SAND SCRAPING AND TRANSFERS ALONG SEABROOK ISLAND, CHARLESTON COUNTY (SC)

Submitted in Conjunction with
Permit Application Pending
Public Notice Pending

BIOLOGICAL ASSESSMENT & ESSENTIAL FISH HABITAT ASSESSMENT

Prepared for:

US Army Corps of Engineers
Regulatory Division – Charleston District
69A Hagood Avenue, Charleston SC 29403–5107

Applicant:

Seabrook Island Property Owners Association

Prepared by:

Coastal Science & Engineering Inc (CSE)
PO Box 8056, Columbia SC 29202–8056

[2534–BA/EFH]
MAY 2022

— THIS PAGE INTENTIONALLY LEFT BLANK —

TABLE OF CONTENTS

— *THIS PAGE INTENTIONALLY LEFT BLANK*

1.0 Introduction and Purpose

This Biological Assessment (BA) and Essential Fish Habitat (EFH) assessment is prepared at the request of the US Army Corps of Engineers (USACE) and the US Fish & Wildlife Service (USFWS) on behalf of the Seabrook Island Property Owners Association (SIPOA) on Seabrook Island, South Carolina (SC) (Permit Number Pending). This BA/EFH is preliminary to formal consultation and preparation of a Biological Opinion (BO) by the USFWS.

The project area lies along the oceanfront beach of Seabrook Island, which consists of intertidal habitat adjacent to semi-vegetated dunes. The proposed project seeks to recycle sand accreting on the down-drift side of Captain Sams Inlet and place material along the eroded portions of the beach approximately 1 mile to the southwest. The exact location of the borrow area is subject to approval by USFWS and SCDNR. The project will result in the creation of new dry-sand beach and dune habitats along the southern tip of Seabrook Island, with minimal impacts to the borrow area.

This BA/EFH is preliminary to formal consultation and preparation of a Biological Opinion (BO) by the USFWS. The BO is required given anticipated impacts to protected species known to be present in the proposed project area. The general purpose of a BA/EFH is to evaluate the potential effects of an action on protected natural resources, specifically, endangered and threatened species. It is required for major construction activities that require federal permitting and could significantly affect the quality of the human environment as referred to in the National Environmental Policy Act of 1969 (NEPA) (42 U.S.C. 4321 et seq.). The requirement is set forth under Section 7(c) of the Endangered Species Act (ESA), in which the BA fulfills consultation requirements of Section 7(a)(2). The BA/EFH is called for if federally-listed species or designated critical habitats *may* be present in the affected area (USFWS).

"*The primary role [of the BA] is to document an agency's conclusions and the rationale to support those conclusions regarding the effects of their proposed actions on protected resources"* (USFWS, www.fws.gov/midwest/endangered/section7/ba_guide.html). The following information is provided to comply with statutory requirements to use the best scientific and commercial information available to assess risks posed to listed and/or proposed species and designated and/or proposed critical habitat by proposed federal actions. The proposed work also requires federal action through USACE to issue permits through Section 10 of the Rivers and Harbors Act and Sections 401 and 404 of the Clean Water Act.

This document provides details on:

- The proposed project
- The proposed project area including existing physical and biological attributes
- Listed and proposed species that "may be present"
- Present habitat conditions of all identified species
- How the proposed project may impact each species
- Section 7 finding for each species

For the current project, the Applicant, SIPOA, is requesting a permit to conduct sand scraping and transfers along Seabrook Island (SC) (public notice pending). Relocation would be accomplished via land-based equipment, excavating a portion of the intertidal beach along northeastern sections of Seabrook Island near Capt Sams Inlet, and placing material along the central portion of Seabrook Island where a considerable sand deficit currently exists. The proposed project is similar to a successful project performed from 2002 to 2007, and includes elements similar to other recent efforts at Kiawah Island.

This BA/EFH describes or lists the following: the proposed project area (Section 2), the proposed project plan (Section 3), the protected species that occur in the project area (Section 4), the general effects on listed species and critical habitat (Section 4), and species assessments (Section 5). It also summarizes protection measures that will be implemented during the project (Section 5), addresses essential fish habitat and habitat areas of concern for marine life (Section 6), and summarizes the effect determinations (Section 7).

The BA/EFH draws on the following sources:

- Environmental protection recommendations by USFWS,
- Reasonable and prudent measures provided by USFWS to the Applicant for similar projects,
- Various research studies of biological impacts of nourishment conducted by SCDNR, and
- Recent experience with similar projects (eg 2018 Singleton Swash Relocation, 2015 Captain Sams Inlet Relocation Project, 2015 Kiawah Island East End Restoration Project, 2002-2007 Seabrook Island Sand Recycling Project).

2.0 Project Area

Seabrook Island is a ~3-mile-long barrier island on the Atlantic shoreline ~20 miles (~30 km) south of Charleston, SC (Figure 2.1). The island is bordered on the west and south by North Edisto River Inlet, a large mixed-energy inlet with a broad ebb-tidal delta extending several miles into the Atlantic Ocean. To the north and east, Seabrook borders Captain Sams Inlet and Kiawah Island. Seabrook receives sand eroded from beaches and dunes along Kiawah Island, which in turn receives its sand from Stono Inlet.

Seabrook Island is strongly influenced by dynamics of the shifting shoals associated with North Edisto River Inlet and sand bypassing the smaller Capt Sams Inlet at the northeastern tip of the island. Unlike the large North Edisto River Inlet, which is anchored in semi-hardened material and remains positionally stable over long time scales, Capt Sams Inlet regularly migrates toward the southwest and encroaches upon the beach and adjacent uplands along Seabrook Island. As a result, several projects have been implemented to mitigate erosion since its development in the 1970s. These projects are detailed below.

Seabrook Island's beach is constantly responding to variations in wave energy and sediment supply due to the effects of Captain Sams Inlet and North Edisto River Inlet. Extensive descriptions of the morphological changes, causes of erosion, and restoration history of Seabrook Island are provided in CSE's (2011) *Captain Sams Inlet Relocation Project: Design Report*. Generally, the beach sediment supply has been controlled by natural and artificial relocations of Captain Sams Inlet, while localized erosion between Renken Point and the Beach Club is influenced by the position of the marginal flood channel of North Edisto River Inlet.

To date, there have been four large-scale projects designed to restore or maintain sediment supply to the beach: three inlet relocations (1983, 1996, 2015) and a nourishment project to realign the northern channel (1990). There have also been at least ten small-scale "sand transfer" events since the 1980s, where some of the excess sand north of Oyster Catcher is excavated and hauled by trucks to eroding downcoast areas.

Table 2.1 provides an updated event log (building from previous CSE reports) of significant shoreline activities along Seabrook Island dating to its initial development in the early 1970s. Major events all bear some relation to erosion and sand transport processes around Captain Sams Inlet and North Edisto River Inlet. What is particularly notable about many events is their cyclic nature.

TABLE 2.1. (shown on 9 pages) Seabrook Island — major shoreline events.

FIGURE T-1. Aerial view of Seabrook Island in November 2013.

1948 Captain Sams Inlet breached Kiawah spit near present-day Beachwalker Park, creating multiple channels. A single channel became dominant by the early 1950s (Fig T-2).

1963 Mouth of Captain Sams Inlet was aligned with the mouth of Captain Sams Creek, about 1.3 miles north of the present-day Oyster Catcher beach access. This shoreline and inlet configuration became the model for the 1983 and 1996 inlet relocations (Fig T–3).

1960s Seabrook's beach was healthy and generally growing seaward. In some places like Renken Point, the growth rate was over 30 feet per year (ft/yr).

Circa 1970 Seabrook Island became a planned-unit development. Roads, golf course, and lots were platted using the existing dune/vegetation line as a basis for the plan. Development was allowed behind the normal limit of tides and waves without regard to historical shoreline trends.

FIGURE T-2. Vertical photograph (1949) of Seabrook Island before development. Sometime in 1948, Captain Sams Inlet breached Kiawah spit near present-day Beachwalker Park (right side of image). The northeastern channel became dominant in the 1950s.

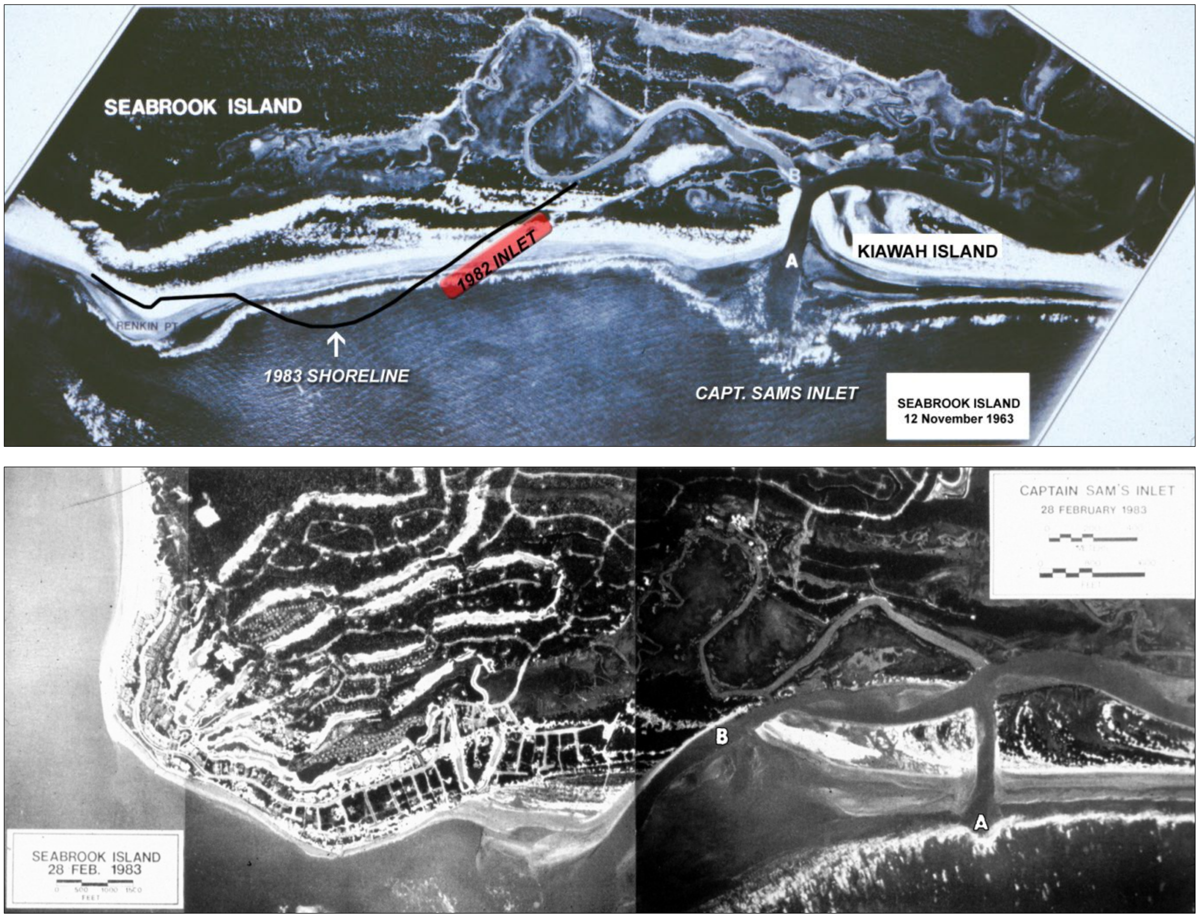


FIGURE T-3. Seabrook Island and Captain Sams Inlet in 1963 (upper) and 1983 (lower). The 1963 condition served as a model for the plan to relocate Captain Sams Inlet. Lower photo shows the new channel (A) open before the old channel (B) was closed on 4 March 1983.

1970s Seabrook Island was in a rapid erosion cycle with some areas like Renken Point eroding at over 20 ft/yr.

1973 Beach Club under construction.

1974 Erosion impacted the Beach Club before construction was complete. First shore-protection measures consisted of large sand bags, sandbag groins, and sheet-pile bulkheads (Fig T-4).

FIGURE T-4. Shore-protection structures at the Beach Club in September 1974 prior to the club's opening.

1975–1981 Succession of sandbag revetments, timber and concrete bulkheads/seawalls, and quarry-stone revetments were installed along Seabrook Island between Pelican Watch Villas and the 13th fairway of the golf course (~2 miles). Individual property owners were generally responsible for the cost of shore-protection structures which, by the late 1980s, totaled over $5 million for the island (Fig T-5).

1979 RPI (c/o Prof Miles Hayes) completed the first shoreline assessment of the island, identified three principal erosion-causing processes, and recommended soft solutions involving inlet relocation and nourishment.

SEP 1979 Hurricane *David* caused extensive damage to the seawall (Fig T-6). The mouth of Captain Sams Inlet was near the Oyster Catcher beach access. Seabrook's only dry beach areas were a 2000-ft reach around Oyster Catcher and the North Edisto Inlet shoreline along Pelican Watch Villas.

FIGURE T-5. During the early 1980s, much of Seabrook lacked any beach even at low tide. **[UPPER]** View north from Renken Point at mid-tide. **[LOWER]** Oblique aerial (1982) looking north at low tide showing no beach around Renken Point.

FIGURE T-6. Collapse of the concrete seawall at Renken Point in September 1979 during Hurricane *David*.

FIGURE T-7. February-March 1983.

[UPPER] Excavation of the basin for the new channel by land-based equipment.

[MIDDLE] The new channel across Kiawah spit and closure dike under construction in the distance on 18 February two weeks before project completion.

[LOWER] Closure of the old channel on a falling tide on 4 March 1983.

MAR 1983 First relocation of Captain Sams Inlet ~1.3 miles north to its 1963 position. Old inlet closed by trucks hauling sand from the new channel basin. The cost of the project was (~)$300,000 (Fig T-7).

LATE 1980s North Beach was restored by natural processes as sand from the delta of abandoned Captain Sams Inlet migrates onshore, adding over 1 million cubic yards to Seabrook's beach. North Beach was upward of 1,000 ft wide in places, a dry beach was restored, and the rock revetment north of Renken Point began to be buried by windblown sand.

1980s Several sections of the seawall (south of Renken Point) breached during minor storm events (Fig T-8). No new sand reached Beach Club Villas or Pelican Watch Villas for nearly a decade, causing loss of the dry beach.

1989 The northern channel of North Edisto Inlet was forced shoreward by the shoal off Renken Point, causing dangerous encroachment along the seawall (Fig T-8). At Amberjack Court, the channel 50 ft from the wall was 22 ft deep. Property owners continued to add rock in this area to shore up the seawall.

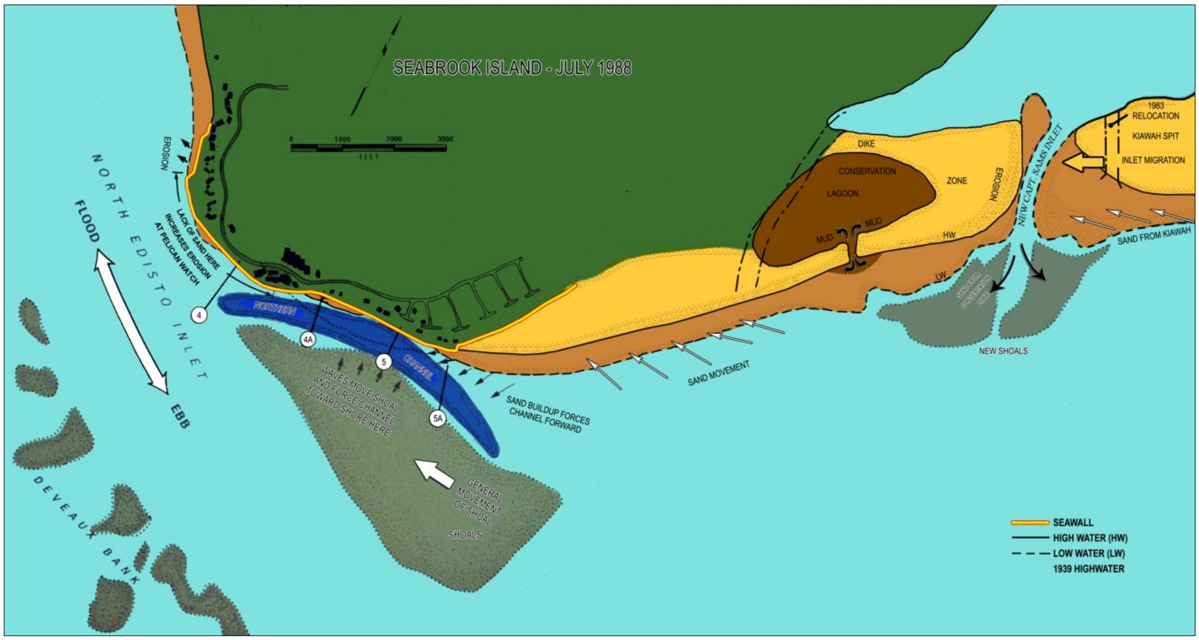


FIGURE T-8. Encroachment (upper) of the northern channel (deep blue area) of North Edisto Inlet and lack of maintenance led to collapse (lower) of a section of seawall near Beach Court in 1983.

FEB 1990 The northern channel was realigned by an ocean-going dredge (Great Lakes Dredge & Dock Company – dredge *Illinois*) which built a parallel channel 600 ft seaward while filling the existing channel along the seawall (Fig T-9). The project added 685,000 cubic yards to the beach between Renken Point and Pelican Watch Villas. A narrow dry beach existed south of Renken Point for less than one year before the project adjusted. A narrow wet-sand beach persisted through the 1990s, which gave the seawall protection. The cost of the nourishment project was $1.6 million.

FIGURE T-9. **[UPPER]** 1989 plan for realignment of the northern channel and nourishment south of Renken Point. **[LOWER]** Start of dredging operations in February 1990 at Renken Point.

CIRCA 1995 Nourishment losses south of Renken Point began to reverse as the area stabilized and began a long period of accretion by natural and artificial means. Captain Sams Inlet has migrated about 3,000 ft since the 1983 relocation.

APR 1996 Captain Sams Inlet relocated again to its 1963/1983 position (Fig T-10). The cost of construction was (~)$400,000, which was comparable to the price of one oceanfront lot at this time.

1998–2001 Winter sand scraping around the abandoned inlet was implemented to accelerate adjustment of the shoreline. An outer dike was constructed 500 ft seaward of the closure dike, leaving a small lagoon between the two dikes. This created a straighter, longer North Beach and led to more efficient sand transport to the south.

2002–2007 Winter sand scraping from North Beach was performed to transfer ~350,000 cubic yards to South Beach. This added to the natural sand transport from north to south and accelerated the recovery of South Beach. By 2005, only about 1,200 ft of shoreline (vicinity of the Beach Club and Beach Court) lacked a dry beach during normal high tides.

FIGURE T-10. The second relocation of Captain Sams Inlet in April 1996. **[UPPER]** First tide into the channel basin on 4 April during a rising tide. **[LOWER]** The new channel (left side) before completion of the closure dike across the old channel.

2007–2008 Migration of Captain Sams Inlet led to focused erosion along North Beach. After review of outside opinions and alternatives, the POA Environmental Committee decided to initiate engineering and permitting for the third inlet relocation project.

2008 Permit application submitted for the third relocation of Captain Sams Inlet.

2009–2012 Additional reviews, studies, and revisions to permit application. Permit application resubmitted in 2010 and issued by SC DHEC OCRM in January 2012 and by USACE in October 2012. The SC permit was appealed by one Seabrook Island property owner.

2008–2015 Captain Sams Inlet continued to migrate to the west, reaching the approximate location of the 1996 channel. Erosion intensified along portions of North Beach. Without sand scraping, sediment supply to the rest of Seabrook was reduced, resulting in erosion of the area near the Beach Club.

FIGURE T-11. Composite image of the Captain Sams Inlet area from the Seabrook side in January 2014. The lagoon formed in the abandoned 1996 channel is on the left side of the image.

2009 Portions of Kiawah spit that were stable for a least 40 years became developable under periodic revisions to state jurisdictional setback lines. The new lines left a wide buffer of foredunes for protection and terminated near the Town of Kiawah Island/Town of Seabrook Island easement boundaries positioned immediately north of the 1983 and 1996 positions of Captain Sams Inlet.

2013 Kiawah Development Partners (owners of Kiawah spit) sold the land to Kiawah Partners, which announced plans to build 50 homes on the spit north of Captain Sams Inlet.

2014 Kiawah Partners requested a modification of the proposed alignment of Captain Sams Inlet relocation to place the cut ~400 ft south of its planned location near the Town easement line.

2014 In December, the Administrative Law Court dismissed the lawsuit against SIPOA (which was brought by a property owner in 2012), clearing the way for the third inlet relocation to occur.

2015 Between 18 May and 18 June, Captain Sams Inlet was relocated for the third time (Fig T-12). The contractor, RE Goodson Construction Inc (Darlington SC), opened the new channel on 2 June, although significant flow did not occur until 12 June because of a "plug" of marsh at the landward end. The first closure attempt on 4 June failed. The old channel was successfully closed during the second attempt on the evening of 11 June. Final grading and equipment removal occurred on 18 June. The total construction cost was $930,500. The volumes required for channel and dike construction were ~165,000 cy. (CSE 2015a)

FIGURE T-12. Captain Sams Inlet after inlet relocation in June 2015. Kiawah spit is to the right and Captain Sams Creek is at the upper right corner of the image. The orthorectified aerial photo was prepared by Independent Mapping Consultants Inc (Charlotte NC).

2016 First monitoring survey after the third inlet relocation project was completed March–April.

2016 Seabrook Island was selected for an ASBPA* Best Restored Beaches Award. *[American Shore and Beach Preservation Association—www.asbpa.org]

2016 Hurricane *Matthew*, a Category 1 hurricane, tracked along the South Carolina coast, impacting Seabrook Island with a storm surge ~5 ft above normal tides on 8 October.

2017 Second annual monitoring survey (after the 2015 inlet relocation) was completed in January. Hurricane *Irma* entered the U.S. as a Category 4 storm in the Florida Keys on 10 September. Despite tracking up the Florida peninsula and moving inland west of South Carolina, the storm's broad diameter produced high waves and a storm surge of 5 ft in Charleston. This caused extensive overwash along the coast, but did not breach the closure dike at old Captain Sams Inlet.

2019 Hurricane *Dorian* passed ~65 miles southeast of Seabrook Island as a Category 3 storm. Like *Matthew*, *Dorian* followed the coastline from Florida to North Carolina. This created a longer storm duration for much of the SC coast and led to widespread beach erosion and dune recession, but did not result in a local landfall with more severe impacts.

2020 Fifth monitoring after the 2015 inlet relocation was completed in February.

3.0 Project Description

3.1 Project Goals

The purpose of the project is for sand management along the Seabrook Island shoreline, wherein excess sand in accreting sections of the island (ie – North Beach) is shifted mechanically to eroding areas (ie – South Beach) (Figure 3.1). The project seeks to augment the natural flow of sand from upcoast (Capt Sams Inlet) to downcoast (North Edisto River Inlet) and restore a viable profile along a segment of the island that presently is backed by an exposed seawall.

FIGURE 3.1. Project map showing proposed borrow area along North Beach ('A') and fill area between the Seabrook Beach Club area and Beach Court ('B').

The applicant closely monitors erosion and accretion along Seabrook Island because of the natural variability in rates. Virtually the entire shoreline is influenced by tidal inlets and their associated shoals, which modify wave heights and directions alongshore. This leads to irregular rates of cross-shore and longshore sediment transport.

Processes of erosion at the confluence of the North Edisto River Inlet and its northern marginal channel are further complicated by an exposed section of seawall that exacerbates wave reflection. Commonly, the junction of large tidal creeks creates zones of extra scour near the mouth of the tributary channel.

At Seabrook, a deep scour hole persists at the downcoast end of the northern marginal flood channel within the general boundaries of the North Edisto River Inlet channel. This leads to instability of the channel slope and contributes to periodic underwater slumping and collapse of the beach along the inlet margins. The applicant has documented at least eight underwater slope failures since 2015 in the project area, whereby a 100–300 foot (ft) segment of the intertidal beach has slumped into the main channel of North Edisto River Inlet (Figures 3.2-3.4). While the erosion arcs in the beach caused by slumping tend to heal naturally by longshore transport from the upcoast, each event produces a significant loss of sand volume on the visible beach, narrowing the profile and lowering the elevation of the wet-sand beach.

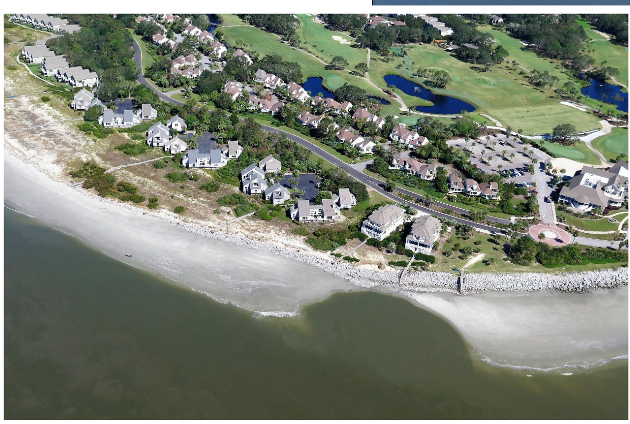


FIGURE 3.2. Aerial images of Reaches 1 and 2 from Camp St Christopher to Deveaux Villas. **[UPPER]** Conditions on 28 July 2016—note horseshoe-shaped scour in beach at Deveaux Villas (right side of image) [SB Traynum]. **[MIDDLE]** A recurring scour hole after Hurricane *Matthew* at Deveaux Villas on 12 October 2016 [SB Traynum]. **[LOWER]** Conditions on 15 May 2020 showing no scour hole but a more eroded section of beach along the seawall. [J Hair]

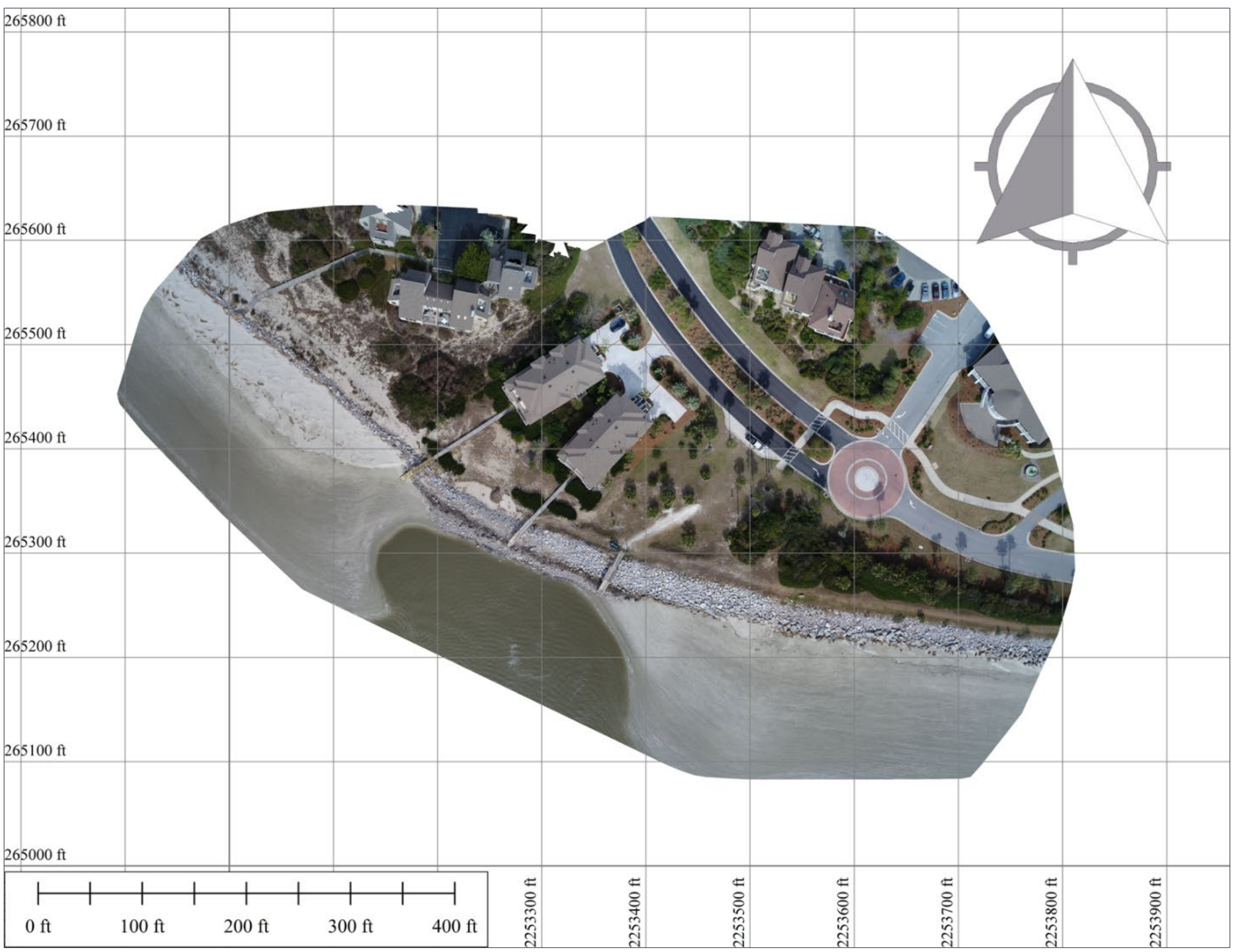
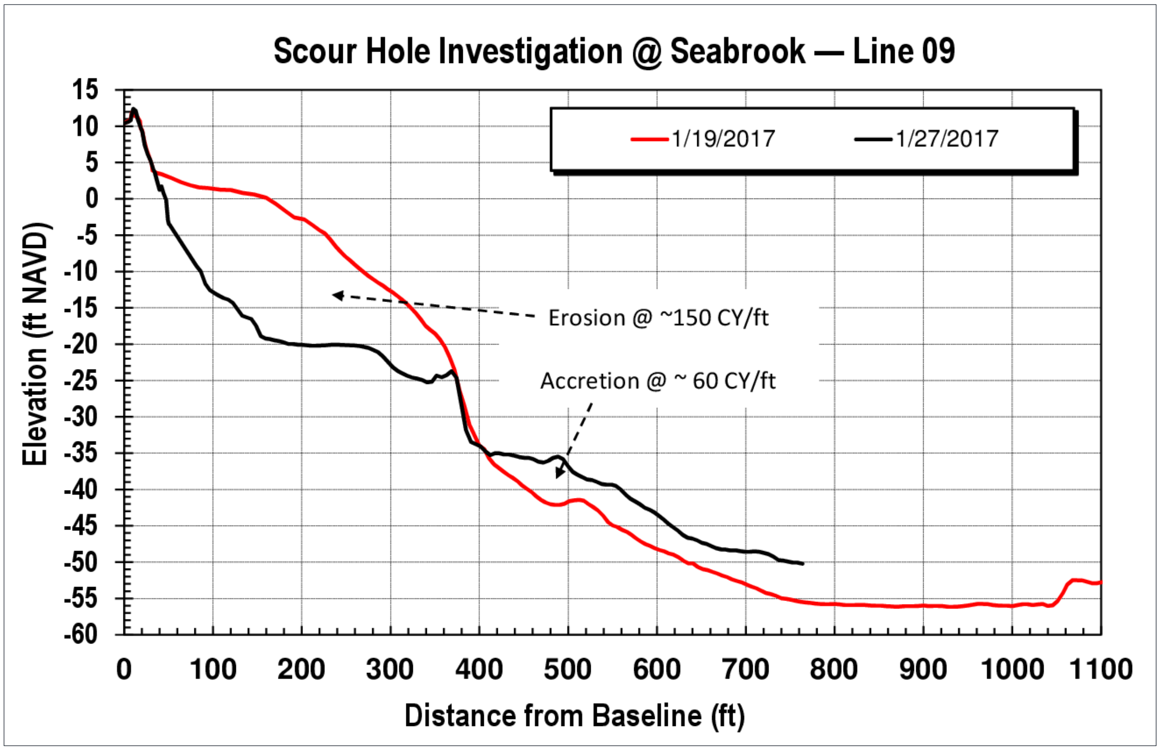


FIGURE 3.3. **[UPPER]** Ground image of the scour-hole event on 25 January 2017 viewed from the community boardwalk next to Deveaux Villas (D Giles). **[LOWER]** Orthorectified mosaic of drone images of the third scour hole obtained at low tide on 27 January 2017 (D Giles).



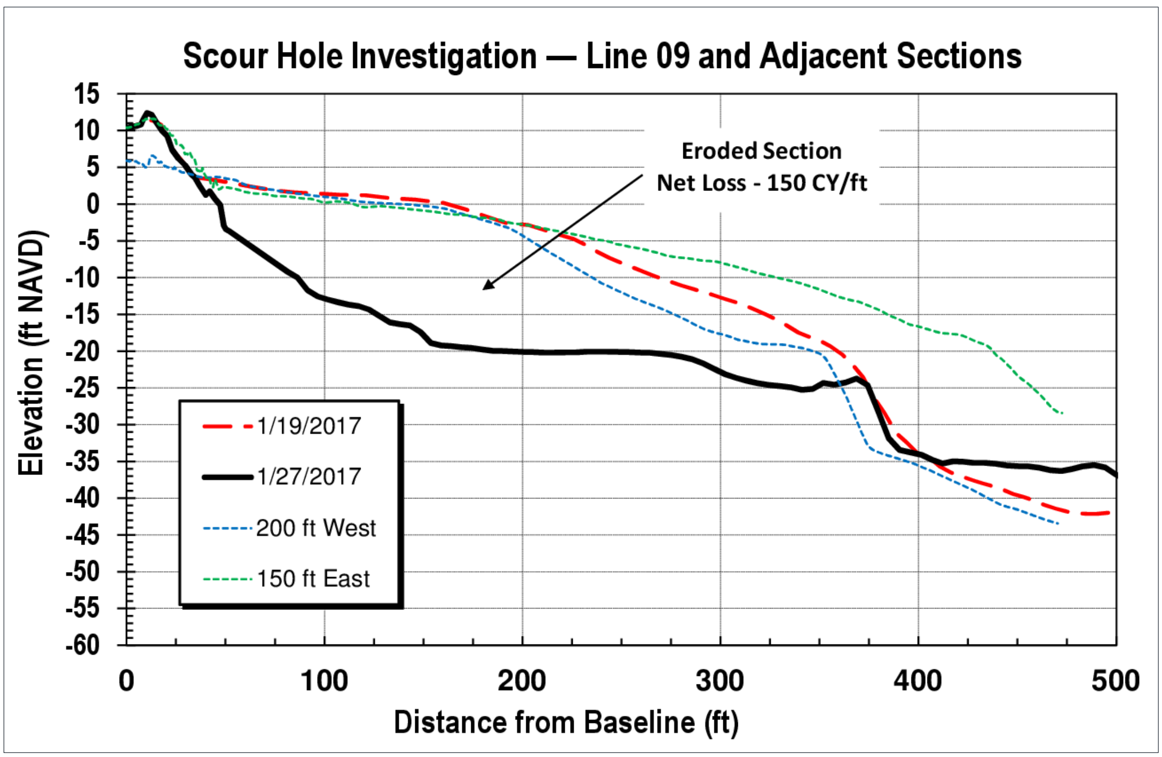


FIGURE 3.4. Representative profiles obtained on 19 and 27 January 2017 before and after formation of the third scour hole. Profile 9 shows extensive sand loss above the 25-ft depth contour and buildup along the margin of the inlet channel between 35 ft and 55 ft depths. The zone between 25 ft and 35 ft did not change, presumably because this area consists of denser consolidated sediments that hold the inlet in place (Moslow 1980, Imperato et al 1988).

Seabrook Island has a positive sediment budget because of the ample sand supply from Kiawah Island (Town of Seabrook Island 2014 p. 112) (Figure 3.5). In fact, Seabrook Island in 2022 contains more sand seaward of the seawall than it had in 1980, around the time seawalls were first constructed (Kana et al 2013). The distribution of sand alongshore is highly uneven. Some areas (eg – North Beach) contain over four times the minimum volume required for a healthy beach, while other areas lack any dry-sand beach.

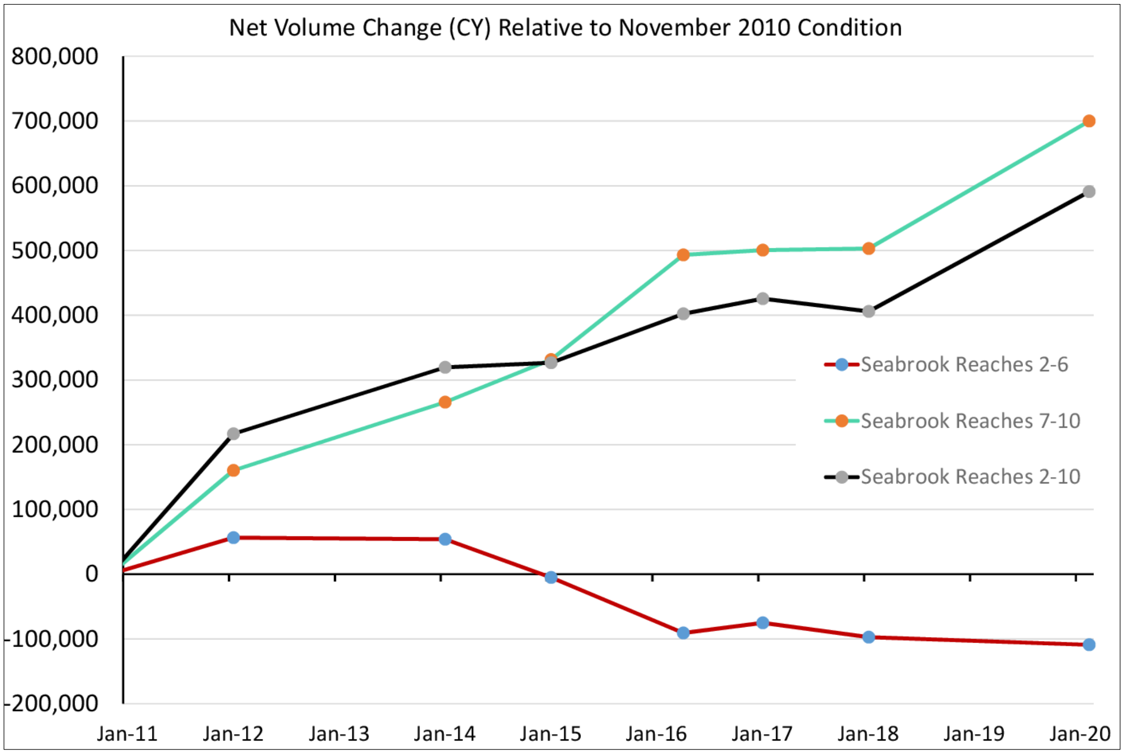


FIGURE 3.5. Seabrook Island has a net positive sand budget but the accumulation is concentrated along North Beach (reaches 7–10). The proposed project seeks to redistribute some of the surplus sand in North Beach to severely eroded sections of South Beach, particularly reaches 3 and 4.

Sand naturally moves from Capt Sams Inlet to North Edisto River Inlet under predominant northeast waves. Because of the proximity to Capt Sams Inlet, migrating shoals provide excess beach volume along much of Seabrook Island. Periodic relocations of the inlet, described in Table 2.1, deliver pulses of sand to the excavation area, which migrate to other portions of Seabrook Island. This process has been continually ongoing with regular maintenance of the inlet channel's location by CSE and SIPOA since 1983.

Another inlet relocation is anticipated between 2025 and 2030, so the proposed project will be scaled to provide a stop-gap solution to the chronic erosion along portions of Seabrook Island. It will also reduce the offset in shoreline position between the placement and borrow areas, thereby increasing shoreline stability in the near term and allowing the community to improve natural beach-dune habitats.

The primary goals of the project are:

- Mitigate erosion hot spots along South Beach associated with sudden slope failures along margins of North Edisto River Inlet and the northern marginal channel.
- Artificially increase the transfer of sand from accreting sections of North Beach to eroding sections of South Beach.
- Maintain a viable wet-sand beach along all exposed sections of the seawall to facilitate downcoast sand transport.
- Accomplish multiple small-scale sand transfer events via land-based equipment during winter months when biological productivity is low, and there will be minimal disruption to beach use.
- Lessen the need for seawall reinforcement or maintenance of failed sections.

3.2 Alternatives Considered

On behalf of the applicant, CSE has identified seven (7) alternatives to the proposed project.

- Do nothing
- Scrape sand from the low-tide beach along North Beach and place it along the critically eroded beach around the Beach Club
- Truck in beach-quality sand from inland borrow areas and place along the critically eroding project area
- Dredge the North Shoal of North Edisto River Inlet, realign the northern channel, and place sand along the critically eroding project area
- Reinforce the existing quarry stone revetment in the critically eroding area
- Construct groins to trap and retain sand in the profile adjacent to the critically eroding area
- Abandon or relocate downcoast developed property as erosion progresses

Based on an alternatives analysis included as part of this permit applciation package, CSE recommends SIPOA pursue sand scraping from along North Beach and placement along the critically eroded area near the Beach Club. Sand scraping and transfers along Seabrook Island are considered a useful management tool for addressing localized erosion during the years between inlet relocations (CSE 2002). They are an integral part of Seabrook's long-term beach management strategy, and are consistent with the soft engineering approach to erosion that the community has followed since the early 1980s (SI 2014).

All work under this alternative could be performed by land-based equipment working between low water and high water along the intertidal beach to minimize impacts to dry-beach habitat. As the project progresses, the area of dry beach would expand and exposure of the seawall would decline. The proposed borrow area would likely be restored naturally as shallow bars from the migrating delta of Captain Sams Inlet shift downcoast into the project area. This, in turn, would help maintain the ephemeral washover habitat upcoast of the borrow area.

3.3 Project Plan and Impacts

Sand scraping would transfer excess sand accumulating on the Seabrook side of Capt Sams Inlet along North Beach to downcoast eroding areas. The anticipated buildup of sand around Oystercatcher beach access would provide a renewable source for transfer downcoast to areas lacking a dry-sand beach. By transferring a portion of the accreting bars to downcoast areas (via trucks), this alternative would potentially offset the reduction in longshore transport which occurs as Capt Sams Inlet shifts south(west).

Sand scraping and transfer along North Beach was implemented in 1981 and 1982 prior to the relocation of Capt Sams Inlet in 1983 (Kana et al 1984). Additional sand transfers were performed after the 1983 inlet relocation because of the severely degraded conditions along North Beach north of Renken Point. At that point in time, seawalls were exposed and failing along upward of 8,000 ft of oceanfront (Figure 3.6). Since 1981, approximately 855,000 cy have been transferred in ten events by trucks from accreting areas around Capt Sams Inlet to eroding areas of Seabrook Island (SI 2014).

Sand scraping and transfers along Seabrook Island are considered a useful management tool for addressing localized erosion during the years between inlet relocations (CSE 2002). They are an integral part of Seabrook's long-term beach management strategy, and are consistent with the soft engineering approach to erosion that the community has followed since the early 1980s (SI 2014).

Figure 3.7 illustrates typical sections for the Preferred Alternative – Sand Scraping from accreting areas of North Beach and transfer by land-based equipment to eroding areas along South Beach. Figure 3.1 shows the maximum footprint of excavation and fill areas along Seabrook Island.

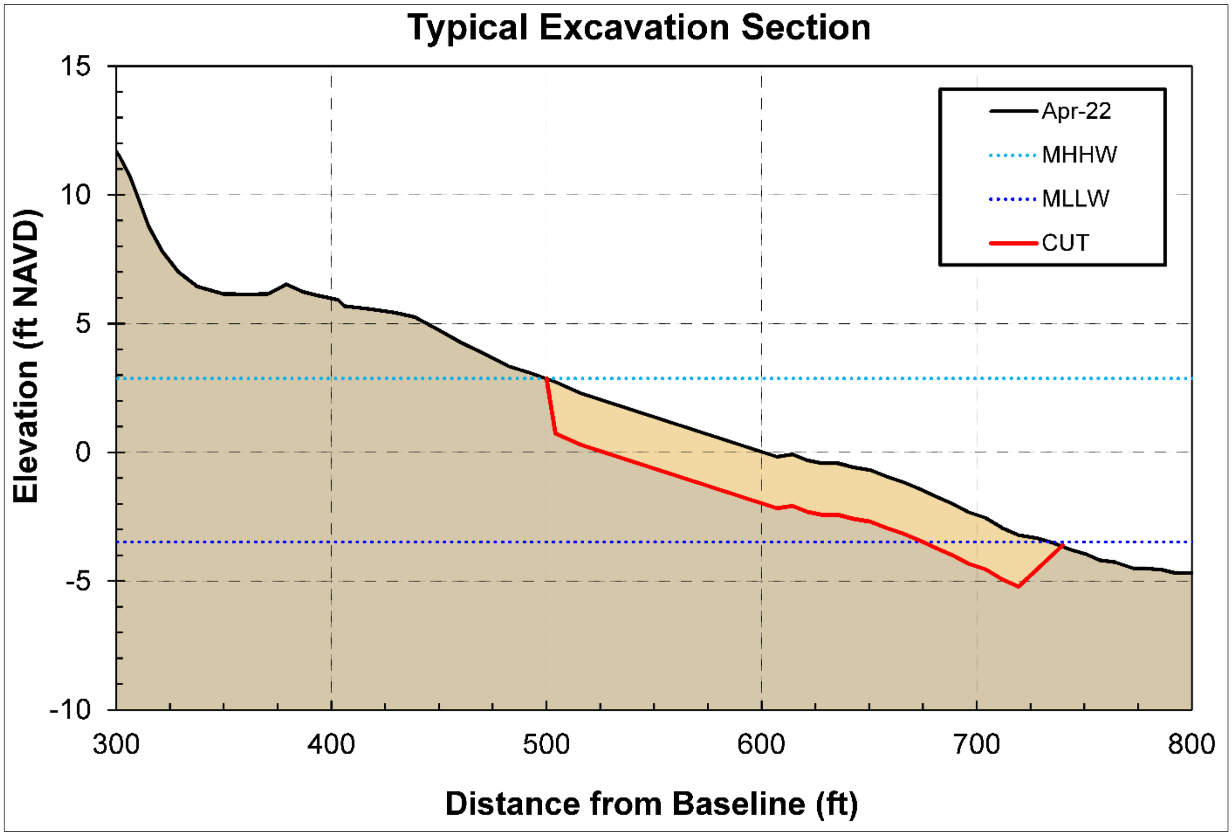
Sand will be transferred by truck along the high intertidal beach to the fill area. Trucks will be required to stay within designated haul paths established with the applicant, USFWS, and SCDNR. Excavation of the intertidal sand will result in the mortality of benthic infauna within the areas excavated; however, the infauna are expected to recover quickly baesd on prior studies (Jutte et al 1999a,b, CZR 2014) and limited excavation zone.

FIGURE 3.6. Beach erosion along North Beach led to exposed seawalls, no recreational beach, and severe damage to structures in 1983. View north along Renken Point in 1985 at low tide. [After CSE 1989]

Typical excavations will be 2 ft deep, and occur primarily between MHHW and MLLW. Bars and shoals associated with Captain Sams Inlet are constantly migrating onshore near the excavation area, so depressions left following excavation are expected to fill quickly.

Following each recycling event, the project area will evolve as the system equilibrates with the newly-placed fill and excavated borrow area. It is likely some native vegetation may establish in the placement area, allowing for the establishment of vegetated beach habitat. It is also likely the excavated area will fill quickly with sand migrating onshore from bars and shoals associated with Captain Sams Inlet.

As the placement area equilibrates to wind and wave conditions, sand is expected to migrate to the west and along the North Edisto River Inlet-facing shoreline. This will increase beach volumes within areas immediately downcoast of the placement area, which have experienced chronic erosion in recent years.



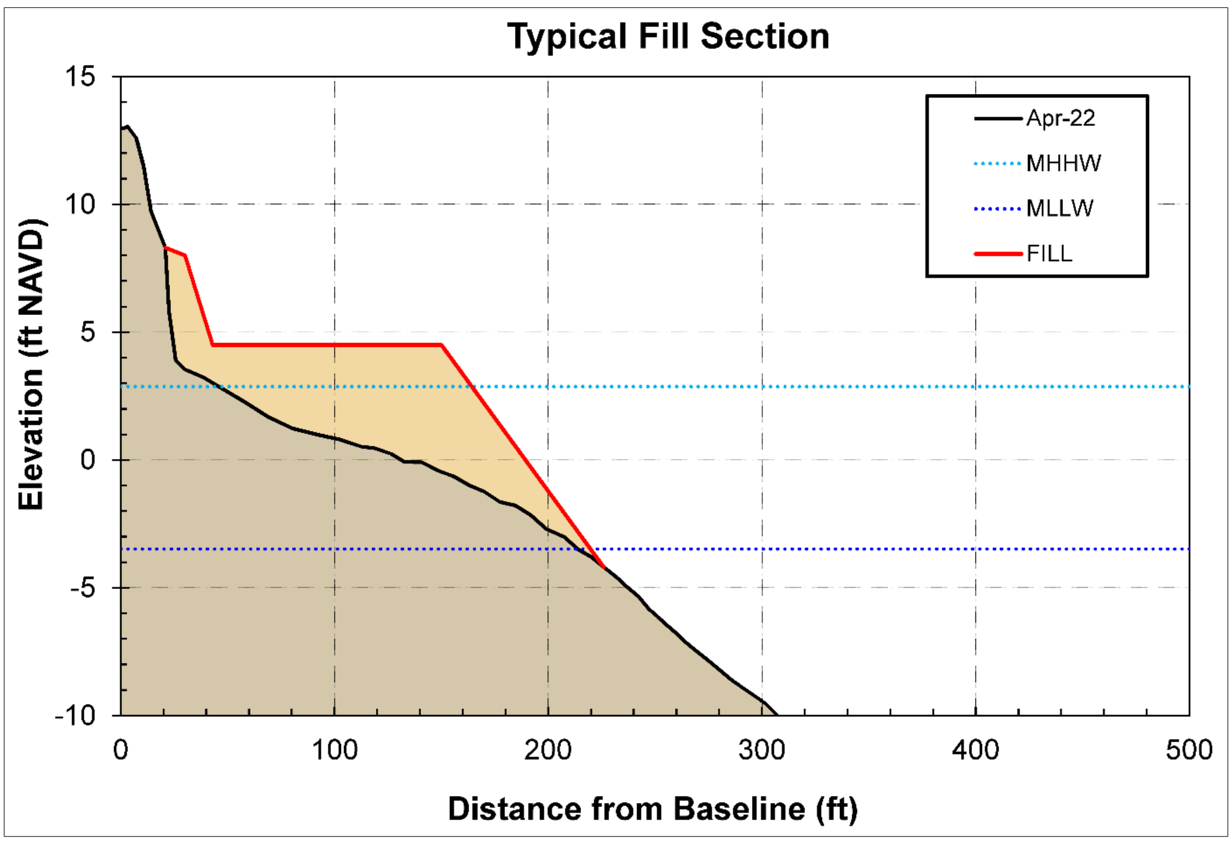


FIGURE 3.7. Typical excavation **[UPPER]** and fill **[LOWER]** sections for the proposed project to be performed in the dry via land-based equipment working around low tide. Excavations of the wet-sand beach would be shallow and expected to heal quickly under daily tidal action.

— THIS PAGE INTENTIONALLY LEFT BLANK —

4.0 List of Species

Threatened and endangered species occurring or possibly occurring in Charleston County (SC) considered relevant to the project area are listed in Table 4.1 [US Fish and Wildlife Service South Carolina Field Office (USFWS) 2015; SC Department of Natural Resources (SCDNR) 2015]. Table 4.2 provides a more detailed list of at-risk, proposed, threatened and endangered species in Charleston County, excluding candidate species and at-risk bats and butterflies (USFWS 2015 and SCDNR 2015). Table 4.3 lists the threatened and endangered marine species in South Carolina as determined by and under the jurisdiction of the National Oceanic Atmospheric Administration–National Marine Fisheries Service (NOAA Fisheries or NMFS-2020).

TABLE 4.1. Threatened and Endangered Species in Charleston County (SC) potentially near/in the project area (DNR 2015, NOAA 2020).

Common Name	Scientific Name	Status
Birds		
American wood stork	*Mycteria Americana*	FT, SE
Bald eagle	*Haliaeetus leucocephalus*	BGEPA, ST
Least tern	*Sterna antilarrum*	ST
Piping plover	*Charadrius melodus*	FT, SE
Red-cockaded woodpecker	*Picoides borealis*	FE, SE
Red knot	*Calidris canutus rufa*	FT
Wilson's Plover	*Charadrius wilsonia*	ST
Fish		
Atlantic sturgeon	*Acipenser oxyrinchus**	FE
Shortnose sturgeon	*Acipenser brevirostrum**	FE, SE
Mammals		
Blue, Finback, Sei, Sperm whales	*In order: Balaenoptera musculus*, Balaenoptera physalus*, Balaenoptera borealis*, Physeter microcephalus**	FE, SE
Humpback whale	*Megaptera novaengliae*	Delisted 2016; moni-toring; 2015 FE, SE
North American Right whale	*Eubalaena glacialis*	FE, SE
West Indian (aka Florida) manatee	*Trichechus manatus*	FT, SE
Plants		
American chaffseed	*Schwalbea americana*	FE
Canby's dropwort	*Oxypolis canbyi*	FE
Pondberry	*Lindera melissifolia*	FE
Seabeach amaranth	*Amaranthus pumulus*	FT
Reptiles		
American Alligator	*Alligator mississippiensis*	FT, ST
Green sea turtle *	*Chelonia mydas*	FT, ST
Kemp's ridley sea turtle *	*Lepidochelys kempii*	FE, SE
Leatherback sea turtle *	*Dermochelys coriacea*	FE, SE
Loggerhead sea turtle *	*Caretta caretta*	FT, ST, P-CH

Key to Species Status

BGEPA - Federally protected under the Bald and Golden Eagle Protection Act
CH - Critical Habitat
FE, SE - Federally Endangered, State Endangered
FT, ST - Federally Threatened, State Threatened
P - Proposed in the Federal Register
* - The FWS and the NMFS share jurisdiction of this species.

TABLE 4.2. List of At-Risk, Proposed, Threatened, and Endangered Species, Charleston (SC). Note: For this report, ARS listed bats and butterflies are omitted from this list. [Sources: dnr.sc.gov/species/charleston.html (2015); https://ecos.fws.gov/ecp0/reports/species-listed-by-state-totals-report?state=SC&s8fid=112761032792&s8fid=112762573902;

Category	Common Name	Scientific Name	Status	Comments (related to project area)
Amphibians	Frosted flatwoods salamander	Ambystoma cingulatum	FT, SE	
	Gopher frog	Lithobates capito	ARS; Risk Priority	
	Broad-striped Dwarf Siren	Pseudobranchus striatus	ST	
Birds	American swallow-tailed kite	*Elanoides forficatus*	SE	Breeding Mar-May; SC in range
	American wood stork	*Mycteria americana*	FT, SE	Nesting season
	Bachman's Warbler	*Vermivora bachmanii*	FE, SE	
	Bald eagle	*Haliaeetus leucocephalus*	BGEPA, ST	Nesting season
	Black-capped Petrel	*Pterodroma hasitata*	FT (proposed)	
	Black rail	*Laterallus jamaicensis*	FT (proposed)	
	Least Tern	*Sterna antillarum*	ST	
	MacGillivray's seaside sparrow	*Ammodramus maritimus macgillivrali*	ARS; Risk Priority	Year-round, marshes
	Piping plover	*Charadrius melodus*	FT, SE, CH	Migration; wintering
	Red-cockaded woodpecker	*Picoides borealis*	FE, SE	Nesting season
	Red knot	*Calidris canutus rufa*	FT	Migration; wintering
	Wilson's plover	*Charadrius wilsonia*	ST	Common year-round
Fish	American eel	*Anguilla rostrata*	ARS	Temp dependent, 13–25°C
	Atlantic sturgeon*	*Acipenser oxyrinchus**	FE	Spawning migration
	Blueback herring	*Alosa aestivalis*	ARS	Peak: Mar-April
	Shortnose sturgeon*	*Acipenser brevirostrum*	FE, SE	Spawning migration
Mammals	Byrde's ("Broodus") whale	*Balaenoptera edeni*	FE (05.15.19)	Off the coast
	Finback whale	*Balaenoptera physalus**	FE, SE	Off the coast
	Humpback whale	*Megaptera novaengliae*	FE, SE	Migration off the coast
	Right whale*	*Balaena glacialis*	FE, SE	Migration off the coast
	West Indian manatee	*Trichechus manatus*	FE, SE	In coastal waters
Plants	American chaffseed	*Schwalbea americana*	FE	1-2 months after fire
	Bog asphodel	*Narthecium americanum*	ARS; Risk Priority	
	Boykin's lobelia	*Lobelia boykinii*	ARS; Risk Priority	
	Canby's dropwort	*Oxypolis canbyi*	FE	Documented mostly SC, GA
	Ciliate-leaf tickseed	*Coreopsis integrifolia*	ARS; Risk Priority	
	Pondberry	*Lindera melissifolia*	FE	
	Seabeach amaranth	*Amaranthus pumilus*	FT	Restoration efforts as of 2017
	Venus' Fly-Trap	*Dionaea muscipula*	ARS; Risk Priority	
Reptiles	American Alligator	*Alligator mississippiensis*	FT, ST	Estuaries, creeks, marshes
	E. Diamondback rattlesnake	*Crotalus adamanteus*	ARS; Risk Priority	Peak: April-Nov
	Green sea turtle**	*Chelonia mydas***	FT, ST	Nesting and hatching
	Kemp's ridley sea turtle**	*Lepidochelys kempii***	FE, SE	In coastal waters
	Leatherback sea turtle**	*Dermochelys coriacea***	FE, SE	Nesting and hatching
	Loggerhead sea turtle**	*Caretta caretta***	FT, CH, ST	Nesting and hatching
	Spotted turtle	*Clemmys guttata*	ARS; Risk Priority	Possible in marsh areas
Other	Atlantic Pigtoe mussel	*Fusconaia masoni*	SE; ARS; Risk Priority	

USFWS Key to Species Status Table 4.2.

BGEPA - Federally protected under the Bald and Golden Eagle Protection Act
CH - Critical Habitat
FE, SE - Federally Endangered, State Endangered
FT, ST - Federally Threatened, State Threatened
P - Proposed in the Federal Register
* - Contact NMFS for more information on this species.
** - The FWS and the NMFS share jurisdiction of this species.

TABLE 4.3. SC Threatened and Endangered Species and Critical Habitats under NOAA Fisheries (NMFS).
[Source: www.fisheries.noaa.gov/southeast/consultations/south-carolina/;
https://www.fisheries.noaa.gov/species-directory/threatened-endangered?title=&species_category=any&species_status=any&regions=1000001121&items_per_page=25&page=1&sort=]

Species	Common Name	Scientific Name	Status
Fish	Atlantic sturgeon	*Acipenser oxyrhynchus oxyrhynchus*	E
	Blueback herring	*Alosa pseudoharengus*	ARS, Risk Priority
	Giant manta ray	*Manta birostris*	T
	Shortnose sturgeon	*Acipenser brevirostrum*	E
Sea Turtles	Green sea turtle*	*Chelonia mydas*	T*
	Hawksbill sea turtle	*Eretmochelys imbricata*	E
	Kemp's ridley sea turtle	*Lepidochelys kempii*	E
	Leatherback sea turtle	*Dermochelys coriacea*	E
	Loggerhead sea turtle	*Caretta caretta*	T
Marine Mammals	Blue whale	*Balaenoptera musculus*	E
	Byrde's ("Broodus") whale	*Balaenoptera edeni*	E (05.15.19)
	Subspecies: Gulf of Mexico Byrde's whale	*Balaenoptera edeni*	E (05.15.19)
	Fin whale	*Balaenoptera physalus*	E
	Right whale	*Eubaleana glacialis*	E
	Sei whale	*Balaenoptera borealis*	E
	Sperm whale	*Physeter macrocephalus*	E
Sharks	Oceanic Whitetip Shark	*Carcharhinus longimanus*	T

Species proposed for listing: None noted
Designated Critical Habitat: None in the area of this proposed project
Proposed Critical Habitat: None in the area of this proposed project
* Green turtles are listed as threatened, except for breeding populations of green turtles in Florida and on the Pacific Coast of Mexico, which are listed as endangered.
C Candidate species are those petitioned species that are actively being considered for listing as endangered or threatened under the ESA, as well as those species which NMFS has initiated an ESA status review.

4.1 General Effects on Listed Species and Critical Habitat

The proposed project will directly impact exposed intertidal beach. The proposed project will be completed using land-based equipment and will not directly impact dunes, dry-sand beach, open ocean, forested, or freshwater habitats. Therefore, listed species such as whales (blue, finback, humpback, right, sei, and sperm), Bachman's warbler, bald eagle, Kirtland's warbler, red-cockaded woodpecker, frosted flatwoods salamander, American chaffseed, Canby's dropwart, and pondberry will not be affected by the proposed project. Species that may be present in or near the proposed project area during construction are West Indian manatee, piping plover, red knot, wood stork, sea turtles, shortnose sturgeon, Atlantic sturgeon, and scalloped hammerhead, dusky, and sand tiger sharks.

The threatened seabeach amaranth is not expected to be observed since occurrences of the low-lying dune plant have not been documented in South Carolina in over 10 years. However, a recent USFWS project to regenerate the plant in East coast wildlife refuges, including South Carolina, may yield plants in the future (J. Koches, 2017). Seabeach amaranth needs certain conditions to survive and is susceptible to a wide range of natural and human factors that compete for or destroy its habitat. In the Carolinas, it has been known to occur after beach nourishment on dry-sand beach, due to the re-creation of suitable amaranth habitat, which provides conditions for the plant to re-propagate (USFWS 1996b, CSE 2004, USACE 2006). This project potentially may create seabeach amaranth habitat. To this date, no seabeach amaranth habitat has been designated critical habitat.

Project impacts to the benthic community around the excavation and placement areas are expected to be temporary as native sand (and infauna) will fill the niche as the borrow and fill areas equilibrate. No vegetated marsh will be directly impacted during construction. Natural shifts in the positions of cat-eye ponds and marginal inlet channels may occasionally erode vegetated beach areas following completion, but these are not expected to be triggered by the project. The low crest elevation of the berm near the excavation area already allows washovers to periodically deposit sand into channels and ponds associated with the inlet. The proposed project is not expected to alter these natural processes. Excavation and fill placement will be restricted to the areas identified in Figure 4.1.

Table 4.3 lists the impacts to wetlands that are expected to occur during the project. The project will involve excavating ~25 acres of intertidal beach to a depth of ~2 ft; so, the majority of excavated area will be within the intertidal zone and not undergo major habitat changes. Up to 10.0 acres of intertidal and unvegetated beach will be filled during each event. There will be localized increases in turbidity during construction due to excavation and filling activities. However, given the lack of clay-sized material in the sediments, turbidity levels will return to normal in minutes to hours (based on settling velocities of fine sand). Furthermore, with only three events proposed over the course of five years these temporary and localized impacts will occur about two years. The applicant will coordinate with resource agencies to identify a designated staging area that reduces environmental and physical impacts to the maximum extent practicable.

TABLE 4.3. Anticipated impacts for the proposed project.

Impact Area	Purpose	Area (ac)	Impact Areas	Anticipated Impacts
1	Excavation	25	Low-Intertidal Beach	Intertidal sands will be excavated from this area and moved to the berm and dike area. The excavated area will infill rapidly (over a tidal cycle) with native sand during high tide. The low-water line in the vicinity will shift landward during the project.
2	Berm	10.0	Intertidal and Subtidal Beach	Construction of the berm at the existing channel will require infilling of subtidal and intertidal beach with native beach sand. The berm will be constructed at +4.5 ft NAVD, leaving it at an elevation that will wash over during spring high tides. This will leave a washover-type beach devoid of vegetation for several years until aeolian deposits produce dunes and vegetation begins to propagate naturally.
3	Haul Path	1.5	High-Intertidal Beach	This area will be subject to equipment traffic only. No excavations will be performed. Sediments may become more compacted along the haul path.
4	Haul Path	1.5	Intertidal Beach	This area will be subject to equipment traffic only. No excavations will be performed. Sediments may become more compacted along the haul path.
5	Staging Area	0.5	Dry Beach	The staging area will support equipment storage and traffic. It will be placed on stable dry beach and located to impact the least amount of vegetation practicable. Some native dune vegetation may be destroyed to allow safe storage of equipment. The area will recover naturally in 1 to 2 growing seasons following construction.

FIGURE 4.1. The proposed project will involve a 2-ft excavation within the area labeled 'A', and placement of material in the area labeled 'B'. The dashed border of the eastern placement area is an optional portion of the fill designed to improve sand bypassing towards the area of rapid erosion, approximately 500 ft west of the Beach Club.

— THIS PAGE INTENTIONALLY LEFT BLANK —

5.0 Species Assessment

5.1 West Indian Manatee

The manatee is an occasional summer resident of the South Carolina coast. The species can be found in shallow (5 ft to usually <20 ft), slow-moving rivers, estuaries, saltwater bays, canals, and coastal areas (USFWS 1991). The West Indian manatee is herbivorous and eats aquatic plants such as hydrilla, eelgrass, and water lettuce (Rathbun et al 1982, Lefebvre et al 2001). Adults average ~11 ft in length but can reach lengths up to 15 ft and weigh 7,000 pounds (Rathbun et al 1990). During winter months, the US manatee population confines itself to the coastal waters of the southern half of peninsular Florida and springs and warm-water outfalls as far north as southeast Georgia. They are sighted infrequently in South Carolina, with most records occurring in July, August, and September as they migrate up and down the coast, but are not known to be resident for long. Sightings of this species in the Charleston region are believed to span all seasons.

Based on these data, the manatee is considered a year-round resident with a maximum population in the late summer months. Manatee population trends are poorly understood, but deaths have increased steadily. A large percentage of mortality (especially calves) is due to collisions with watercraft. Another closely related factor in their decline has been the loss of suitable habitat through incompatible coastal development, particularly the destruction of sea-grass beds by boating facilities. Based on these considerations, **the manatee may be found in the vicinity of the proposed action during the anticipated period of construction**.

Effect Determination

Following the effect determination for the Folly Beach nourishment project (USACE 2005), the proposed work is currently scheduled to occur during the time of year when manatees are generally not present in the area. If schedule or weather changes cause construction to be performed when conditions are more favorable for the presence of manatees, then precautions will be taken to ensure that any manatees in the vicinity are not harmed or harassed. No impacts to the manatee are anticipated, since manatees are uncommon in the vicinity of the Seabrook Island area and the proposed project involves excavation by land-based equipment within the intertidal zone.

For these reasons, the Applicant has determined that the proposed project may affect, but is not likely to adversely affect the manatee.

5.2 Wood Stork

The wood stork is the only stork species that breeds in the United States. The species was listed as endangered in 1984. The species is generally associated with freshwater wetland habitat, including man-made wetlands, forested riverine floodplains, ponds, ditches, and diked marshes. They tend to feed in large groups in open wetlands with water depths <2 ft. They have also been observed to forage near low tide in coastal tidal creeks.

Historically, the species was present in South Carolina during summer and fall, foraging after nesting. In 1981, the first nesting wood storks were observed. Numbers have increased substantially since 1981, with 2,057 nests at 14 sites in 2004 (SC Department of Natural Resources—SCDNR). In September 2010, USFWS issued a 90-day finding on a petition to reclassify the wood stork from endangered to threatened, with the understanding that "*substantial scientific or commercial information indicating that reclassifying the U.S. breeding population of the wood stork to threatened may be warranted*" (Federal Register: 21 September 2010, Vol 75, No 182).

Since the proposed project action area includes intertidal beach near tidal creeks, the **wood stork species may be present in the proposed action area.**

Effect Determination

The wood stork is generally associated with freshwater wetland habitat; however, the species has been noted to forage in tidal creek areas. The project will not alter the position of tidal channels or exposed flats of the interior of adjacent lagoons, or incipient marsh areas associated with Capt Sams Inlet. Equipment movements and noise may cause individual storks to avoid the immediate construction area during the project, though the equipment will not be present in habitat that is preferred by storks (marsh channels, etc). The species may avoid the construction area during construction and utilize nearby estuarine and freshwater habitats. Construction will not impact nesting sites, which are generally cypress and black gum trees bordering freshwater wetlands. It is determined that **the proposed action may impact, but is not likely to adversely impact, the wood stork.**

5.3 Shortnose Sturgeon

The shortnose sturgeon (*Acipenser brevirostrum)* ranges along the Atlantic seaboard from southern Canada to northeastern Florida (Gilbert 1989). The shortnose sturgeon feeds on invertebrates and the stems and leaves of macrophytes. From historical accounts, it appears that this species was once relatively abundant throughout South Carolina waters; however, many of these early records are unreliable because of confusion between this species and the Atlantic sturgeon (*Acipenser oxyrhynchus*).

The Pee Dee River is one site in South Carolina where shortnose sturgeon have been found in some abundance (Gilbert 1989). Spawning has been recorded in the lower Pee Dee River in late May/early June (Van den Avyle 1984). Shortnose sturgeon reportedly prefer slow current, turbid water with bottom substrates having abundant organic debris, sand, and silt (Van den Avyle 1984). Shortnose sturgeon in South Carolina reportedly move downstream after spawning in April and May and spend the rest of the year in coastal plain rivers, estuaries, or along the coast within a few miles of the shore (Marchette & Smiley 1982). No data on population dynamics exist in the proposed project area (NMFS 1998). Because of the lack of suitable freshwater spawning areas in the proposed project area and the requirement of low salinity waters by juveniles, any shortnose sturgeons present would most likely be non-spawning adults, according to NMFS (1998).

NMFS (2000) reports that the species is considered very hardy due to its ability to survive under extremely stressful conditions. Pollution, blockage of traditional spawning grounds, and overfishing are believed to be the principal factors in the severe decline of the species. SCDNR now prohibits taking any sturgeon in South Carolina waters. This is expected to help protect the species and increase their population.

The type of habitats needed by this species are principally (1) non-tidal fresh-water areas for spawning and occasional over-wintering, (2) tidal areas near the fresh/saltwater mixing zone for juveniles year-round and for adults during summer, and (3) high-salinity estuarine areas for adults during winter. The North Edisto River Inlet adjacent to the project site can be classified as the third habitat type.

Shortnose sturgeon feed on invertebrates and the stems and leaves of macrophytes. Adults forage at night in shallows immediately adjacent to deep-water areas occupied during the day. Juveniles generally remain in deep-water areas throughout the day. Because shortnose sturgeon are mobile, they can avoid interactions with dredges and other machinery. In this case, **because the proposed project will impact intertidal beach at the mouth of high-salinity inlet/estuarine areas, shortnose sturgeon may be present in the action area**.

Effect Determination

While the project area is close to a large coastal plain river, no impacts to sturgeon spawning grounds are expected. No impacts to sturgeon habitat are anticipated during or after the proposed project, as inlet processes will be unimpeded throughout construction, allowing ingress/egress between the estuary and ocean. Land-based equipment working in the dry along the intertidal beach will not impact sturgeon. For these reasons, it has been determined that **the proposed project is not likely to adversely affect the shortnose sturgeon.**

5.4 Atlantic Sturgeon (Candidate Species)

The Atlantic sturgeon (*Acipenser oxyrhynchus*) occupies much of the same habitat as the shortnose sturgeon and is similar in appearance. The Atlantic sturgeon is larger than the shortnose and has a smaller mouth and different snout shape. They reach up to 14 ft long and weigh up to 800 pounds. Spawning occurs between the salt front and fall line of large rivers, beginning in February or March in the south. Following spawning, Atlantic sturgeon typically inhabit coastal estuarine waters with gravel or sand substrate. Adult sturgeon typically feed on benthic invertebrates such as mussels, worms, and shrimp.

Atlantic sturgeon have historically been present from the St Johns River (FL) to St Croix (ME). Sturgeon are currently present in 35 rivers spanning this range, with spawning occurring in at least 20 of these rivers (NMFS, unpublished data). Commercial fishing led to a decline in the sturgeon population between 1950 and 1998, after which a moratorium was put in place on wild Atlantic sturgeon. The species is separated into five distinct population segments (DPS), including the South Atlantic, Carolina, Chesapeake, New York Bight, and the Gulf of Maine. All of these DPSs are listed as endangered except for the Gulf of Maine DPS, which is listed as threatened.

The project area is positioned between the South Atlantic and Carolina DPS boundaries. The southern boundary of the Carolina DPS is Charleston Harbor (~10 miles northeast of the project area), while the northern boundary of the South Atlantic DPS is the ACE basin (~24 miles southwest of the project area). The project area lacks an associated large freshwater river; however, **because the proposed project will impact high-salinity estuarine areas, Atlantic sturgeon may be present in the action area**.

Effect Determination

Since the project area lacks a large freshwater river, no impacts to Atlantic sturgeon spawning grounds are expected. No impacts to sturgeon habitat are anticipated during or after the proposed project, as flushing will be maintained throughout construction, allowing ingress/egress between the lagoon and ocean. Land-based equipment working along the intertidal beach will not impact sturgeon. Since sturgeon are mobile, if any are present during the project, they should be able to avoid a filling operation near the low tide line. For these reasons, it has been determined that **the proposed project is not likely to adversely affect the Atlantic sturgeon.**

5.5 Alewife and Blueback Herring (Candidate Species)

The alewife (*Alosa pseudoharengus*) and blueback herring (*Alosa aestivalis*) are similar-looking anadromous fish commonly referred to as "river herring" due to the difficulty of distinguishing between the two. The species are often managed together due to their likeness. The alewife has historically been found from South Carolina to Newfoundland, though it has not been observed in South Carolina in recent years (NMFS 2009). Due to the lack of species in South Carolina, impacts to alewife herring will not be considered further for this project.

The blueback herring has a more southerly distribution, being found from the St Johns River (FL) to Nova Scotia. This species lives offshore during winter and migrates to shore in late spring, spawning in freshwater from late March through mid-May. Blueback herring prey on planktivores such as ctenophores, copepods, amphipods, mysids, and pelagic shrimp. Populations have apparently been declining, with several examples showing local populations dropping from several hundred thousand to only a few thousand individuals (NMFS 2009). Potential contributors to the decline are loss of access to spawning grounds, habitat degradation, fishing, and increased predation due to recovering striped bass populations.

Because the proposed project will impact inshore coastal waters, **blueback herring may be present in the action area.**

Effect Determination

Since blueback herring are pelagic fish and feed on planktivores, construction activities are not expected to have a direct effect on the species. No tidal channels will be altered or closed off by the project, allowing ingress and egress to other reaches of the estuary at all times. Alewife herring are not known to inhabit South Carolina coastal waters. For these reasons, it has been determined that **the proposed project is not likely to adversely affect the alewife and blueback herring.**

5.6 Seabeach Amaranth

Seabeach amaranth is an annual herb occurring on beaches, lower foredunes, and overwash flats (Fussell 1996). Weakley (1986) found that in the Carolinas, the plant is most common on overwash flats on accreting ends of barrier islands. This species occupies elevations ranging from 0.2–1.5 meters (m) above mean high tide (Weakley & Bucher 1992). Historically, seabeach amaranth has been found from Massachusetts to South Carolina. But according to recent surveys (USACE 1992–1995), its distribution is now restricted to North and South Carolina, with several populations on Long Island (NY). Seed dispersal occurs by wind and water (USFWS 1996a).

The decline of this species is caused mainly by development of its habitat (inlet areas and barrier islands) and increased off-road vehicles and human traffic, which trample the plants (Fussell 1996). There are no known populations of seabeach amaranth in the proposed project area; however, the species has been documented in Charleston County. The absence of the species from the area is likely due to a lack of a seed source (USACE 2005). Table 5.1 shows the abundance in South Carolina since 1987.

It is important to note that habitat suitable for seabeach amaranth can be created by beach restoration projects, as they tend to inhabit dry areas of the beach without much other vegetation. This type of habitat usually is created following a nourishment project. Amaranth surveys were performed at Bogue Banks (NC) before and after nourishment. Over an ~16-mile length of shoreline, the number of plants observed in August 2001 before nourishment was under 35. After nourishment, seabeach amaranth increased to over 5,000 plants as mapped in August 2002, August 2003, and August 2004 (CSE 2004).

Results of seabeach amaranth surveys from other developed barrier islands show very large variations in plant populations from year to year. At Topsail Beach (NC), USACE (2006) reported a range of 3 to 22,410 plants per year between 1992 and 2004. Physical conditions (saltwater inundation, temperature, etc) control seabeach amaranth propagation (Hancock 1995, Hancock & Hosier 2003). The seeds must be within ~1 cm of the surface substrate to propagate. However, amaranth seeds are noted for their resilience and longevity, with century-old seeds reportedly capable of successful germination and growth (USFWS 1996a).

TABLE 5.1. Seabeach amaranth counts for Georgetown County (GC), Horry County (HC), and Charleston County (CC), South Carolina. Values for 2003 and 2004 were not separated by county.

Year	GC	HC	CC	SC	Year Totals
1987	1305	1	**35**	0	1341
1988	1668	95	**37**	0	1800
1989	0	0	**0**	0	0
1990	172	15	**1**	0	188
1991	0	0	**0**	0	0
1992	15	0	**0**	0	15
1993	0	0	**0**	0	0
1994	560	0	**0**	0	560
1995	6	0	**0**	0	6
1996	0	0	**0**	0	0
1997	2	0	**0**	0	2
1998	141	0	**0**	0	141
1999	0	0	**196**	0	196
2000	1136	0	**1176**	0	2312
2001	0	0	**231**	0	231
2002	0	0	**0**	0	0
2003	0	0	**0**	1381	1381
2004	0	0	**0**	2110	2110
2005	0	0	**0**	0	0
GC	*Georgetown County*				
HC	*Horry County*				
CC	*Charleston County*				
SC	*State Total (not specified by county)*				
Source	*USFWS 5-Year Review on Seabeach Amaranth*				

Because seabeach amaranth is principally dependent on physical conditions of the site and is confined to a relatively narrow elevation range just 0.2–1.5 m above mean high tide, any physical process (human or animal activity) that modifies this zone poses a threat to the species. Furthermore, seabeach amaranth is an annual which propagates from seed at temperatures between ~25°C and 35°C (USFWS 1996a) during a limited growing season in the summer months and cannot grow where other perennials are established. Physical factors (some of which are interrelated) that pose the greatest threat to its occurrence include:

- Beach erosion
- Active washovers or flooding and inundation
- Burial by windblown sand
- Vehicle traffic on the beach
- Pedestrian traffic on the beach

- Expansion of perennials by natural succession into its habitat, particularly along stable narrow beaches
- Fortnightly tide cycle which may cause periodic tidal inundation of the dry-beach habitat required by seabeach amaranth
- Minor storm surges associated with northeasters which inundate the habitat during the growing season
- Beach bulldozing, which is a common practice along many erosional, developed beaches
- Installation of erosion control structures, including sand bags which inhibit recovery of the dry beach
- Major storm surges associated with landfall hurricanes during the growing season

Of the above-listed factors, beach erosion is considered to be the primary threat (USACE 2006). Beach bulldozing in response to erosion further exacerbates the erosion problem in the zone where seabeach amaranth is most likely to propagate. Beach stabilization (ie, nourishment) has been considered a leading contributor to the reduction in seabeach amaranth populations (USFWS 1996a). However, evidence from Wrightsville Beach and Bogue Banks suggests populations may expand exponentially in the subsequent growing season after nourishment (USFWS 1996a, CSE 2004, USACE 2006).

The proposed project may create habitat for seabeach amaranth propagation as an unvegetated dry-sand beach and washover terrace will be created on and around the closure dike. However, favorable conditions are not likely to persist on the dike after the proposed project as hardier perennials begin to propagate rapidly, leaving fewer washover-type areas for seabeach amaranth.

Due to the documented presence of seabeach amaranth in Charleston County (SC), the applicant considers that amaranth may be present in the proposed action area.

Effect Determination

While data provided by USFWS did not confirm existing seabeach amaranth in the proposed action area (which is thought to be at the southern limit of the species' habitat), the species has been confirmed in Charleston County (SC). Also, reintroduction efforts have previously taken place on nearby Kiawah Island; however, the introduced populations did not persist. Placement of sand during construction may prevent the germination of seeds found in the proposed action area in the short term. Construction and preservation of a stable dry-sand beach may create suitable habitat for seabeach amaranth in the long term. Due to the presence of this species in Charleston County, but the lack of unvegetated dry beach in the project area, the determination is that **the proposed action may impact, but is not likely to adversely impact, seabeach amaranth.**

5.7 Scalloped Hammerhead

The scalloped hammerhead (*Sphyrna lewini*) can be found in tropical and subtropical coastal and oceanic waters worldwide. Adults tend to be found over shelf waters while pups stay in coastal zones, including estuaries and bays. Pups feed on near-bottom fish and crustaceans for approximately two years before migrating offshore. Adult females pup yearly, with large litters between 12-41 pups. When born, pups are 31–57 cm and are susceptible to predation by other sharks (including predators of the same species).

Scalloped hammerheads may be the most abundant hammerhead shark, though local depletions are a concern (Federal Register Vol 76, No 228, 28 November 2011; 50 CFT Parts 223 & 224). A stock assessment by Hayes et al (2009) found the northwestern Atlantic population has decreased from a range of 146,000-165,000 individuals in 1981 to 25,000-28,000 individuals in 2005. Another study (Myers et al 2007) documented a 98 percent decline of the species off the coast of North Carolina from 1972 to 2003.

The decrease in scalloped hammerhead populations has been attributed to fisheries that target the species and take them as bycatch. The species is mainly targeted for its fins, which have high commercial value in the Asian market. In the US, scalloped hammerheads are mostly taken as products of longline bycatch and recreational fishing.

Since the project is adjacent to a tidal inlet and close to estuarine areas, juvenile scalloped hammerheads may be in the action area.

Effect Determination

Since pups are mobile, no direct impacts due to the construction are expected. Indirect impacts due to alteration of benthic habitat will be minimal due to the small footprint of the action area and expected rapid recovery. No impacts to this species are expected due to beach filling operations. For these reasons, it has been determined that **the proposed project will not have an adverse impact on the scalloped hammerhead.**

5.8 Red Knot

Red knots (*Calidris canutus rufa*) are the largest of the small shorebirds and have one of the longest-distance migration patterns of any species. They are roughly 9 inches long with a wingspan of 20 inches. Three of five identified species are found in the Western Hemisphere. They generally winter in the southern portions of South America, although some populations winter as far north as the southeast coast of the United States. The birds migrate up to 9,300 miles to breeding grounds in the arctic (USFWS 2005).

Red knots rely heavily on the eggs of the horseshoe crab as a food source. An increase in harvesting horseshoe crabs along the Delaware Bay is thought to be a major contributing factor to the recent decline in Red knot populations. The species was also hunted heavily during the early 20th century, never fully recovering from that practice. The listing status of the species is presently proposed-threatened. Threats to the red knot habitat in South Carolina include wetlands being degraded by pollution, development, oil spills, declining invertebrate populations, and over-harvesting of horseshoe crabs (NJDEP 2007).

In the project area (either while wintering or migrating), red knots may forage on bivalves, gastropods, and crustaceans. Red knots may forage on sandy beaches, tidal mudflats, salt marshes, and peat banks, all of which exist in or near the action area. The project area is a potential stop for migrating birds, which stop for periods of two to three weeks to rebuild energy reserves needed to continue their migration to the breeding grounds (USFWS 2011). There is less likelihood that the project area will be used as a wintering ground; however, it remains possible. Red Knots show less site fidelity than piping plovers while wintering; therefore, short-term disruptions caused by construction activities are less of a concern with this species if suitable alternate habitat is available.

In recent years, SCDNR reported that the species declined from an estimated population of over 150,000 to ~25,000 (SCDNR 2022). Wintering and migrating red knots are drawn to the southeastern coast, including South Carolina, where they forage on clams, mussels, and crab eggs in coastal areas. Red knot surveys show they stop for several weeks to rebuild energy reserves before continuing their migration to breeding grounds (USFWS 2013). Threats to red knot habitat in South Carolina include development, oil spills, wetlands degradation, declining invertebrate populations, and over-harvesting of horseshoe crabs (NJDEP 2007).

Red knots have been confirmed on nearby Kiawah Island, using the area for wintering or as a stop-over during the migration process. An April 2003 survey counted ~7,000 knots in South Carolina (NJDEP 2007), and in 2008, over 3,000 birds were counted on Kiawah Island (Cape Romain Bird Observatory; crbo.net). The New Jersey Department of Environmental Protection (NJDEP) gives data showing greater than 2,400 birds at Harbor Island and Hunting Island (~20 miles southwest of the action area). **It is likely that red knots may be present in the action area during construction.**

Effect Determination

No critical habitat for the red knot has been designated in the proposed action area. The species uses a broader range of habitat than does the piping plover, though the general migration patterns for both species are similar. Both species have the potential to use portions of the proposed action area for wintering or as a staging area during migration. Neither species nests in the proposed action area. Red knots have been confirmed on beaches nearby the action area (eg Kiawah Island, Folly Beach). During construction, these areas will be available to the species for foraging.

Construction activities will temporally alter the intertidal beach. Equipment used during construction will likely force red knots to utilize other nearby areas during construction of the proposed project. Immediately following the proposed project, this impact will be eliminated and new dry-beach habitat in the fill area will offer more foraging area for the species. Red knots do not nest in the proposed action area; therefore, no direct or indirect takes are expected. Due to the nearby alternate habitat and temporary construction impact, the applicant concludes **the proposed action may impact, but will not adversely impact, red knots.**

5.9 Piping Plover

The Atlantic Coast piping plover (*Charadrius melodus*) population breeds on coastal beaches from Newfoundland to North Carolina (and occasionally in South Carolina) and winters along the Atlantic Coast from North Carolina south, along the Gulf Coast, and in the Caribbean (USFWS 1996b). Only six **breeding** pairs have been observed in South Carolina since 1986, and none since 1993 (USFWS 2006). Since being listed as threatened in 1986, the population has increased from ~800 pairs to almost 1,680 pairs in 2003, although most of this increase may be attributable to an increase in surveying intensity (Mitchell et al 2000).

Piping plovers roost above the high tide line on coastal beaches, sand flats at the ends of sand spits and barrier islands, gently sloping foredunes, blowout areas behind primary dunes, sparsely vegetated dunes, and washover areas cut into or between dunes (USFWS 1996b). Feeding areas include intertidal portions of ocean beaches, washover areas, mud flats, sand flats, wrack lines, and shorelines of coastal ponds, lagoons, or salt marshes. Loss and degradation of habitat due to development and shoreline stabilization have been major contributors to the species' decline.

The USFWS has designated (2001—Federal Register 36093) critical habitat for the piping plover encompassing a portion of the action area and nearby areas on Kiawah Spit (on the west end of Kiawah Island). The regional critical area is shown on Figure 5.1, and the local critical area in Figure 5.2. The habitats most beneficial to piping plover are washover-type areas and intertidal areas. Plover utilize the dry beach area for roosting and the intertidal areas for foraging. These habitats are more ephemeral than the vegetated upland habitat on the main portion of Seabrook Island.

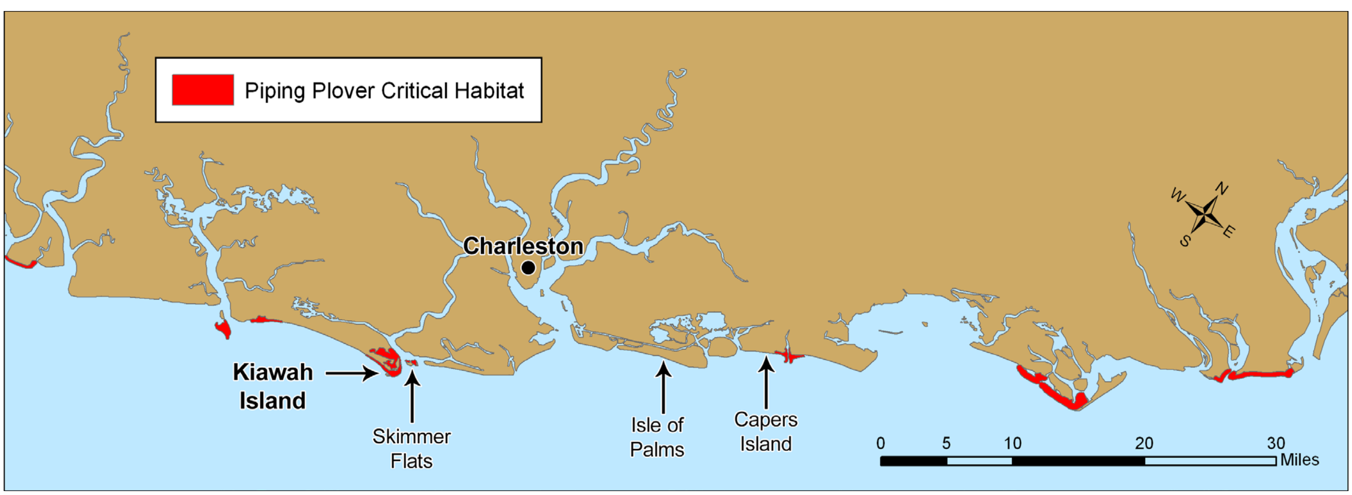


FIGURE 5.1. Piping plover critical habitat in the central portion of South Carolina. Additional habitat is further west on Harbor Island (off the image).

FIGURE 5.2. Piping plover critical habitat (yellow shade with red outline) in the action area (black and blue outline). Location was provided by USFWS and is for illustrative purposes only. Legal descriptions are provided in the Federal Register (given below).

The legal description of the designated habitat is (USFWS).

Unit SC-10: Seabrook Island. 117 ha (289 ac) in Charleston County. This unit runs from just 0.16 km (0.10 mi) north of Captain Sams Inlet to the southwest approximately 3.4 km (2.1 mi) along the Atlantic Ocean shoreline. It includes land areas from the MLLW on the Atlantic Ocean to where densely vegetated habitat, not used by the piping plover, begins and where the constituent elements no longer occur. Most of the unit is privately owned.

As part of the 2006 beach restoration project at Kiawah Island, piping plover and benthic macro-invertebrate surveys were conducted to document potential changes due to the project. Plover data collection began in August following the project (which was completed in July 2006). Surveys were conducted between two and eight times per month along the east end spanning the months from August to April. Additional surveys of the front beach and western end of Kiawah began in the 2007-2008 season using the same methods. The only pre-project data available is from surveys conducted in March and April 2006 (these data were excluded from the analysis due to an incomplete seasonal record). The average number of birds per survey for each season is shown in Figure 5.3. The abundance of plovers at the east end decreased between 2006/2007 and 2011/2012 from 14.7 birds per survey to 2.9. Abundance shows a small increase at the west end, and a small decrease along the front beach.

While these data help provide a record of the plover abundance and distribution along Kiawah Island, since no pre-project data are available, it is not possible to determine the direct impacts of the 2006 project. It is clear that the site was still being used by plovers immediately after the project (11.5 birds per survey were observed in August 2006, the month after the project, and at least 14.8 birds per survey were observed each month through February 2007), when impacts to the benthic community and beach morphology would likely be greatest. Continued declines of the abundance in the years after the project (when projects impacts would be indistinguishable from natural events) suggest that plovers have a reduced preference for the site for reasons not presently understood. Potential reasons include natural habitat evolution as portions of the lagoon evolve into a mature marsh system and additional sand is added via shoal bypass events, predation, or site preference for nearby areas (west end of Kiawah Island, Deveaux Banks, Skimmer Flats).

Much like the plover census data, data collection for the benthic study (DNR 2011) began after the project was complete; therefore, no before-and-after analyses were possible. The study sought to compare the project site to a nearby control area on Bird Key (across the Stono River Inlet from Kiawah Island); however, the control aspect of that site was compromised by a sand-placement event in 2006. The report concludes that there was a general shift from plover utilization of sheltered habitats to exposed habitats over the course of the study (2006-2011); however, the study did not necessarily document the spatial distribution of plovers throughout the area, rather the researchers chose sampling sites based on recent plover observations.

The shift in habitat preference by plovers resulted in a shift in benthic species composition in the active feeding areas, as more polychaetes were present in sheltered areas (inside of the lagoon) and more amphipods were present on the exposed beach. The study also found a general reduction in macro-invertebrate densities between occupied and abandoned sites for sites abandoned between the fall and spring sampling events and those abandoned between the spring and fall events (when plovers are not as likely to be present).

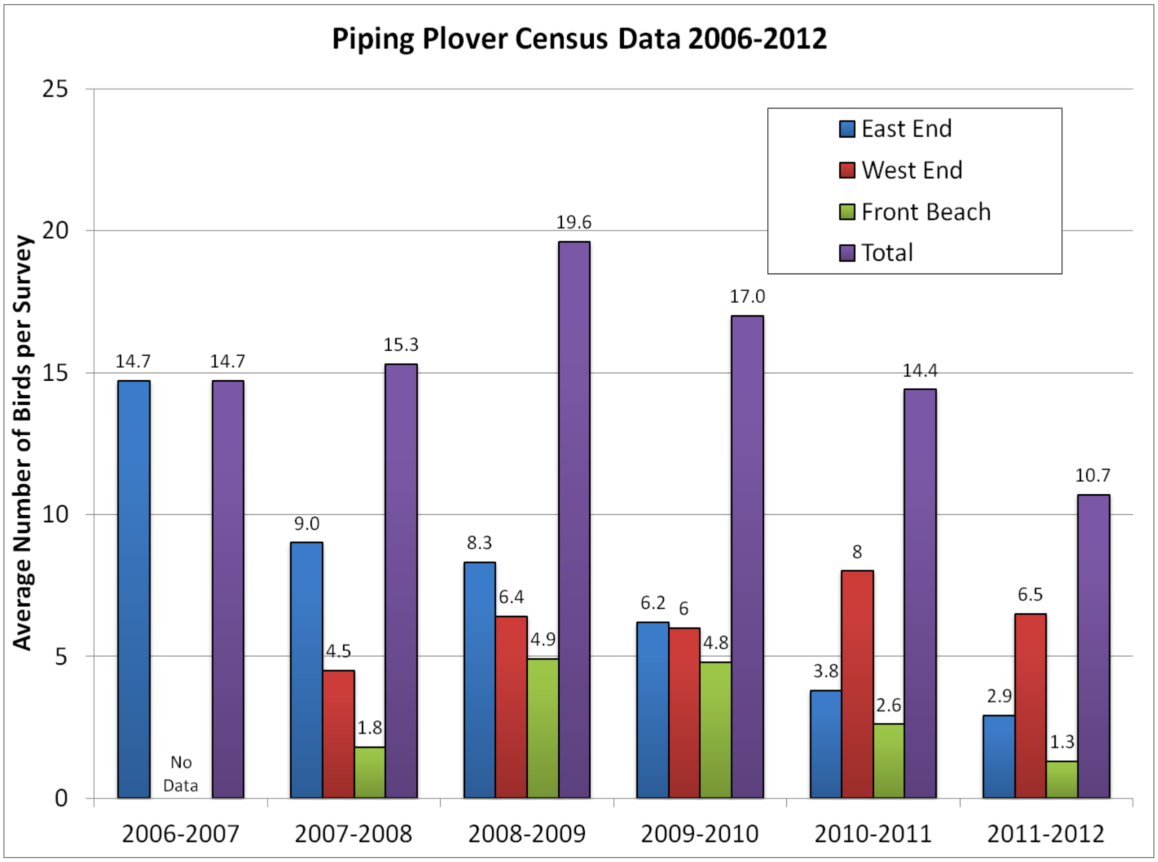


FIGURE 5.3. Piping plover abundance at Kiawah Island, SC between 2006 and 2012. Values are average number of birds observed per survey for the months of August-April. The 2006 east end beach restoration project occurred prior to the 2006-2007 survey. [Source Data c/o Town of Kiawah Island]

The study was limited due to the lack of pre-project data and the unanticipated alteration of the control site. Therefore, the researchers could not ascertain any impacts of the 2006 east end project on piping plovers. The study suggests a link between the decreasing trend in polychaete density and a reduction in the number of wintering piping plovers. However, the sampling method of selecting active foraging sites (rather than a systematic approach) prevents determining the overall changes to the benthic community along the east end. Therefore, assuming a system-wide reduction in polychaete density is not appropriate. Remaining unanswered is what factors influenced the plovers' shift in habitat utilization (sheltered versus exposed) or if this was even a real shift or a function of the study design.

Based on Kiawah East End study results, during the 2008–2011 period, there was less sheltered intertidal (unvegetated sand and mud flats) habitat present within the lagoon. Much of the loss was due to the sand flats becoming vegetated with a landward recession of the outer berm. At the same time, another shoal-bypass event was occurring, which increased the amount of exposed intertidal area (active wet-beach area). While exposed, the approaching shoal provides a breakwater effect which reduces wave energy in the lee and may have provided a favorable foraging area for plovers. The loss of sheltered intertidal habitat and increase in exposed intertidal may have contributed to the shift in plover habitat utilization found in DNR 2011.

The species is not known to nest in the proposed project area but **may utilize the area for roosting or feeding and, therefore, may be in the vicinity of the action area at some point during construction**.

Effect Determination

The proposed project will have a direct short-term impact on piping plover critical habitat. Critical habitat was designated in 2001 (USFWS), encompassing the action area and surrounding beach and lagoon. The project will directly impact the critical habitat through excavation of the intertidal beach. However, there will be no loss of washover habitat near the excavations; though washover dry-beach habitat will be created along the fill areas. The intertidal beach will be used as a borrow source. This will remove benthic organisms which may be used as a food source for piping plovers. Benthic organisms will also be buried in the footprint of the placement area. Due to the mobility of piping plovers and the fact that they do not nest in the proposed project area, no direct takes of the species are expected. The excavation area overlapping with designated critical piping plover habitat is highly dynamic, and expected to rebuild rapidly as the shoals of Capt Sams Inlet migrate into the area. The applicant anticipates triggering large releases of sand to the beach after a future planned inlet relocation within 10 years after the proposed action is completed.

The effects of the proposed project are expected to be temporary. Several studies of beach nourishment projects using offshore sand sources show that the recovery of benthic organisms typically takes place in 3 to 6 months (Burlas et al 2001, CZR 2014). This is despite complete burial of the benthic community during typical nourishment projects. The present project is expected to allow recovery of the benthic community even faster due to the smaller scale of the project and the quality of sand (transfer along the intertidal zone rather than addition of new sand from offshore into the productive surf zone at the rapid rates produced by hydraulic dredging).

Impacts of sand recycling are expected to be difficult to distinguish from natural processes occurring at the site. The proposed project seeks to move beach sand a few thousand feet downshore as infrequently as practicable, and only in response to erosion and loss of dry beach and dune habitats within the placement area.

The long-term impacts of the proposed project are anticipated to be beneficial for piping plovers by preservation of habitat created by the earlier projects and by reducing the likelihood of the beach reaching a condition where a much larger project is needed. However, temporary impacts associated with construction activities lead the applicant to determine that **the proposed action may impact and will likely have an adverse impact on piping plovers and designated piping plover critical habitat.**

5.10 Hawksbill Sea Turtle and Leatherback Sea Turtle

Leatherback (*Dermochelys coriacea*) and hawksbill (*Eretmochelys imbricate*) sea turtles are found mainly in tropical waters of the Atlantic, Pacific, and Indian Oceans. Nesting in the U.S. for these species occurs in spring and is generally restricted to Florida. Although neither species is considered common along the South Carolina coast, they may be found in South Carolina waters all year and can be present in inshore waters from April through December (Epperly et al 1995).

The leatherback is an open-ocean species that sometimes moves into shallow bays, estuaries, and even river mouths. Their preferred diet is jellyfish and may also include sea urchins, squid, shrimp, fish, blue-green algae, and floating seaweed. The hawksbill is found along submerged rocky areas, reefs, shallow coastal areas, lagoons of oceanic islands, and narrow creeks (USFWS 1991), but is not often seen in water over 65 ft deep. Its diet includes algae, fish, mangroves, barnacles, clams, sponges, snails, and sea urchins.

Murphy et al (2006) provide detailed information about leatherback turtle occurrence and distribution along the South Carolina coast based on aerial surveys between 1994 and 2003. Records from April to June of each year (total of 50 flights) recorded 1,131 live leatherbacks with concentrations as high as 175 individuals in a single flight. The aerial observations were initiated earlier in response to an increased number of strandings of leatherback turtles observed between 1980 and 1992 (Fig 5.4).

From 1980 to 1984, there were no recorded strandings of leatherbacks in South Carolina; from 1985 to 1988, there were only six strandings. However, between 1989 and 2003, there were about 135 recorded leatherback strandings (Murphy et al 2006). The majority of these occurred between 1989 and 1993 during April, May, and June (Fig 5.4). Griffin et al (2007) reported a mean number of leatherback turtle observations from aerial surveys at 36 per flight for 2000–2002 and 18 per flight for 2003–2007. The year 2002 yielded an unusually high number of observations which skews the data. Omitting 2002 data yields a mean of 18 observations per flight.

These data generally show an increased occurrence of leatherback turtles along the South Carolina coast between 1980 and the present, although the numbers each year are highly variable. Despite the apparent number of leatherbacks in the area, few nests have been recorded in recent years. There are records of nests at Huntington Beach State Park in 2000, Botany Bay Island in June 2003, and Folly Beach in July 2003 (USACE 2005). There is no critical habitat designation for sea turtles in South Carolina. **Based on the SCDNR sightings data, the leatherback and hawksbill turtle may be found in the area of the proposed action**.

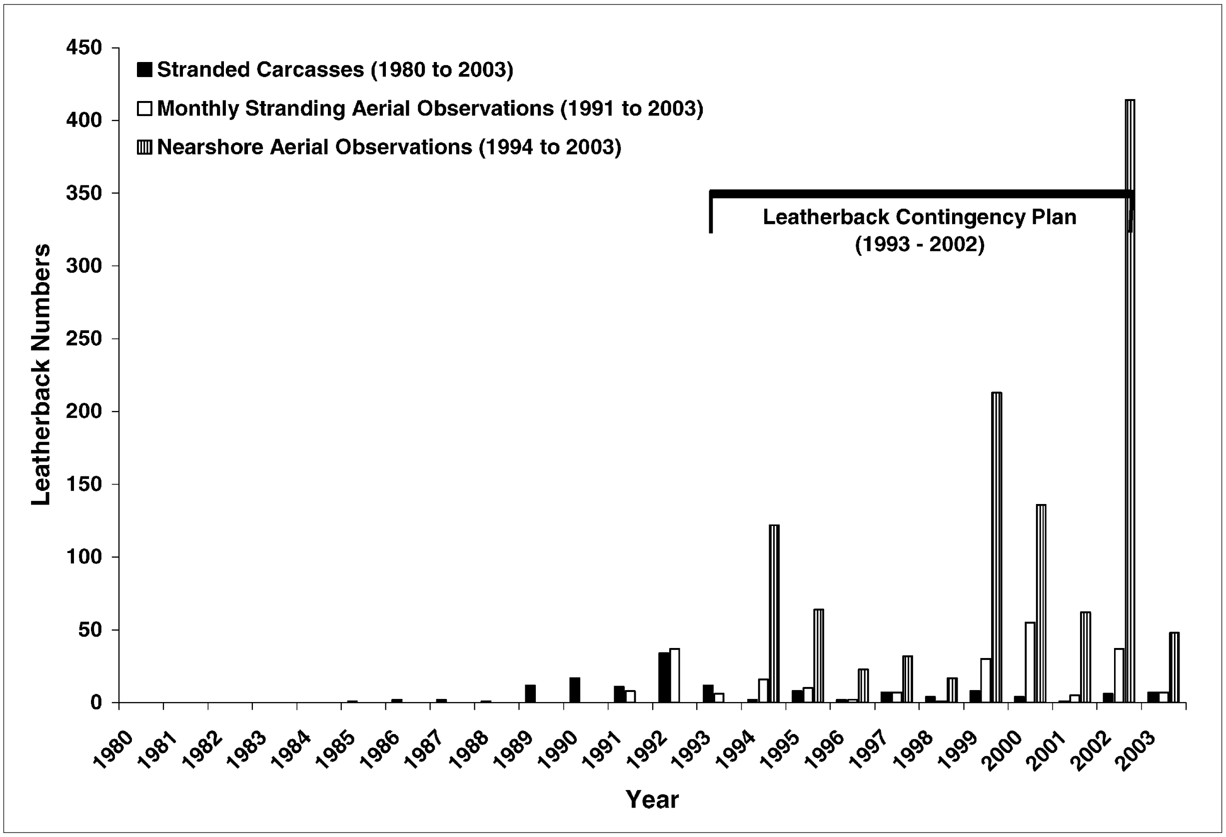


FIGURE 5.4. Annual numbers of stranded carcasses and live leatherback observations during monthly stranding (n=121) and nearshore (n=50) aerial surveys in South Carolina. [From Murphy et al (2006), Fig 2]

5.11 Kemp's Ridley Sea Turtle

Kemp's Ridley sea turtles (*Lepidochelys kempii*) inhabit shallow coastal and estuarine waters, often in association with subtropical shorelines of red mangrove. Nearly the entire population nests on ~15 miles of beach in Mexico between the months of April and June (USFWS 1991). Outside of nesting, the major habitats for adult Kemp's Ridley are the nearshore and inshore waters of the northern Gulf of Mexico, especially Louisiana waters. However, immatures have been observed along the Atlantic coast as far north as Massachusetts.

The Kemp's Ridley sea turtle is commonly observed migrating within South Carolina inshore waters during spring and fall, but has only rarely nested in South Carolina (the last nest reported by seaturtle.org was in 2008). However, juveniles of the species are known to migrate in estuarine and oceanic waters off the South Carolina coast (Schwartz 1977, Epperly et al 1995). Over-harvesting of both eggs and adults for food and the skin has been a major factor in their decline. Presently, the major threat in South Carolina is drowning when inadvertently caught in shrimp nets (NOAA–NMFS Draft Revised Recovery Plan 2010). Presently, there are ~3,000 nests per year; however, the total population is presently unknown because juveniles and males do not come ashore (NOAA 2000).

SCDNR (2006, 2007) reported a total of 17 Kemp's Ridley turtle strandings in South Carolina in 2006 and a total of 19 strandings in 2007. Strandings of Kemp's Ridley sea turtles were second only to loggerheads which experienced 69 (2006) and 63 (2007) during the same period. The number of South Carolina strandings for all turtle species in 2006 and 2007 (91 and 92, respectively) was "much lower than previous years" (SCDNR 2006, 2007 – pg 1). Based on the above-noted records, it is likely **Kemp's Ridley sea turtles may be present in the vicinity of the action area during construction**.

5.12 Green Sea Turtles

With an estimated population of no more than 100,000 nesting females worldwide, the green sea turtle (*Chelonia mydas*) exists in both tropical and temperate seas and oceans (USFWS 1991). The North American distribution ranges from Massachusetts to Mexico and from British Columbia to Baja California. Green sea turtles generally favor protected waters inside reefs, bays, estuaries, and inlets. Primary habitats appear to be lagoons and shoals supporting an abundance of marine grass and algae. These turtles are predominantly herbivorous, feeding upon marine algae and shallow beds of marine grasses. However, additional food sources may include mollusks, sponges, crustaceans, and jellyfish.

While there are relatively large numbers of green turtles worldwide, their numbers are declining because of over-exploitation of eggs and meat for food, commercial fishing and dredging operations, and nesting habitat destruction associated with beach development (USFWS 1991). Green sea turtle nesting habitat consists of open beaches with a sloping platform and minimal human disturbance.

Eastern US nesting is limited primarily to the east coast of Florida (300–1,000 nests reported annually). Occasional nesting has been documented in South Carolina (Hopkins-Murphy et al 1999). Because of this limited occurrence, the species cannot be considered to be a regular nester within the proposed project area. However, **juvenile green sea turtles are known to migrate in estuarine and oceanic waters off of the South Carolina coast and may be present during the proposed action**.

5.13 Loggerhead Sea Turtles

Loggerhead sea turtles (*Caretta caretta*) are found worldwide in temperate and subtropical waters. Major nesting areas occur along the southeast US coast from North Carolina to Florida. The highest incidences of nests in South Carolina are reported on Cape Island (Cape Romain Wildlife Refuge), Botany Bay Island, Hilton Head Island, and Lighthouse Island. Juvenile loggerhead turtles prefer shallow-water bays and estuaries. They feed on crustaceans, mollusks, squid, jellyfish, fish, and plants. They move offshore at maturity and can be found at the edge of the continental shelf, feeding on benthic invertebrates and foraging around coral reefs and artificial reefs. In South Carolina, the nesting season generally begins in mid-May and ends by mid-August, with nesting activity greatest in June and July. Final hatching occurs around the end of October.

Loggerheads are known to nest an average of ~4 times within a nesting season (USACE 2005). The inter-nesting interval varies around a mean of about 14 days. Females are believed to mate prior to the nesting season (and possibly only once) and then lay multiple clutches of fertile eggs during the nesting season. Mean clutch size varies from about 100 to 125 along the southeastern U.S. coast. The incubation period is related to nest temperature and is of the order of 60 days. Sex determination in loggerhead hatchlings is temperature dependent, with the highest nest temperatures tending to lead to more females. Hatchlings, upon emergence from nests, swim rapidly offshore, where they become associated with sargassum rafts and debris lines. After growing to a carapace length of about 45 centimeters (cm), they migrate to nearshore and estuarine waters of the eastern United States, the Gulf of Mexico, and the Bahamas, where they begin their subadult stage. As adults, loggerheads become migratory for the purpose of breeding (USFWS 1991).

Research has shown that turtle populations have greatly declined in the last 20 years due to the loss of nesting habitat along the beachfront and incidental drowning in shrimp trawl nets. Dredging activities in the warmer months of the year could impact the subadults, but this has not been well documented. It appears that the combination of poorly placed nests coupled with acute erosion and unrestrained human use of the beach by vehicle and foot traffic, and nest degradation by natural predators (eg – foxes and raccoons) have greatly impacted this species. Eroding steep beach escarpments, lights, sand fences, and other physical barriers (debris) often cause the mature females to select poor nesting sites at the toes of dunes which causes higher nestling mortality rates (Schwartz 1977, Epperly et al 1995).

USFWS and NFWS have proposed designating critical habitat for loggerhead sea turtles along the southeastern United States, spanning ~740 miles of shoreline from Mississippi to North Carolina (Federal Register Vol. 78, No. 57, 18000; and Federal Register Vol. 78, No. 138, 43006). The FWS designation encompasses the terrestrial environment, and the Service has determined that the following warrant conservation for loggerheads:

(1) Beaches that have the highest nesting densities (representation);

(2) Beaches that have a good geographic spatial distribution to ensure protection of genetic diversity (resiliency and redundancy);

(3) Beaches that collectively provide a good representation of total nesting (representation);

(4) Beaches adjacent to the high density nesting beaches that can serve as expansion areas and provide sufficient habitat to accommodate and provide a rescue effect for nesting females whose primary nesting beach has been lost

FWS has identified primary constituent elements for loggerheads which are considered essential to the conservation of the species, listed below (source: Fed Register Vol. 78, No. 57, 18000):

(1) Primary Constituent Element 1— Suitable nesting beach habitat that has (a) relatively unimpeded nearshore access from the ocean to the beach for nesting females and from the beach to the ocean for both post-nesting females and hatchlings and (b) is located above mean high water to avoid being inundated frequently by high tides.

(2) Primary Constituent Element 2— Sand that (a) allows for suitable nest construction, (b) is suitable for facilitating gas diffusion conducive to embryo development, and (c) is able to develop and maintain temperatures and a moisture content conducive to embryo development.

(3) Primary Constituent Element 3— Suitable nesting beach habitat with sufficient darkness to ensure nesting turtles are not deterred from emerging onto the beach and hatchlings and post-nesting females orient to the sea.

Primary threats to loggerheads identified in the proposed critical habitat designation included 12 categories. Threats include recreational beach use, beach driving, predation, sand placement activities, shoreline alterations, development, lighting, erosion, climate change, habitat obstructions, disasters, and military activities. Of the listed threats, the project area is most likely to be impacted by recreational use, beach driving, predation, shoreline alterations, and erosion.

NMFS proposes to designate 36 marine areas within the Northwest Atlantic Ocean Distinct Population Segment (DPS). The nearshore environment (MHW to 1 mile seaward of MHW) off of Seabrook Island is included in LOGG-T-SC-11, which encompasses the SC shoreline between Captain Sams Inlet and North Edisto River Inlet (Fig 5.5). The areas designated for protection contain nearshore reproductive habitat, wintering habitat, breeding habitat, migratory corridors, and sargassum habitat. Of these, the nearshore reproductive habitat is most relevant to the proposed project. The proposed designation describes the Primary Constituent Elements of nearshore reproductive habitat as the:

> *portion of the nearshore waters adjacent to nesting beaches that are used by hatchlings to egress to the open-water environment as well as by nesting females to transit between beach and open water during the nesting season.*
>
> *PCEs that support this habitat are the following:*
>
> *(1) Nearshore waters directly off the highest density nesting beaches as identified in 78 FR 18000 (March 25, 2013) to 1.6 km [1 mile] offshore;*
>
> *(2) Waters sufficiently free of obstructions or artificial lighting to allow transit through the surf zone and outward toward open water; and*
>
> *(3) Waters with minimal manmade structures that could promote predators (i.e., nearshore predator concentration caused by submerged and emergent offshore structures), disrupt wave patterns necessary for orientation, and/or create excessive longshore currents.*

Sea Turtle Nesting Census

SCDNR maintains statistics on sea turtle nesting activities along South Carolina beaches. Table 5.2 lists the number of nests in South Carolina for all species of sea turtle during the period 2010–2021. Note that this table only shows data on beaches that were surveyed. Some beaches were not surveyed every year, and values of zero (0) are given during un-surveyed years. During the past five years (2017-2021), the total number of reported turtle nests in South Carolina has averaged ~5,497 per year, of which ~66 (~1.2 percent) per year occurred on Seabrook Island.

Between 1989 and 1995, South Carolina averaged 3,484 nests per year (TEWG 1998). Most observers note a decline in the aggregate turtle nesting along South Carolina beaches over the past 20 years; however, since 2016 strong numbers have been observed statewide (seaturtle.org). Of the 52 South Carolina locations included in the seaturtle.org database, 43 have seen the largest number of nests in their observational records since 2016 (Table 5.2)

Present Threats to Continued Use of the Proposed Project Area by Sea Turtles

Loggerhead and other sea turtle species face threats in the proposed project area that are the same as the primary threats they face worldwide. Table 5.3 lists the estimated annual numbers of deaths and the relative importance of various sources of human-induced mortality of juvenile and adult loggerhead sea turtles in United States waters (NRC 1990, Plotkin 1995). Shrimp trawling is ranked number one (highest) in relative importance, with an estimated 5,000–50,000 mortalities per year. Other fisheries are responsible for an estimated 500–5,000 mortalities per year and are ranked 2.5 (moderate to low) in relative importance.

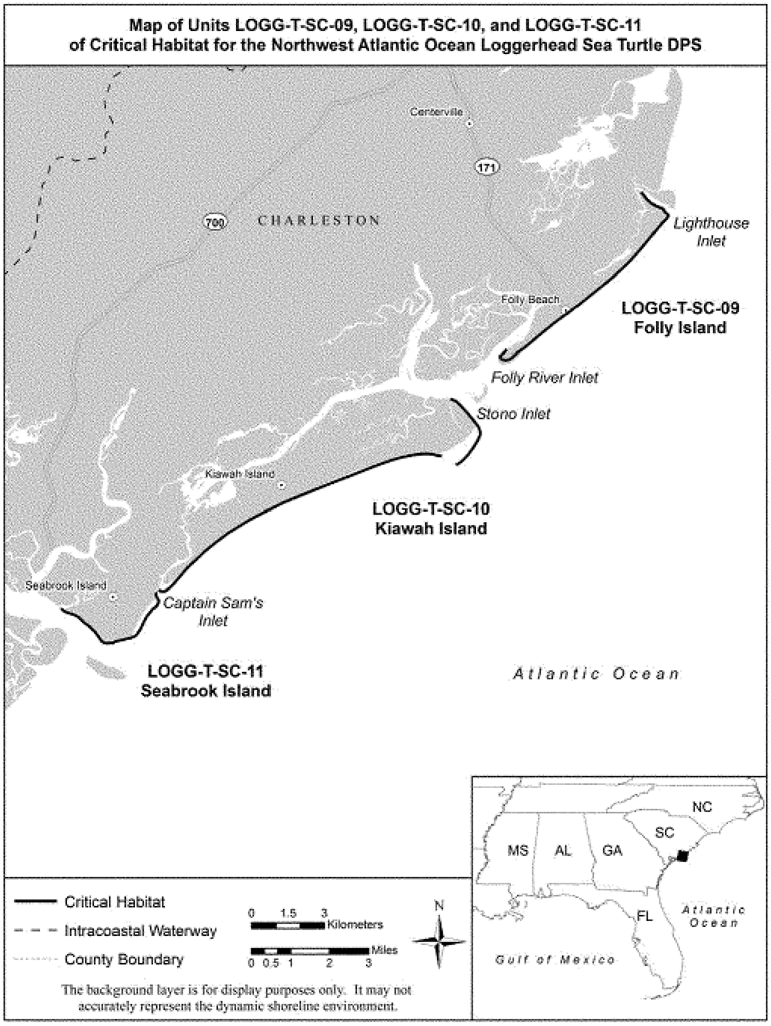


FIGURE 5.5.

Proposed critical habitat for the loggerhead sea turtle.

The terrestrial habitat is managed by FWS (above) and the nearshore habitat by NMFS (right).

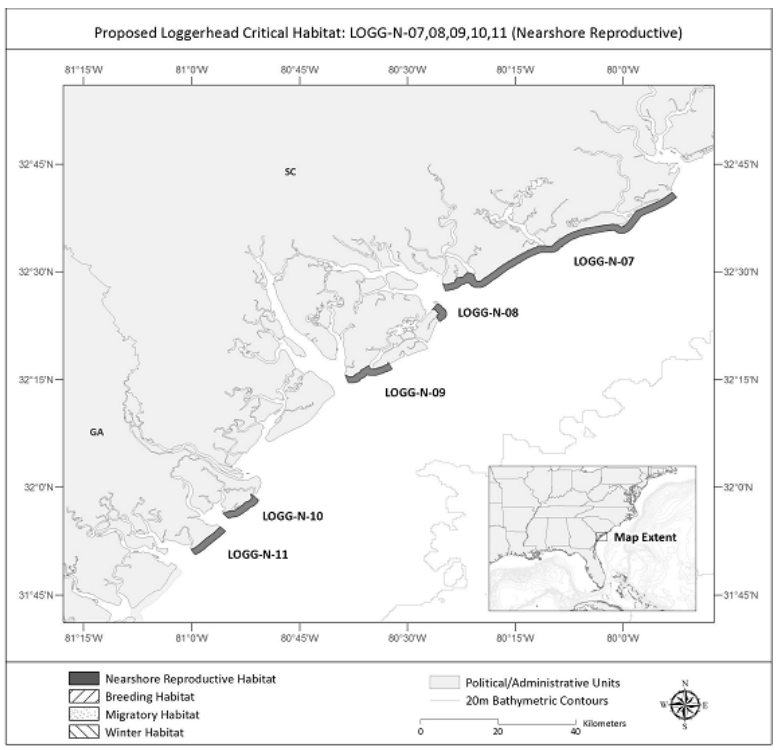


TABLE 5.2 Sea turtle nest census (2010–2021) for South Carolina (source: seaturtle.org).

Beach	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	Average*
Bay Point Island	35	67	82	101	22	56	119	68	68	107	33	49	**67**
Botany Bay Island	97	141	136	177	55	200	208	199	94	278	109	190	**157**
Botany Bay Plantation	176	184	271	292	103	326	295	175	103	327	169	182	**217**
Bull Island	138	133	159	162	64	140	167	139	76	164	166	99	**134**
Cape Island	1,045	1,075	1,140	1,248	556	1,357	1,592	1,338	548	2,044	1,127	1,042	**1,176**
Capers Island	11	5	7	6	3	13	13	4	2	24	8	10	**9**
Cedar Island	NDA	NDA	60	17	25	59	83	68	21	68	40	80	**52**
Charleston Harbor Interior	NDA	5	NDA	NDA	NDA	NDA	NDA	3	NDA	NDA	NDA	NDA	**4**
Coffin Point	NDA	12	0	12	6	8	15	20	7	26	29	23	**16**
Daufuskie Island	65	69	68	85	36	54	98	57	39	108	66	80	**69**
Debidue Beach	12	31	35	37	9	25	34	42	18	63	29	47	**32**
Deveaux Island	NDA	1	5	3	16	16	11	0	1	3	NDA	10	**7**
Dewees Island	15	13	7	14	3	5	19	9	15	28	21	6	**13**
Edingsville Beach	58	71	90	86	33	66	67	23	23	45	41	44	**54**
Edisto Beach State Park	103	65	169	152	54	178	240	153	109	351	181	206	**163**
Edisto Town Beach	80	42	173	109	41	102	162	74	114	244	164	117	**119**
Folly Beach	54	82	74	108	22	98	88	71	34	145	57	100	**78**
Fripp Island	25	69	37	92	37	78	117	115	58	165	140	80	**84**
Garden City Beach	5	6	16	10	6	7	14	22	NDA	35	10	10	**13**
Harbor Island	30	68	42	57	19	54	113	41	49	96	86	65	**60**
Hilton Head Island	239	324	320	339	131	325	411	325	179	463	291	283	**303**
Hobcaw Beach	17	31	38	71	22	15	33	34	6	68	46	39	**35**
Hunting Island State Park	111	68	120	125	39	82	141	106	60	153	134	130	**106**
Huntington Beach State Park	9	23	15	9	12	12	17	23	11	42	23	21	**18**
Interlude Beach	13	10	6	12	9	14	28	19	3	23	16	12	**14**
Isle of Palms	23	42	62	34	11	31	27	43	18	57	40	36	**35**
Kiawah Island	219	256	227	399	125	277	355	333	216	574	342	339	**305**
Lands End	NDA	8	NDA	8	NDA	2	7	NDA	4	4	2	4	**5**
Lighthouse Island	177	243	352	478	189	397	739	482	262	1,338	1,091	1,078	**569**
Litchfield by the Sea	4	7	5	4	4	3	1	5	3	6	2	1	**4**
Little Capers Island	39	39	55	65	16	62	75	46	24	51	69	82	**52**
Long Bay Estates	NDA	2	1	2	NDA	NDA	3	2	1	1	1	2	**2**
Morris Island	1	5	NDA	NDA	NDA	4	5	12	2	5	NDA	13	**6**
Murphy Island	NDA	NDA	14	2	5	15	29	15	15	24	21	39	**18**
Myrtle Beach	4	16	12	24	1	3	20	14	5	31	12	17	**13**
Myrtle Beach State Park	1	4	3	4	1	2	2	4	1	2	2	3	**2**
North Island	26	158	226	162	90	222	216	239	108	286	215	201	**179**
North Litchfield	4	14	0	7	2	2	5	8	1	11	5	5	**6**
North Myrtle Beach	10	18	9	6	6	8	8	21	1	25	10	9	**11**
Otter Island	5	73	85	69	52	83	75	75	37	134	88	113	**74**
Pawleys Island	16	24	11	23	4	17	24	24	15	39	14	35	**21**
Pine Island	NDA	NDA	12	6	0	12	11	27	18	23	22	8	**15**
Pritchards Island	NDA	87	61	72	30	94	81	109	67	110	108	63	**80**
Raccoon Key	NDA	NDA	28	28	8	36	23	17	13	49	45	18	**27**
Sand Island	66	175	121	214	49	175	212	245	76	124	19	74	**129**
Seabrook Island	68	38	73	74	32	75	60	70	31	90	61	76	**62**
South Island	138	150	167	137	101	210	273	247	169	604	313	382	**241**
South Litchfield	1	21	11	22	7	14	10	25	1	23	7	14	**13**
St. Phillips Island	3	18	2	8	5	9	8	6	14	21	6	5	**9**
Sullivan's Island	2	4	6	3	6	7	15	8	3	15	8	13	**8**
Surfside Beach	2	5	7	1	NDA	1	4	4	2	5	2	2	**3**
Waties Island	2	19	9	14	10	6	28	14	14	27	20	12	**15**
Total	**3,114**	**3,954**	**4,547**	**5,089**	**2,055**	**5,001**	**6,282**	**5,155**	**2,691**	**8,642**	**5,478**	**5,520**	**4,794**

TABLE 5.3. Estimated annual numbers of deaths and relative importance of sources of human-induced mortality of juvenile and adult loggerhead sea turtles (*Caretta caretta*) in US waters. Relative importance: 1 = high; 2 = moderate; 3 = low; 4 = unimportant. [From Plotkin 1995, adapted from NRC 1990]

Cause	Mortalities Per Year	Relative Importance
Shrimp Trawling	5,000–50,000	1.0
Other Fisheries	500–5,000	2.5
Beach Development	?	3.0
Dredging	50–500	3.0
Entanglement	?	3.0
Oil Platform Removal	10–100	3.0
Collisions with Boats	50–500	3.0
Directed Take	5–50	3.0
Power Plant Entrainment	5–50	3.0
Recreational Fishing	?	3.0
Beach Vehicles	?	3.0
Beach Lighting	?	3.5
Beach Replenishment	?	4.0
Toxins / Ingestion of Plastics or Other	?	?

Collisions with boats and dredging are responsible for 50–500 mortalities per year (ranked number 3.0 — low in relative importance). Other causes of mortality are ranked low or unimportant, including beach development, entanglement, oil platform removal, direct takes, power plant entrainment, recreational fishing, beach vehicles, and beach lighting. Toxins and ingestion of plastics or other debris are not ranked because of limited information. Beach nourishment is the only activity listed in Table 5.3 that is ranked number 4.0 — unimportant — in relation to the other causes of mortality.

If considered in terms of percentages of mortalities, the data in Table 5.3 suggest that shrimp trawling activities account for about 90 percent of turtle deaths each year; other fishing activities account for about 9 percent; and dredging or collisions with boats account for about 0.9 percent each year. Thus, these four causes account for over 99 percent of the mortalities. All other causes, combined, account for <1 percent of the estimated mortalities.

To partially address the problem of turtle takes by shrimpers, NMFS began championing the development and use of turtle excluder devices (TEDs) in the 1970s. By the late 1980s, most shrimping states had enacted regulations that mandated the use of TEDs (eg – http://www.dnr.sc.gov/seaturtles/teds.htm). While TEDs have had a demonstrated success, they have not eliminated takes, and shrimping remains by far the greatest threat to sea turtles (Plotkin 1995).

The conservation group, Oceana, reviewed biological opinions for 25 fisheries that were authorized to take sea turtles (Griffin et al 2006, 2008). The review found that a total of 4,770 lethal takes of loggerhead turtles were authorized for the various fisheries. Of these, 4,253 were authorized in the southeast region. Additionally, nearly 165,000 incidental takes were authorized (such as a turtle passing through a TED-equipped trawl net). The study also found that many of the fisheries exceeded the authorized take on a yearly basis. For example, the sea scallop fishery was authorized to take 25 turtles in 2003; however, it actually killed 579 turtles. Various changes to authorized takes, methods, and limits have been enacted since this review, though it is clear that takes of sea turtles from fisheries far exceed direct takes due to dredging and beach nourishment efforts.

Crouse et al (1987) reported the most serious threat to sea turtles appears to be the loss of breeding females as a result of commercial shrimping. Human encroachment on traditional nesting beaches has also exacerbated the threat and contributed to the decline in the last 20 years. NMFS (2003) and USACE (2006) suggest that a combination of poorly placed nests (often along highly eroded beaches) coupled with unrestrained human use of the beach by vehicles and foot traffic has impacted loggerhead turtles. These effects have not been quantified. As Table 5.2 illustrates, there is great variability in turtle nest density, with developed beaches having only ~50 percent as many nests as preserved (undeveloped) beaches in South Carolina.

Coastal sand loss has had a direct impact on turtle nesting activities. Long-term (chronic) as well as short-term (storm) erosion has degraded many beaches, reduced the area of dry beach needed for turtle nests, and left dune escarpments fronted by wet-sand beaches. Such conditions either eliminate habitat or significantly increase the probability of nests being eroded or flooded before turtles hatch. Presently, the majority of the action area is characterized by eroded dunes or washover beach. Neither of these areas is preferred nesting habitat (assuming a nest is left in situ) as the possibility of washout is high.

Studies on other beaches are mixed regarding the impacts of nourishment on turtle nesting. Some beaches where regular sediment disposal associated with navigation projects occurs have shown the same nesting and hatch rate success as unnourished beaches [eg – Topsail Island (NC), USACE 2006]. Other beach disposal projects have indicated a reduction in nesting and hatchling success where the sediments contained excessive mud [eg – Atlantic Beach (NC) 2005] or shells [eg – Pine Knoll Shores (NC) 2002] (Mihnovets & Godfrey 2004, Holloman & Godfrey 2006). The BA and draft EA for the Folly Beach shoreline protection project and Section 206 Folly Beach project (respectively) suggest that beach nourishment and stabilization in highly eroded areas may be beneficial to nesting turtles.

Variations in hatchling success have also been attributed to the sediment quality and color of the nourishment sand (eg — Ackerman 1996, Holloman and Godfrey 2006), although there are not sufficient data to confirm whether the outcomes are positive or negative. For example, darker nourishment sediments are considered to raise incubation temperatures which, in turn, tend to favor the hatching of females (Mrosovsky et al 1984, Mrosovsky 1988, Mrosovsky & Provancha 1992). It is unclear whether more females are desirable, although, intuitively, it would appear so, as Crouse et al (1987) found the loss of breeding females to be the most serious threat to the species.

SCUTE (http://www.hobcawbarony.org/foundationnewsletter.html) reports that in their ~70-mile turtle monitoring area of northern South Carolina, 40–50 percent of nests occur along Debidue Beach. Since 1990, ~40 percent of Debidue Beach has been nourished three times. Edisto Beach, Edisto Beach

State Park, Hunting Island, and Hilton Head Island have been nourished yet maintain relatively high densities of turtle nests compared with many unnourished sites in South Carolina. As a result, there does not appear to be a clear relation between nesting frequency and nourishment in South Carolina.

The most important factor contributing to egg mortality is nest predation. A variety of natural and introduced predators such as raccoons, foxes, ghost crabs, and ants prey on incubating eggs and hatchling sea turtles. Raccoons are considered the principal predator, followed by foxes and ghost crabs. Raccoons patrol primary dune lines at night and dig up nests after they are buried. Raccoons may take up to 96 percent of all nests deposited on a beach if there is no intervention (USFWS 1991, USACE 2005). After predation, these nests may be empty or only have a few eggs remaining. While remaining eggs can be cleaned and then relocated, these small nests normally exhibit very low hatching success. In addition to the destruction of eggs, other predators may take considerable numbers of hatchlings just prior to or upon emergence from the sand (USFWS 1991).

5.14 Cumulative Effects on Sea Turtles

It is believed that declines in sea turtle populations are a direct result of loss of habitat and human activities. Erosion of nesting beaches can result in partial or total loss of suitable nesting habitat. Dynamic coastal processes, including storms and sea-level rise, also influence habitat availability. Shoreline armoring is implemented to protect upland structures, and ultimately, this reduces the available habitat. Shoreline armoring includes sea walls, rock revetments, and sandbag installations. Beach armoring can result in permanent loss of a nesting beach through accelerated erosion or elimination of a dry-sand beach.

Clutches found seaward of coastal structures may be inundated at high tide or washed out by increased wave action near the base of structures. If the structures fail or break apart, their debris can be scattered across the beach, further impeding access to suitable nesting sites. This, in turn, increases the incidences of false crawls or traps hatchlings and nesting turtles. Sandbags are particularly susceptible to rapid failure and result in extensive debris on nesting beaches. Rock revetments, riprap, and sand bags can cause nesting turtles to abandon nesting attempts or to create improperly sized and shaped egg cavities if there are inadequate amounts of sand cover near these structures. Approximately 21 percent (234 km) of Florida's beaches, 10 percent (18 km) of Georgia's beaches, and 10 percent (30 km) of South Carolina's beaches are armored (USFWS 1991). This estimate for South Carolina may be high given the extensive beach nourishment activities along the Grand Strand, Folly Beach, and Seabrook Island since 1990, which have buried large sections of seawalls. Natural accretion along much of Fripp Island has resulted in the burial of ~1.5 miles of revetment.

Reductions in nesting success have been documented on severely compacted nourished beaches. Compaction level measurements at ten renourished east coast Florida beaches led researchers to conclude that 50 percent were hard enough to inhibit nest digging, 30 percent were questionable as to whether their hardness affected nest digging, and 20 percent were probably not hard enough to affect nest digging (USACE 2005).

In general, Florida beaches nourished from offshore sites tend to be harder than natural beaches, and while some may soften over time through erosion and accretion of sand, others may remain hard for ten years or more (USACE 2005). However, it is not known if these conclusions about Florida beaches are applicable to South Carolina. Cone penetrometer testing in South Carolina has shown nesting occurring on natural as well as unnourished beaches where sand compaction is over 500 psi, the recommended compaction limit (USFWS 1991).

Tilling after nourishment is commonly implemented as a mitigation measure (CSE 2006), but it is unclear whether this has a significant impact on turtle nesting frequency and nest viability. Turtle nesting also remains prevalent along Edisto Beach despite high proportions of dense, shelly sediments, which comprise the principal back beach sediment type (seaturtle.org, CSE 2008).

5.15 Sea Turtles Effect Determination

5.15.1 Hawksbill, Kemp's Ridley, and Leatherback Sea Turtles

Hawksbill sea turtles do not nest on South Carolina beaches, and Kemp's Ridley and leatherback turtles rarely nest in South Carolina, so the proposed project will not adversely impact the nesting of such species. The proposed project is also anticipated to be constructed during the winter (outside of turtle laying season), and construction activities will be limited to land-based methods, eliminating offshore turtle takes, which are associated with dredging projects.

Notwithstanding protective measures anticipated by the applicant, the chance of encountering sea turtles during construction still exists. Therefore, it has been determined that **the proposed action may impact, but is not likely to adversely impact, the hawksbill, Kemp's Ridley, and leatherback sea turtles.**

5.15.2 Loggerhead and Green Sea Turtles

Loggerhead sea turtle nesting activities have been recorded within the proposed project area; however, most activity occurs during the late spring and summer months, outside of the anticipated project construction window. No critical habitat for loggerhead or green sea turtles presently exists in the proposed action area; however, critical habitat has been proposed by FWS and NMFS in the action area. The proposed project will alter the proposed critical habitat through land-based excavations of intertidal beach and the filling of intertidal beach. Construction equipment will necessarily move through the proposed critical habitat during construction. Since the project involves the transfer of native beach sand, no sediment compatibility issues are anticipated.

In the event resource agencies prefer construction to occur during turtle-nesting season, impacts to sea turtles will be minimized by the following measures:

- If any construction of the proposed project occurs during the period between 1 May and 31 July, daily nesting surveys will be conducted beginning 1 May or a date prescribed by resource agencies. These surveys will be performed between sunrise and 8:00 a.m. and will continue until the end of the proposed project, or 31 July, whichever is earlier. Any nests found in the area that will be impacted by construction activities will be moved to a safe location. The nesting surveys and nest relocations will be performed only by people with a valid SCDNR permit.

- For construction activities occurring during the period 1 May through 31 July, staging areas for equipment and supplies will be located off the beach to the maximum extent possible.
- For construction activities occurring during the period 1 May through 31 July, all on-beach lighting associated with the proposed project will be limited to the minimum amount necessary around active construction areas to satisfy Occupational Safety and Health Administration (OSHA) requirements.

The above-stated precautions and mitigation measures should minimize the effects to nesting sea turtles and emerging sea-turtle hatchlings. The monitoring and relocation program will minimize potential adverse impacts to nesting sea turtles.

Because of the alteration of potential nesting habitat and proposed critical habitat, not sighting a sea turtle nest during nest monitoring, or the inadvertent breaking of eggs during relocation, it has been determined that **the proposed action may impact, but is not likely to adversely impact, the loggerhead and green sea turtles. The proposed action may impact, and is likely to adversely impact, proposed terrestrial loggerhead critical habitat.**

— THIS PAGE INTENTIONALLY LEFT BLANK —

6.0 Essential Fish Habitat Assessment

Amendments to the Magnuson–Stevens Fishery Conservation and Management Act (1996), overseen by the South Atlantic Fishery Management Council (SAFMC), mandated that NMFS and other federal agencies identify and protect certain marine and fish habitats. Habitat areas particularly important to federally managed species were delineated as Essential Fish Habitat (EFH) and Habitat Areas of Particular Concern (HAPC). Any federal actions which fund, permit, or carry out activities that have potential effects on EFH require NMFS consultation. Since the proposed project is to be permitted by the USACE, EFH consultation is required. Table 6.1 lists designated EFH and HAPC for the southeast region. Table 6.2 lists fisheries with management plans and managed species.

6.1 Impacts on EFH and HAPC

For the proposed project at Seabrook Island, work will encompass the areas shown in Section 3.1, including the sand harvesting areas and the sections demarcated at the impoundment. Below, the Essential Fish Habitats (EFH) and Habitat Areas of Particular Concern (HPAC) are addressed by category.

Neither the South Atlantic (area-wide) or South Carolina-specific HAPCs will be impacted by the proposed project. South Carolina's three designated HAPCs are as follows:

- Broad River — runs on the west side of Laurel Bay into Port Royal Sound near Beaufort
- Charleston Bump — 80–100 miles southeast of Charleston
- Hurl Rocks — ~100 miles east-southeast of Myrtle Beach

This section will review impacts to EFH that may be in the vicinity of the project area. These include artificial reefs, hardbottom habitat, sargassum, and the marine water column. HAPC not impacted by the proposed project will not be discussed. The anticipated impacts to EFH are listed below:

- Sargassum — N/A
- Artificial / Manmade Reefs — N/A
- Hardbottom Habitat — N/A
- Marine Water Column — 5 acres (only during active construction; negligible otherwise)

TABLE 6.1. Categories of EFH and HAPC in the southeastern US. Areas shown are identified in Fishery Management Plan amendments of South Atlantic Fishery Management Council (SAFMC 1998) and are included in Essential Fish Habitat: New Marine Fish Habitat Mandate for Federal Agencies, February 1998 (rev. 10/2000, Appendices 6 and 7). *Indicates habitat type may be impacted by the proposed project.

Essential Fish Habitat (EFH)		Habitat Areas of Particular Concern (HAPC)
Estuarine Areas		**South Atlantic [area-wide]**
Aquatic Beds Estuarine Emergent Wetlands * Estuarine Scrub / Shrub Mangroves Estuarine Water Column* Intertidal Flats * Oyster Reefs & Shell Banks Palustrine Emergent and Forested Wetlands Submerged Aquatic Vegetation (SAV)		Council Designated Artificial Reef Hard Bottoms Hermatypic (reef-forming) Coral Habitat & Reefs Hoyt Hills Sargassum Habitat Special Habitat Management Zones State-Designated Areas of Importance to Managed Species Submerged Aquatic Vegetation (SAV) Coastal Inlets*
Marine Areas		**South Carolina**
Artificial / Manmade Reefs Coral & Coral Reefs Live / Hardbottoms Sargassum Water Column		Broad River Charleston Bump Hurl Rocks
*Indicates habitat type may be impacted by the proposed project.		

TABLE 6.2. Fishery management plans and managed species for the South Atlantic region (2009).

SNAPPER GROUPER COMPLEX

Sea basses and Groupers (Serranidae) - 21 species

Gag	*Mycteroperca microlepis,*
Red grouper	*Epinephelus morio*
Scamp	*Mycteroperca phenax*
Black grouper	*Mycteroperca bonaci*
Rock hind	*Epinephelus adcensionis*
Red hind	*Epinephelus guttatus*
Graysby	*Cephalopholis cruentata*
Yellowfin grouper	*Mycteroperca venenosa*
Coney	*Cephalopholis fulva*
Yellowmouth grouper	*Mycteroperca interstitialis*
Tiger grouper	*Mycteroperca tigris*
Goliath grouper	*Epinephelus itajara*
Nassau grouper	*Epinephelus striatus*
Snowy grouper	*Epinephelus niveatus*
Yellowedge grouper	*Epinephelus flavolimbatus*
Warsaw grouper	*Epinephelus nigritus*
Speckled hind	*Epinephelus drummondhayi*
Misty grouper	*Epinephelus mystacinus*
Black sea bass	*Centropristis striata*
Bank sea bass	*Centropristis ocyurus*
Rock sea bass	*Centropristis philadelphica*

Wreckfish (Polyprionidae) - 1 species

Wreckfish	*Polyprion americanus*

Snappers (Lutjanidae) - 14 species

Queen snapper	*Etelis oculatus*
Yellowtail snapper	*Ocyurus chrysurus*
Gray snapper	*Lutjanus griseus*
Mutton snapper	*Lutjanus analis*
Lane snapper	*Lutjanus synagris*
Cubera snapper	*Lutjanus cyanopterus*
Dog snapper	*Lutjanus jocu*
Schoolmaster	*Lutjanus apodus*
Mahogany snapper	*Lutjanus mahogoni*
Vermilion snapper	*Rhomboplites aurorubens*
Red snapper	*Lutjanus campechanus*
Silk snapper	*Lutjanus vivanus*
Blackfin snapper	*Lutjanus buccanella*
Black snapper	*Apsilus dentatus*

Porgies (Sparidae) - 9 species

Red porgy	*Pagrus pagrus*
Sheepshead	*Archosargus probatocephalus*
Knobbed porgy	*Calamus nodosus*
Jolthead porgy	*Calamus bajonado*
Scup	*Stenotomus chrysops*
Whitebone porgy	*Calamus leucosteus*
Saucereye porgy	*Calamus calamus*
Grass porgy	*Calamus arctifrons*
Longspine porgy	*Stenotomus caprinus*

Grunts (Haemulidae) - 11 species

White grunt	*Haemulon plumieri*
Black margate	*Anistotremus surinamensis*
Margate	*Haemulon album*
Tomtate	*Haemulon aurolineatum*
Sailor's choice	*Haemulon parra*
Porkfish	*Anisotremus virginicus*
Bluestriped grunt	*Haemulon sciurus*
French grunt	*Haemulon flavolineatum*
Cottonwick	*Haemulon melanurum*
Spanish grunt	*Haemulon macrostomum*
Smallmouth grunt	*Haemulon chrysargeryum*

SNAPPER GROUPER COMPLEX (continued)

Jacks (Carangidae) - 8 species

Greater amberjack	*Seriola dumerili*
Crevalle jack	*Caranx hippos*
Blue runner	*Caranx crysos*
Almaco jack	*Seriola rivoliana*
Banded rudderfish	*Seriola zonanta*
Bar jack	*Caranx ruber*
Lesser amberjack	*Seriola fasciata*
Yellow jack	*Caranx bartholomaei*

Tilefishes (Malacanthidae) - 3 species

Tilefish	*Lopholatilus chamaeleonticeps*
Blueline tilefish	*Caulolatilus microps*
Sand tilefish	*Malacanthus plumier*

Triggerfishes (Balistidae) - 3 species

Gray triggerfish	*Balistes capriscus*
Ocean triggerfish	*Canthidermis sufflamen*
Queen triggerfish	*Balistes vetula*

Wrasses (Labridae) - 2 species

Hogfish	*Lachnolaimus maximus*
Puddingwife	*Halichoeres radiates*

Spadefishes (Eppiphidae) - 1 species

Atlantic spadefish	*Chaetodipterus faber*

COASTAL MIGRATORY PELAGICS

Cero	*Scomberomorus regalis*
Cobia	*Rachycentron canadum*
King mackerel	*Scomberomorus cavalla*
Little tunny	*Euthynnus alletteratus*
Spanish mackerel	*Scomberomorus maculates*

DOLPHIN WAHOO

Dolphinfish	*Coryphaena hippurus*
Wahoo	*Acanthocybium solandri*

GOLDEN CRAB

Golden crab	*Chaceon fenneri*

SHRIMP

White shrimp	*Litopenaeus setiferus*
Pink shrimp	*Farfantepenaeus duorarum*
Brown shrimp	*Farfantepenaeus aztecus*
Rock shrimp	*Sicyonia brevirostris*
Royal red shrimp	*Pleoticus robustus*

SPINY LOBSTER

Spiny lobster	*Panulirus argus*

SARGASSUM

Sargassum fluitans
Sargassum natans

CORAL, CORAL REEFS AND LIVE/HARD BOTTOM HABITAT

The management unit for coral includes coral belonging to the Class Hydrozoa (fire corals and hydrocorals) and coral belonging to the Class Anthozoa (sea fans, whips, precious corals, sea pens and stony corals). Coral reefs constitute hardbottoms, deepwater banks, patch reefs and outer bank reefs as defined in the Coral, Coral Reefs and Live/Hardbottom Habitat FMP (SAFMC 1982). In addition, live rock comprises living marine organisms, or an assemblage thereof, attached to a hard substrate, including dead coral or rock (but excluding individual mollusk shells).

6.1.1 Impacts on Sargassum

Sargassum is a pelagic brown alga which occurs in large floating mats in the waters of the continental shelf, in the Sargasso Sea, and in the Gulf Stream. It is a major source of biological productivity in nutrient-poor regions of the ocean. Masses of sargassum provide extremely valuable habitat for a diverse assemblage of marine life including juvenile sea turtles, sea birds, and over 100 species of fish. Unregulated commercial harvest of sargassum for fertilizer and livestock feed has prompted concerns over the potential loss of this important resource. There have been instances of relatively small masses of sargassum washing ashore or into the proposed project area under certain wind conditions. Since sargassum is not commonly found in the proposed project area and all activity will occur on the active beach, it is not subject to impacts from excavation or disposal associated with the proposed project.

6.1.2 Impacts to Artificial Reefs

SCDNR lists one artificial reef in the vicinity of the proposed project. The site is the North Edisto Nearshore Reef which is located 1.5 nautical miles (bearing 090°) from the North Edisto channel buoy "2NE." Water depths in the location are ~30 ft. NOAA navigation chart 11522 (Stono and North Edisto Rivers) shows two wrecks located on the shoals of the North Edisto River Inlet, ~1.5 miles southwest of the proposed project area. None of the wrecks/obstructions are in close proximity to the excavation area.

No adverse impacts would be expected to the artificial reef area since excavation and fill conducted as part of the proposed project will not be performed in close proximity to the reef. Disposal of the sand on the beach will involve discharge of rapidly settling, quality sand and shell fragment material (sand and shell content >99 percent) onto the beach and will have no effect on the reefs, wrecks, or obstructions.

Elevated turbidity levels occur during dredging in the immediate vicinity of borrow sites and disposal sites, but decrease rapidly as suspended sediments settle or disperse (Hanes 1994). Turbidity associated with land-based excavations of intertidal beaches is generally expected to be lower than hydraulic dredging operation because much of the work is performed "in-the-dry" and the borrow material tends to be well sorted sandy material devoid of mud. Turbidity increases in the presence of muddy sediments, which are more commonly encountered offshore in the project area. Beach sediments have little mud because of the high energy associated with surf zones.

6.1.3 Impacts on Hard Bottom

Hard-bottom habitats are not known to be present in the project area, so they will not be impacted by the action. As mentioned previously, the material being excavated is clean beach sand. Any increase in turbidity is likely to be temporary and localized as the clean sand will settle rapidly.

6.1.4 Impacts to the Marine Water Column

Excavation and disposal activities conducted during project construction may cause impacts in the marine water column in the immediate areas of the borrow and deposition sites that could potentially impact nearshore and intertidal resources. These impacts may include minor, and short term, suspended-solids sediment plumes and related turbidity as well as the release of trace constituents from the sediment. The nature of the excavation methods for the proposed project will likely result in significantly less suspended sediment and turbidity than typical offshore dredging projects, which have the potential to introduce much more fine sediment into the water column. Scientific data are limited with regard to the effects of beach disposal on fishery resources.

The impacts associated with the proposed project may be similar, on a smaller scale, to the effects of storms. Storm effects may include increased turbidity and suspended sediment load in the water column and, in some cases, changes in fish community structure (Hackney et al 1996). Severe storms have been documented to create conditions of fish kills, but such situations are not associated with beach disposal of dredged sand.

In a 1999 environmental report on the use of federal offshore sand resources for beach and coastal restoration, the U.S. Department of Interior, Minerals Management Service (ACRE 1999) provided the following assessment:

In order to assess if turbidity causes an impact to the ecosystem, it is essential that the predicted turbidity levels be evaluated in light of conditions such as during storms. Storms on the Mid-Atlantic shelf may generate suspended matter concentrations of several hundred mg/L (e.g. Styles and Glenn, 1999). Concentrations of plumes decrease rapidly during dispersion. Neff (1981, 1985) reported that solids concentrations of 1000 ppm two minutes after discharge decreased to 10 ppm within one hour. Poopetch (1982) showed that the initial concentration in the hopper overflow of 3,500 mg/l decreased rapidly to 500 mg/l within 50 meters. For this reason, the impact of settling particles from the turbidity plume is expected to be minimal beyond the immediate zone of dredging.

Beach disposal of dredged/excavated sediments can affect fishery resources and essential fish habitats through increases in turbidity and burial of beach resources. These impacts may create localized, stressful habitat conditions and may result in the temporary displacement of fish and other biota. However, the sand proposed for disposal on the Seabrook Island beach is expected to average >99 percent sand and shell fragments (<1 percent mud) because it is already part of the active beach system. Because of the low mud content in the sediment, turbidity-induced water column impacts are expected to be localized, short-term, and minor.

There are several environmental issues relating to the benthic habitat and resources that arise in considering a beach renourishment project. The most significant include:

1) Impacts to and recovery of the benthic invertebrate community at the borrow sites.
2) Potential impacts to commercially or recreationally important demersal fishes and crustaceans, in part because of the effects on their benthic invertebrate prey.
3) Impacts to and recovery of the benthic invertebrate community on the intertidal and shallow subtidal beach.
4) Potential impacts to commercially and recreationally important fishes in the surf zone and/or shorebirds, in large part because of the effects on their benthic invertebrate prey and because of enhanced turbidity along the shoreline.

Again, it is important to note that the proposed project differs substantially from an offshore dredging project in that the excavations will be made using land-based equipment excavating sand from the active beach. No slurry containing a sand/water mixture will be used during construction, thus greatly reducing turbidity associated with the project. The material to be excavated and placed is local beach sand, from which fine material has naturally winnowed through wave action. Because excavations are from a natural beach, the borrow material will be perfectly compatible as fill material.

6.1.5 Impacts to Offshore Vertebrates

Fish and other mobile animals in the vicinity of a borrow area during excavation are unlikely to be affected during excavations because of their ability to avoid the disturbed areas. Work will only encompass the areas shown on Figure 1.8 including the excavation area through the existing spit, the dike construction area, and the excavation area on the intertidal beach. The present inlet channel will be impacted during the closure sequence; however, no direct impacts to offshore species are anticipated. In offshore projects, fish species have been observed to leave the area temporarily during dredging operations and return when dredging ceases (Pullen and Naqvi 1983). A study of nearshore borrow areas after dredging offshore of South Carolina revealed no long-term impacts to fisheries (both fish and planktonic organisms) as a result of the dredging (Van Dolah et al 1992, 1998). Another study in New Jersey found no significant difference in finfish populations before and after dredging [USACE (Burlas et al) 2001].

6.1.6 Impacts to Nearshore Resources

Sediment will be placed along the margins of the present inlet channel, building out the beach fronting an exposed seawall at the normal dry sand level (+6 to +7 ft NAVD). During the construction, sediment will be reworked into the surf zone. Short-term increases in turbidity are expected in the surf zone due to the release of excavated material. An "*Environmental Assessment, Hunting Island Ecosystem Restoration Study*," conducted by the USACE (2004) concluded that:

"*Since animals associated with high energy beaches are continually subjected to effects of erosion and accretion and major physical changes resulting from storms and hurricanes, initial construction and any periodic nourishments… will not unduly stress beach and intertidal animals beyond their adaptive capacities*."

There are three direct impacts from nourishment projects:

1) Short-lived increases in turbidity during the excavation and placement operations alter the water column conditions sufficiently that mobile species leave the area. Return is rapid, typically 2–6.5 months [USACE (Burlas et al) 2001]. Studies have found that speed of return of mobile species is more dependent on the compatibility of fill material than on the rapid return of normal turbidity levels (Van Dolah et al 1992/1994/1998, Jutte et al 1999/2000/2002).

2) Burial of bottom-dwelling organisms essentially destroys the existing community, but Reilly and Bellis (1983) found that larval recruitment is rapid and recovery typically occurs in one or two seasons.

3) Alteration of sediment type necessarily results in changes in type and densities of species. Numerous monitoring studies recommend that the key to minimizing impact is to match the sediment types as closely as possible [USACE (Burlas et al) 2001, Dean 2002].

6.1.7 Impacts to Intertidal Resources

During project construction, there will be an increase in the turbidity of the surf zone in the immediate area of sand deposition and excavation. Very little fine material is expected to be encountered and that is will likely be washed seaward into the surf during construction. This increase in fine material may cause the temporary displacement of various species of sport fish, causing a negative impact to surf fishing in the area of deposition. Again, turbidity associated with the proposed project will be much less than that of a typical dredging project. A study performed by NMFS on the effects of beach nourishment on nearshore macrofauna concluded that beach nourishment projects using offshore dredged material have no harmful effects, provided that the sediments are similar to those where they are placed [Saloman and Naughton 1984, USACE (Burlas et al) 2001, Dean 2002]. In the present case, sediment quality will match perfectly, which should facilitate species recovery in the impacted areas.

Following the project, intertidal habitat area is expected to increase as sand from Captain Sams Inlet delta migrates into the proposed borrow area, and fill sand expands the area of wet sand beach along an exposed seawall. The net gain in intertidal beach area (order of ~5 acres) is expected to be beneficial for shorebirds and marine species, which forage such areas.

6.1.8 Impacts to Intertidal Vertebrates

In view of their high mobility, it is expected that fish will leave the areas under active construction. Impact on fishing resources in the intertidal zone will be minimized simply by the limited area of construction affecting the project area during a given day.

6.1.9 Impacts to Intertidal Invertebrates

Impacts on intertidal macrofauna in the immediate vicinity of the project are expected as a result of excavation and placement of sediment on the beach. Much work has been done to study the impacts of offshore dredging projects on the intertidal benthic community. The USACE Charleston District (in planning for the 2005 Folly Beach renourishment project) recognized that non-motile benthic animals would be adversely affected by the placement of sand but that recolonization was expected to be relatively rapid, with reestablishment of the beach zone community within 1–2 years in affected areas (USACE 2005). Monitoring studies of the Folly Beach project by SCDNR (Bergquist et al 2007) found that "*burrowing macroinvertebrates showed little evidence of nourishment impact. Ghost shrimp increased in density following nourishment.*"

A study by Reilly and Bellis (1983) was conducted on Bogue Banks (NC) and is used as a seminal study on beach projects throughout the southeastern U.S. "*The Ecological Impact of Beach Nourishment with Dredged Materials on the Intertidal Zone at Bogue Banks, North Carolina*" concluded that beach nourishment virtually destroys existing intertidal macrofauna, but that recovery is rapid once the pumping operation ceases. In most cases, recovery occurs within one or two seasons following the sediment placement – "*. . . a speedy recovery largely depended on recruitment from pelagic larval stocks.*" Most species fell into this category. The few that did not, and recruited instead from neighboring beaches, were slower to recover.

It is unclear whether the proposed project, which will transfer sand (and accompanying invertebrates) from the active beach to a nearby area, will reduce the recovery time of certain species. Some species may survive the transfer, while others may not. Invertebrates in the fill area may be able to accommodate the disruption caused by construction. This possibility is not documented in literature to the knowledge of the applicant, but may prove to be the case if placement of fill continues at a rate sufficient to allow upward mobility of the infauna.

6.1.10 Impacts to Beach and Terrestrial Resources

The proposed project is intended to maintain beach habitat on the Seabrook side Captain Sams Inlet, but it will not stop or accelerate the natural processes of inlet migration (~200 ft/yr). Thus, critical habitat in and adjacent to the proposed borrow area will be more impacted by inlet processes over the five-year period of a permit. The Reilly and Bellis (1983) study that focused on the intertidal zone also encompassed dry-beach sampling. Most species, including all of the larger organisms such as ghost crabs, recruited from pelagic larvae and thus recovered rapidly (one or two seasons). Bergquist et al (2007) found that ghost-crab densities near the base of dunes were lower one year after nourishment. This latter result may also reflect the fact that the resulting dry-beach area after nourishment was much larger than the pre-nourishment conditions.

Positive impacts from project construction will be expansion of wet beach and dry beach habitats along the Seabrook seawall. These habitats were created following the 1983, 1996, and 2015 inlet relocation projects. Based on previous experience, sediment transport to downcoast areas of Seabrook declines midway between inlet relocation projects. The proposed project will augment the diminishing southerly transport and help maintain a continuous wet sand beach platform to North Edisto River Inlet. Dry beach habitat will expand after the project for the benefit of nesting sea turtles. The project will not reduce washover habitat or impact the incipient lagoon, which is beneficial to piping plover. Areas of this type created naturally following the earlier inlet relocation projects are now designated critical areas for piping plover (USFWS). Other potential impacts are restoration and protection of shorebird habitat and maritime forest.

In a 1999 environmental report on the use of federal offshore sand resources for beach and coastal restoration, the U.S. Department of the Interior, Minerals Management Service (ACRE 1999) provided the following assessment of the potential impacts to beach fauna from beach disposal:

As with benthic organisms living in borrow areas, benthic organisms are significantly impacted by beach nourishment activities (Nelson 1985; Van Dolah et al 1992). These impacts, however, are considered shorter in duration than the impacts observed in offshore borrow areas. Because benthic organisms living in the beach habitats are adapted to high energy environments, they are able to quickly recover to original levels following beach nourishment events; sometimes in as little as three months (Van Dolah et al 1994; Levison and Van Dolah, 1996). This is again attributed to the fact that intertidal organisms are living in high energy habitats where disturbances are more common. Because of lower diversity of species compared to other intertidal and shallow subtidal habitats (Hackney et al 1996), the vast majority of beach habitats are recolonized by the same species that existed before nourishment (Van Dolah et al 1992, Nelson, 1985; Levision and Van Dolah, 1996; Hackney et al 1998).

— *THIS PAGE INTENTIONALLY LEFT BLANK* —

7.0 Summary

The findings presented in Section 4.0 and Section 6.0 outline potential impacts to endangered and threatened species that may occur in the proposed project area. The restorative nature of the project and the lack of impacts to freshwater or estuarine wetlands indicate that no mitigation for the action is required. Work would likely occur between 15 November and 28 February and include manipulation via machinery and truck of up to 300,000 cy (cumulative) of beach-quality sediment along up to 9,000 linear feet of oceanfront shoreline over the course of three discrete events occurring ~once per two years. The project will nourish high-use areas of the beach and address localized erosion hotspots to offset high erosion rates.

The project will restore and preserve beach habitat used by shorebirds, turtles, and other protected species. Impacts of sand recycling projects are well understood and, when designed properly, and the site allows, limited to temporary impacts to the immediate beach and borrow area. Borrow areas are located along the updrift portion of Seabrook Island and closely match the grain size and characteristics along the placement area.

The project's proposed construction would occur during periods of low biological activity to minimize impacts to benthic organisms and sea turtles. If logistics necessitate construction extending into turtle nesting season, standard sea turtle conservation measures will be incorporated into the project scope. Long-term, the proposed project will potentially provide more habitat to piping plover, red knot, green sea turtle, and loggerhead sea turtle. Table 7.1 summarizes the findings of impact associated with the proposed project.

TABLE 9.1. Summary of findings of this biological assessment regarding the impacts on endangered species at Seabrook Island (SC). [Impacts can be minimized if construction activities are performed outside the normal nesting period.]

Species	Occurs in Proposed Action Area	Finding
No Effect		
American alligator	No	No Impact
American chaffseed	No	No Impact
Bald eagle	No	No Impact
Canby's dropwart	No	No Impact
Frosted flatwoods salamander	No	No Impact
Pondberry	No	No Impact
Red-cockaded woodpecker	No	No Impact
Seabeach amaranth	No	No Impact
May Affect, Not Likely to Adversely Impact		
Alewife and Blue Herring	Potentially	May affect, not likely to adversely affect
Atlantic Sturgeon	Potentially	May affect, not likely to adversely affect
Hammerhead Shark	Potentially	May affect, not likely to adversely affect
Piping Plover	Yes	May affect, not likely to adversely affect
Red knot	Yes	May affect, not likely to adversely affect
Shortnose Sturgeon	Potentially	May affect, not likely to adversely affect
Sea Turtles: Hawksbill Kemp's ridley Leatherback	Potentially	May affect, not likely to adversely affect
West Indian Manatee (Florida)	Potentially	May affect, not likely to adversely affect
Whales	Potentially	May affect, not likely to adversely affect
Wilson's Plover	Yes	May affect, not likely to adversely affect
Wood Stork	Potentially	May affect, not likely to adversely affect
May Affect, Likely to Adversely Impact		
Green and Loggerhead Sea Turtles	Potentially	May affect, likely to adversely affect

References

Ackerman, RA. 1996. The nest environment and the embryonic development of sea turtles. In *The Biology of Sea Turtles* (Lutz, PL and JA Musick, eds), Boca Raton, FL, CRC Press, pp 83-106.

Bergquist, DC, S Crowe, M Levisen, and R Van Dolah. 2008. Change and recovery of physical and biological characteristics at beach and borrow areas impacted by the 2005 Folly Beach renourishment project. Final Report to USACE, Charleston District, SC. SCDNR, Marine Resources Research Inst, Marine Resources Div, Charleston, SC, 114 pp.

Burlas, M., G.L. Ray, and D.G. Clarke, 2001. "The New York District's biological monitoring program for the Atlantic coast of New Jersey, Asbury Park to Manasquan Section beach erosion control project." Final report, prepared by U.S. Army Engineer Research and Development Center for U.S. Army Engineer District, New York.

Crouse, DT, LB Crowder, and H Caswell. 1987. A staged-based population model for loggerhead sea turtles and implications for conservation. Ecology, Vol 68(5), pp 1412–1423.

CSE. 2004. Seabeach amaranth survey. Letter Report for USACE (Wilmington District) and NC Div Coastal Management. Submitted by Carteret County, Town of Pine Knoll Shores, Town of Indian Beach, Town of Emerald Isle, NC. Prepared by CSE, Columbia, SC and Morehead City, NC, 5 pp.

CSE. 2006. Beach restoration project, Edisto Beach, Colleton County, South Carolina. Final Report for Town of Edisto Beach, Edisto Island, SC and SC Department of Parks Recreation & Tourism, Columbia, SC. CSE, Columbia, SC, 75 pp + 7 appendices.

CSE. 2008. Borings and sediment quality in potential offshore borrow areas, Phase 1 and Phase 2 — Edisto Beach and Edingsville Beach (SC).. Geotechnical data report for HDR Engineering Inc of the Carolinas, Charlotte, NC. Coastal Science & Engineering (CSE), Columbia, SC, 45 pp + appendices.

CSE. 2011. Captain Sams Inlet relocation project: essential fish habitat assessment. Report to US Army Corps of Engineers for Seabrook Island POA. Prepared by CSE, Columbia, SC, 35 pp plus Appendix A - Fish Species.

CZR. 2014. Nags Head beach 2011 nourishment project. Post-Year 2 and Final Report for Town of Nags Head, North Carolina. CZR Incorporated (Wilmington NC) and CSE (Columbia SC), 65 pp plus appendices.

DNR (Bergquist, Crowe, Levisen). 2011. The 2008 Arcadian Shores renourishment project: sediment and benthic community responses to borrow area dredging. Final Report to Horry County, Conway, SC. South Carolina Department of Natural Resources, Marine Resources Research Institute, Marine Resources Division, Charleston, SC, 91 pp.

Dean, RG. 2002. *Beach Nourishment: Theory and Practice*. World Scientific, NJ, 399 pp.

Epperly, SP, J Braun, and A Veishlow. 1995. Sea turtles in North Carolina waters. Conservation Biology, Vol 9(2), pp 384–394.

Fussell, J. 1996. Comments about piping plover, beach amaranth, and other declining species on south spit of Figure Eight Island. December 1996.

Gilbert, CR. 1989. Species profiles: life histories and environmental requirements of coastal fishes and invertebrates (Mid-Atlantic Bight) Atlantic and shortnose sturgeons. USFWS Biol Rept 82(11.122), USACE TR EL-82-4.

Griffin, E, G Brogan, C Sakai, S Wingard, M Hirshfield. 2006. Net casualties. Oceana.org, Washington, DC, 34 pp.

Griffin, DB et al. 2007. South Carolina endangered species program. Final completion report to NOAA Fisheries: September 1, 2002 through August 31, 2007. SC Department of Natural Resources, Charleston, SC, 21 pp.

Griffin, E, KL Miller, S Harris, and D Allison. 2008. Trouble for turtles: trawl fishing in the Atlantic Ocean and Gulf of Mexico. Oceana.org, Washington, DC, 15 pp.

Hancock, TE. 1995. Ecology of the threatened species seabeach amaranth (*Amaranthus pumilus* Rafinesque). MS Thesis, University of North Carolina at Wilmington.

Hancock, TE, and PE Hosier. 2003. Ecology of the threatened species *Amaranthus pumilus* Rafinesque. Castanea, Vol 68(3), pp 236–244.

Hayes, CG, Y Jiao, and E Cortes. 2009. Stock assessment of scalloped hammerheads in the western North Atlantic Ocean and Gulf of Mexico. North American Journal of Fisheries Management, Vol 29(5), pp 1406-1417.

Holloman, KT, and MH Godfrey. 2006. Sea turtle monitoring project report (2005), Bogue Banks, NC. Interim Report for NC Wildlife Resources Commission, 17 pp.

Hopkins-Murphy, SR, CP Hope, and ME Hoyle. 1999. A history of research and management of the loggerhead turtle (*Caretta caretta*) on the South Carolina coast. Final Report to US Fish & Wildlife Service. SCDNR, Div Wildlife and Freshwater Fisheries, Wildlife Diversity Section, Charleston, SC.

Jutte, PC, RF Van Dolah, and MV Levisen. 1999a. An environmental monitoring study of the Myrtle Beach renourishment project: intertidal benthic community assessment. Phase 1 – Cherry Grove to North Myrtle Beach. Final Report, SC Dept Natural Resources, Charleston.

Jutte, PC, RF Van Dolah, and MV Levisen. 1999b. An environmental monitoring study of the Myrtle Beach renourishment project: intertidal benthic community assessment. Phase II – Myrtle Beach. Final Report, SC Dept Natural Resources, Charleston, 38 pp + app.

Lefebvre, LW, M Marmontel, JP Reid, GB Rathbun, and DP Domning. 2001. Status and biogeography of the West Indian manatee. In CA Woods and FE Sergile (eds.), Biogeography of the West Indies: Patterns and Perspectives, CRC Press, Boca Raton, FL, pp 425–474.

Marchette, DE and R Smiley. 1982. Biology and life history of incidentally captured shortnose sturgeon (*Acipenser brevirostrum*) in South Carolina. SC Wildlife Marine Resources, unpublished manuscript.

Mihnovets, AN, and MH Godfrey. 2004. Sea turtle monitoring project report (2003), Bogue Banks, NC. Interim Report for NC Wildlife Resources Commission, 21 pp.

Mitchell, WA, MP Guilfoyle, and MS Wolters. 2000. Riparian shorebirds potentially impacted by USACE reservoir operations. EMRRP Tech Notes Collection (ERDC TN-EMRRP-SI-17), US Army Engineer Research and Development Center, Vicksburg, MS (www.wes.army.mil/el/emrrp).

Mrosovsky, N. 1988. Pivotal temperatures for loggerhead turtles (*Caretta caretta*) from northern and southern nesting beaches. Canadian Journal of Zoology, Vol 66, pp 661–669.

Mrosovsky, N, and J Provancha. 1992. Sex ratio of hatchling loggerhead sea turtles: data and estimates from a 5-year study. Canadian Journal of Zoology, Vol 70, pp 530–538.

Mrosovsky, N, SR Hopkins-Murphy, and JI Richardson. 1984. Sex ratio of sea turtles: seasonal changes. Science, Vol 255, 739–741.

Murphy, T M, SR Murphy, DB Griffin, and CP Pope. 2006. Recent occurrence, spatial distribution, and temporal variability of leatherback turtles (*Dermochelys coriacea*) in nearshore waters of South Carolina, USA. Chelonian Conservation and Biology, Vol 5(2), pp 216-224.

Myers, RA, JK Baum, TD Shepherd, SP Powers, and CH Peterson. 2007. Cascading effects of the loss of apex predatory sharks from a coastal ocean. Science Magazine, Vol 315(5820), pp 1846-1850.

NJDEP. 2007. Status of the red knot (*Calidris canutus rufa*) in the Western Hemisphere. Environmental Report, New Jersey Department of Environmental Protection, 287 pp.

NMFS. 1998. Final Recovery Plan for the Shortnose Sturgeon (*Acipenser brevirostrum*). Shortnose Sturgeon Recovery Team for NOAA National Marine Fisheries Service, Silver Spring, MD, 104 pp.

NMFS. 2000. A protocol for use of shortnose and Atlantic sturgeons. NOAA Tech Memo NMFS-OPR-18, May 2000.

NMFS. 2003. Biological opinion on the effects of the Army Corps of Engineers dredging in Cape Henry Channel, York Spit Channel, York River Entrance Channel, and Rappahannock Shoal Channel, Virginia, on threatened and endangered species. National Marine Fisheries Service, NE Region, Gloucester, MA, 101 pp plus.

NMFS. 2009. River herring (alewife & blueback herring). Species of Concern, NOAA National Marine Fisheries Service, Silver Spring, MD, 8 pp.

NOAA. 2000. Assessment update for the Kemp's ridley and loggerhead sea turtle populations in the Western North Atlantic. Turtle Expert Working Group, US Department Commerce, NOAA Tech Mem NMFS-SEFSC-444, 115 pp.

NRC. 1990. Decline of Sea Turtles. National Research Council, National Academy Press, Washington, DC, 259 pp.

Plotkin, PT (ed). 1995. National Marine Fisheries Service and US Fish & Wildlife Service status reviews for sea turtles listed under the Endangered Species Act of 1973. National Marine Fisheries Service, Silver Spring, MD.

Rathbun, GB, RK Bonde, and D Clay. 1982. The status of the West Indian manatee on the Atlantic coast of Florida. In RR Odum and JW Guthrie (eds.), Proc Symposium for Nongame and Endangered Wildlife, Tech Bull WL 5, Georgia Dept Natural Resources, Social Circle, GA, pp 152–165.

Rathbun, GB, JP Reid, and G Carowan. 1990. Distribution and movement patterns of manatees (*Trichechus manatus*) in northwestern peninsular Florida. State of Florida, Department of Natural Resources, Florida Marine Research Institute, Publ No 48, December.

Reilly, FJ, and VJ Bellis. 1983. The ecological impact of beach nourishment with dredged materials on the intertidal zone at Bogue Banks, North Carolina. Misc Paper 83-3, USACE, CERC, Ft Belvoir, VA.

SCDNR. 2006, 2007. Logger headlines newsletter, December. South Carolina Department of Natural Resources, Marine Turtle Conservation Program, Charleston, 4 pp.

SCDNR. 2011. *North Island one of the densest sea turtle nesting beaches in SC*, DNR News, 18 July 2011. www.dnr.sc.gov/news/yr2011/july21/july21_turtle.html.

SCDNR. 2022. *ACE Characterization Study Species Gallery > Red Knot*. South Carolina Department of Natural Resources. https://www.dnr.sc.gov/marine/mrri/acechar/speciesgallery/Birds/RedKnot/index.html

Saloman, CH, and SP Naughton. 1984. Beach restoration with offshore dredged sand: effects on nearshore macrofauna. NOAA Tech Memo NMFS-SEF-133, U.S. Dept of Commerce.

Schwartz, FJ. 1977. *Caretta* (Linnaeus), Atlantic loggerhead; *Chelonia mydas* (Linnaeus), Altantic green turtle; *Eretmochelys imbricata* (Linnaeus), Atlantic hawksbill; *Lepidochelys kempi* (Garman), Atlantic ridley; *Dermochelys coriacea* (Linnaeus), Atlantic leatherback (pp 303-308). In JE Cooper, SS Robinson, and JB Funderburg (eds.), *Endangered and Threatened Plants and Animals of North Carolina*, NC State Museum of Natural History, Raleigh, NC, 444 pp.

USACE. 1993. Environmental assessment and finding of no significant impact. Disposal of dredged material on the ocean beach of Bogue Banks from combined maintenance dredging and deepening of Morehead City harbor and pumpout of Brandt Island upland diked disposal site, Carteret County, North Carolina. Wilmington District, U.S. Army Corps of Engineers, 12 pp + app.

USACE. 1995. Environmental assessment: channel realignment maintenance dredging, Masonboro Inlet, New Hanover County, North Carolina. U.S. Army Corps of Engineers, pp 9-15.

USACE (Burlas et al). 2001. The New York District's Biological Monitoring Program for the Atlantic Coast of New Jersey, Asbury Park to Manasquan Section Beach Erosion Control Project. Final Report, USACE, Waterways Experiment Station, Vicksburg, MS, 11 chapters.

USACE. 2004. A General Investigation Study for Hurricane and Storm Damage Reduction at Pawleys Island, South Carolina. Feasibility Report, US Army Corps of Engineers, Charleston District, SC, PWI 010606, 55 pp + appendices A–I.

USACE. 2005. Environmental Assessment and Finding of No Significant Impact (FONSI) for the Folly Beach, South Carolina, shore protection project. US Army Corps of Engineers, Charleston District, SC.

USACE. 2006. Appendix I – Biological Assessment. In Draft General Reevaluation Report and Environmental Impact Statement on Hurricane Protection and Beach Erosion Control: West Onslow Beach and New River Inlet (Topsail Beach), North Carolina. US Army Corps of Engineers, pp 11-I28.

USFWS. 1991. Endangered and Threatened Species of the Southeast United States. US Fish & Wildlife Service.

USFWS. 1996a. Piping plover (*Charadrius melodus*), Atlantic coast population, revised recovery plan. Hadley, MA, 258 pp.

USFWS. 1996b. Recovery plan for seabeach amaranth (*Amaranthus pumilus*). Southeast Region, Atlanta, GA.

USFWS. 2001. 50 CFR Part 7 endangered and threatened wildlife and plants: final determination of critical habitat for wintering piping plovers: final rule. Federal Register, Vol 66(132), 10 July 2001, pp 36038-36079.

USFWS. 2005. Red knot. US Fish & Wildlife Service (http://northeast.fws.gov).

USFWS. 2006. Biological opinion: Kiawah Island beach nourishment (P/N 2005-1W-310-P). US Department of the Interior, US Fish & Wildlife Service, Charleston, SC, 51 pp + app.

USFWS. 2011. Biological opinion: Captain Sams Inlet relocation, Seabrook Island (SC) (P/N SAC-2008-1870-21G). US Department of the Interior, USFWS, Charleston, SC, 116 pp.

USFWS. 2013. Rufa red knot (*Calidris canutus rufa*). US Fish & Wildlife Service: US Department of the Interior. Hadley, MA, 2 pp.

Van den Avyle, MJ. 1984. Species profiles: life histories and environmental requirements of coastal fishes and invertebrates (south Atlantic) – Atlantic sturgeon. USFWS Biol Rept 81(11.25), USACE Tech Rept EL-82-4, 17 pp.

Van Dolah, RF, PH Wendt, RM Martore, MV Levisen, and WA Roumillat. 1992. A physical and biological monitoring study of the Hilton Head Island beach nourishment project. Final Report to the Town of Hilton Head Island, South Carolina. SC Wildlife & Marine Resources Div, Charleston, 159 pp.

Van Dolah, RF, RM Martore, AE Lynch, PH Wendt, MV Levisen, DJ Whitaker, and WD Anderson. 1994. Environmental evaluation of the Folly Beach nourishment project. Final Report, USACE, Charleston District and the South Carolina Department of Natural Resources, Marine Resources Division, 101 pp.

Weakley, AS. 1986. Summary of Information on Seabeach Amaranth (Amaranthus pumilus). NCDHENR, Natural Heritage Program, Raleigh.

Weakley, AS, and MA Bucher. 1992. Status survey of seabeach amaranth (Amaranthus pumilus Rafinesque) in North and South Carolina. Report to the North Carolina Plant Conservation Program and Endangered Species Field Office. 178p.