effort should be employed ensuring avoidance of such habitats while assessing potential groin locations, borrow sources, and/or shoreline and adjacent shoreline sand placement templates.

In general, the following conclusions result from an extensive evaluation of available scientific literature, regulatory documentation, and available data from each of the selected study sites:

- The effects of a terminal groin structure alone could not be assessed for most sites without considering the associated beach nourishment activity;
- Minimizing natural overwash at the end of an island limits natural barrier island processes which affects inlet habitats, thus affecting species use;
- Anchoring the end of an island may curtail an inlet's natural migration patterns thereby minimizing the formation of sand flats;



- Fillet material should be compatible to minimize effects on benthic infauna recovery and upper trophic levels;
- Resources continue to use locations where terminal groins exist, however, if habitat succession occurs, species suitability may be affected; and
- Available data and a limited time frame resulted in non-discernable site specific trends.