

United States Department of the Interior

FISH AND WILDLIFE SERVICE
South Florida Ecological Services Office
1339 20th Street
Vero Beach, Florida 32960



March 9, 2006

Colonel Robert M. Carpenter
District Engineer
U.S. Army Corps of Engineers
701 San Marco Boulevard, Room 372
Jacksonville, Florida 32207-8175

Service Federal Activity Code: 41420-2006-FA-0075
Corps Public Notice: SAJ-2006-1212 (IP-AAZ)
Dated: February 22, 2006
Project: Blind Creek Restoration and South St. Lucie
Emergency Berm Remediation Project
Applicant: St. Lucie County Board of County
Commissioners
County: St. Lucie County

Dear Colonel Carpenter:

This document transmits the Fish and Wildlife Service's (Service) Biological Opinion based on our review of the Blind Creek restoration project at latitude 26° 59'44.48" north, longitude 80° 35'43.89" west and St. Lucie County's emergency berm remediation project at latitude 27° 27'92.60" north, longitude 80° 21'60.30" west, Hutchinson Island, St. Lucie County, Florida, and its effects on the threatened loggerhead sea turtle (*Caretta caretta*), the endangered green sea turtle (*Chelonia mydas*), the endangered leatherback sea turtle (*Dermochelys coriacea*), the endangered hawksbill sea turtle (*Eretmochelys imbricata*), the endangered Kemp's ridley sea turtle (*Lepidochelys kempii*), and the endangered wood stork (*Mycteria americana*). This biological opinion is provided in accordance with section 7 of the Endangered Species Act of 1973, as amended (ESA) (87 Stat. 884; 16 U.S.C. 1531 *et seq.*) and the Fish and Wildlife Coordination Act of 1958, as amended (48 Stat. 401; 16 U.S.C. 661 *et seq.*). Your request for formal consultation was received on February 22, 2006.

Because the project will restore coastal wetlands which were filled with sand as a result of hurricanes in 2004, we concur with your February 22, 2006, determination that the proposed project at Blind Creek "is not likely adversely affect" the wood stork.

We concur with your February 22, 2006, determination that the proposed action "is likely to adversely affect" the loggerhead, green, leatherback, hawksbill, and Kemp's ridley sea turtles.

This biological opinion is based on information provided by the U.S. Army Corps of Engineers (Corps), the Federal Emergency Management Agency (FEMA), St. Lucie County (Applicant),



Dickerson Mine Incorporated, Coastal Planning and Engineering (CPE), Hazen and Sawyer, Ecological Associates Incorporated (EAI), Coastal Tech, Post Buckley Shuh and Jernigan (PBS&J), the Florida Department of Environmental Protection (DEP), the Florida Fish and Wildlife Conservation Commission (FWC), telephone conversations, email correspondence, field investigations, and other sources. A complete administrative record of this consultation is on file at the South Florida Ecological Services Office, Vero Beach, Florida.

CONSULTATION HISTORY

On February 24, 2005, the Service provided technical assistance to FEMA concerning the 3.6-mile St. Lucie County emergency berm project. The purpose of the project was to create a flood control berm from DEP monuments R-88 to R-115.

On April 19, 2005, the Service conducted a site visit to the emergency berm remediation site and observed that material placed on the beach appeared to be incompatible with native beach material and that the berm had steep escarpments.

On April 20, 2005, the Service contacted DEP to discuss the emergency berm site visit.

On April 21, 2005, the Service informed FEMA via email of the April 19, 2004 site visit.

On May 17, 2005, DEP notified the Applicant of a possible permit violation concerning DEP permit SL-213.

On May 25, 2005, DEP contracted PBS&J to conduct a post construction assessment of the materials used in the emergency berm construction. PBS&J's report, published in July 2005, concluded that the emergency berm was not constructed with compatible beach material and did not satisfy DEP permit SL-213 conditions.

On November 18, 2005, the Service, FWC, National Marine Fisheries Service (NMFS), DEP, U.S. Environmental Protection Agency, the Applicant, CPE, Dickerson Mine, and their legal council met to discuss potential remediation strategies and expectations. It was agreed that the Applicant would explore an alternative remediation method and develop a plan for removal and replacement of the incompatible material before March 1, 2006. Dickerson Mine indicated that a proposal would be submitted within the first week of December 2005.

On December 29, 2005, the Applicant's attorney submitted a proposed remediation plan to DEP.

On January 12, 2006, the Service participated in a teleconference with DEP to discuss the proposed remediation plan. It was agreed that the Applicant's proposal to partially remove the existing material was insufficient to remediate the berm.

On February 3, 2006, the Service participated in a site visit with the Corps, the Applicant, and Hazen and Sawyer staff to discuss the new proposed sand source located at Blind Creek, and the restoration of approximately 5 acres of red mangrove (*Rhizophora mangle*) wetlands. It was

agreed that sand removed from the Blind Creek site, once cleaned, could be used to remediate the emergency berm site.

On February 7, the DEP issued a field permit (8020617-SL) to reconstruct portions of the emergency berm completed under DEP permit SL-213. Work was to be completed by February 28, 2006, before the commencement of the marine sea turtle nesting season.

On February 22, 2006, the Service received the Corps' request for formal consultation regarding the restoration of coastal wetlands at Blind Creek and use of excavated sand to restore the 3.6 miles of incompatible beach material between DEP monuments R-88 to R-90 and R-98 to R-115.

On February 27, 2006, the Service participated in a site visit with the Applicant and their consultants, Dickerson Mine staff, and DEP to evaluate the progress of the remediation. It was determined that approximately 1,500 to 2,000 feet of berm had not been removed and would not be completed before the February 28, 2006, deadline.

On March 2, 2006, DEP amended permit 8020617-SL to allow berm remediation activities to continue to March 10, 2006.

BIOLOGICAL OPINION

DESCRIPTION OF THE PROPOSED ACTION

Proposed Action

During two hurricane events in September 2004, approximately 3 to 6 feet of sand was deposited by storm surges into 5 acres (about 0.8 linear mile) of red mangrove wetlands located between Blind Creek and Little Mud Creek on Hutchinson Island, St. Lucie County, Florida (Figure 1). The Applicant proposes to restore these wetlands to pre-storm wetland elevations, by excavating about 60,000 cubic yards of beach quality sand from this area. In addition, culverts would be installed to allow tidal exchange. In total, approximately 15 acres of red mangrove wetlands will be restored and/or enhanced.

The material removed from the red mangrove restoration area will be placed along 3.6 miles of beach in southern St. Lucie County from DEP monuments R-88 to R-90 and R-98 to 115 at the St. Lucie - Martin County line (Figure 2). This beach quality material is identified as the preferred sand source for the remediation of South St. Lucie emergency berm project that was constructed in the spring of 2005. The material placed in 2005 was determined to be incompatible with beach material and was ordered by DEP to be removed and replaced with beach compatible material. The unsuitable material will be removed and placed at the bottom of a new cell of the St. Lucie County Landfill.

To ensure the excavated material will not contain incompatible material, the sand in the red mangrove restoration area will be processed through a sifter to remove the woody debris or large particulates. Once processed, the material will be stockpiled and trucked to the project site. The

Applicant has agreed to implement sediment quality control measures both at the sand source and deposition area to ensure beach compatibility. The Applicant states that all woody debris piles located between the excavation area and the beach will be removed before March 30, 2006. Once the debris piles are moved as landward as possible, the piles without sand will be burned at a later date. To minimize potential impacts to sea turtles at the restoration site, the Applicant has agreed to monitor sea turtle nesting activity and place a silt screen barrier on top of the existing dune at Blind Creek to prevent turtles from becoming entrapped in the debris piles or behind the dune. No nighttime work at the restoration site or sand placement area is anticipated.

The Applicant has also agreed to re-vegetate the berm with native, salt-tolerant beach vegetation. Since the berm planting is likely to occur during the sea turtle nesting season, the applicant has agreed to install irrigation and plant material by hand, per DEP permit requirements. No mechanical equipment will be used.

Action Area

The Service has determined that the action area for this project includes 3.6 miles of the emergency berm remediation area along southern St. Lucie County shoreline from DEP monuments R-88 to R-90 and R-98 to R-115. Since heavy equipment may be used during the removal of the debris piles at the excavation site, the action area also includes 4,000 feet of shoreline between Blind Creek and Little Mud Creek, from DEP monuments R-75.5 to R-79.

STATUS OF THE SPECIES AND CRITICAL HABITAT RANGEWIDE

Species/Critical Habitat Description

Loggerhead Sea Turtle

The loggerhead sea turtle, listed as a threatened species on July 28, 1978 (43 FR 32800), inhabits the continental shelves and estuarine environments along the margins of the Atlantic, Pacific, and Indian Oceans. Loggerhead sea turtles nest on coasts within the continental United States (U.S.) from Louisiana to Virginia. Major nesting concentrations in the U.S. are found on the coastal islands of North Carolina, South Carolina, and Georgia, and on the Atlantic and Gulf coasts of Florida (Hopkins and Richardson 1984).

No critical habitat has been designated for the loggerhead sea turtle.

Green Sea Turtle

The green sea turtle was federally listed as a protected species on July 28, 1978 (43 FR 32800). Breeding populations of the green turtle in Florida and along the Pacific Coast of Mexico are listed as endangered; all other populations are listed as threatened. The green sea turtle has a worldwide distribution in tropical and subtropical waters. Major green sea turtle nesting colonies in the Atlantic occur on Ascension Island, Aves Island, Costa Rica, and Surinam. Within the U.S., green sea turtles nest in small numbers in the U.S. Virgin Islands and Puerto Rico, and in

larger numbers along the east coast of Florida, particularly in Brevard, Indian River, St. Lucie, Martin, Palm Beach, and Broward Counties (NMFS and Service 1991a). Nesting also has been documented along the Gulf coast of Florida on Santa Rosa Island (Okaloosa and Escambia Counties) and from Pinellas County through Collier County (FWC 2004). Green sea turtles also nest sporadically in Georgia, North Carolina and South Carolina.

Critical habitat for the green sea turtle has been designated for the waters surrounding Culebra Island, Puerto Rico, and its outlying keys.

Leatherback Sea Turtle

The leatherback sea turtle, listed as an endangered species on June 2, 1970 (35 FR 8491), nests on the shores of the Atlantic, Pacific and Indian Oceans. Non-breeding animals have been recorded as far north as the British Isles and the Maritime Provinces of Canada and as far south as Argentina and the Cape of Good Hope (Pritchard 1992). Nesting grounds are distributed worldwide, with the Pacific Coast of Mexico supporting the world's largest known concentration of nesting leatherbacks. The largest nesting colony in the wider Caribbean region is found in French Guiana, but nesting occurs frequently, although in lesser numbers, from Costa Rica to Columbia and in Guyana, Surinam, and Trinidad (NMFS and Service 1992; National Research Council 1990).

The leatherback regularly nests in the U.S. in Puerto Rico, the U.S. Virgin Islands, and along the Atlantic coast of Florida as far north as Georgia (NMFS and Service 1992). Leatherback turtles occasionally nest in Georgia, South Carolina, and North Carolina (Murphy 1996; Winn 1996; Boettcher 1998). Leatherback nesting has also been reported on the northwest coast of Florida (LeBuff 1990; FWC 2004); a false crawl (non-nesting emergence) has been observed on Sanibel Island (LeBuff 1990).

Marine and terrestrial critical habitat for the leatherback sea turtle has been designated at Sandy Point on the western end of the island of St. Croix, U.S. Virgin Islands.

Hawksbill Sea Turtle

The hawksbill sea turtle was listed as an endangered species on June 2, 1970 (35 FR 8491). The hawksbill is found in tropical and subtropical seas of the Atlantic, Pacific, and Indian Oceans. The species is widely distributed in the Caribbean Sea and western Atlantic Ocean. Within the continental U.S., hawksbill sea turtle nesting is rare and is restricted to the southeastern coast of Florida (Volusia through Dade Counties) and the Florida Keys (Monroe County) (Meylan 1992; Meylan et al. 1995). However, hawksbill tracks are difficult to differentiate from those of loggerheads and may not be recognized by surveyors. Therefore, surveys in Florida likely underestimate actual hawksbill nesting numbers (Meylan et al. 1995). In the U.S. Caribbean, hawksbill nesting occurs on beaches throughout Puerto Rico and the U.S. Virgin Islands (NMFS and Service 1993).

Critical habitat for the hawksbill sea turtle has been designated for selected beaches and/or waters of Mona, Monito, Culebrita, and Culebra Islands, Puerto Rico.

Kemp's Ridley Sea Turtle

The Kemp's ridley sea turtle was listed as endangered on December 2, 1970 (35 FR 18320). The range of the Kemp's ridley includes the Gulf coasts of Mexico and the U.S., and the Atlantic coast of North America as far north as Nova Scotia and Newfoundland. Most Kemp's ridleys nest on the coastal beaches of the Mexican states of Tamaulipas and Vera Cruz, although a very small number nest consistently along the Texas coast (TEWG 1998). In addition, rare nesting events have been reported in Florida, Alabama, South Carolina, and North Carolina. Hatchlings, after leaving the beach, are believed to become entrained in eddies within the Gulf of Mexico, where they are dispersed within the Gulf and Atlantic by oceanic surface currents until they reach about 8 inches in length, at which size they enter coastal shallow water habitats (Ogren 1989). Outside of nesting, adult Kemp's ridleys are believed to spend most of their time in the Gulf of Mexico, while juveniles and subadults also regularly occur along the eastern seaboard of the United States (NMFS and Service 1992).

No critical habitat has been designated for the Kemp's Ridley sea turtle.

Life History

Loggerhead Sea Turtle

Loggerheads are known to nest from one to seven times within a nesting season (Talbert et al. 1980; Richardson and Richardson 1982; Lenarz et al. 1981); the mean is approximately 4.1 (Murphy and Hopkins 1984). The interval between nesting events within a season varies around a mean of about 14 days (Dodd 1988). Mean clutch size varies from about 100 to 126 along the southeastern U.S. coast (NMFS and Service 1991b). Nesting migration intervals of 2 to 3 years are most common in loggerheads, but the number can vary from 1 to 7 years (Dodd 1988). Age at sexual maturity is believed to be about 20 to 30 years (TEWG 1998).

Green Sea Turtle

Green sea turtles deposit from 1 to 9 clutches within a nesting season, but the average is about 3.3. The interval between nesting events within a season varies around a mean of about 13 days (Hirth 1997). Mean clutch size varies widely among populations. Average clutch size reported for Florida was 136 eggs in 130 clutches (Witherington and Ehrhart 1989). Only occasionally do females produce clutches in successive years. Usually 2, 3, 4 or more years intervene between breeding seasons (NMFS and Service 1991a). Age at sexual maturity is believed to be 20 to 50 years (Hirth 1997).

Leatherback Sea Turtle

Leatherbacks nest an average of 5 to 7 times within a nesting season, with an observed maximum of 11 (NMFS and Service 1992). The interval between nesting events within a season is about 9 to 10 days. Clutch size averages 80 to 85 yolked eggs, with the addition of usually a few dozen smaller, yolkless eggs, mostly laid toward the end of the clutch (Pritchard 1992). Nesting migration intervals of 2 to 3 years were observed in leatherbacks nesting on the Sandy Point National Wildlife Refuge, St. Croix, U.S. Virgin Islands (McDonald and Dutton 1996). Leatherbacks are believed to reach sexual maturity in 6 to 10 years (Zug and Parham 1996).

Hawksbill Sea Turtle

Hawksbills nest on average about 4.5 times per season at intervals of approximately 14 days (Corliss et al. 1989). In Florida and the U.S. Caribbean, clutch size is approximately 140 eggs, although several records exist of over 200 eggs per nest (NMFS and Service 1993). On the basis of limited information, nesting migration intervals of 2 to 3 years predominate. Hawksbills are recruited into the reef environment at about 14 inches in length and are believed to begin breeding about 30 years later. However, the time required to reach 14 inches in length is unknown and growth rates vary geographically. As a result, age at sexual maturity is not known.

Kemp's Ridley Sea Turtle

Nesting occurs from April into July during which time the turtles appear off the Tamaulipas and Vera Cruz coasts of Mexico. Precipitated by strong winds, the females swarm to mass nesting emergences, known as arribadas or arribazones, to nest during daylight hours. Clutch size averages 100 eggs (NMFS and Service 1992). Some females breed annually and nest an average of 1 to 4 times in a season at intervals of 10 to 28 days. Age at sexual maturity is believed to be between 7 to 15 years (TEWG 1998).

Population Dynamics

Loggerhead Sea Turtle

Total estimated nesting in the Southeast U.S. is approximately 68,000 to 90,000 nests per year, according to the FWC statewide nesting database 2002, the Georgia Department of Natural Resources statewide nesting database 2002, the South Carolina Department of Natural Resources statewide nesting database 2002, and the North Carolina Wildlife Resources Commission statewide nesting database 2002. In 1998, there were over 80,000 nests in Florida alone. From a global perspective, the southeastern U.S. nesting aggregation is of paramount importance to the survival of the species and is second in size only to that which nests on islands in the Arabian Sea off Oman (Ross 1982; Ehrhart 1989; NMFS and Service 1991b). The status of the Oman colony has not been evaluated recently (Meylan et al. 1995). The loggerhead nesting aggregations in Oman, the southeastern U.S., and Australia account for about 88 percent of nesting worldwide (NMFS and Service 1991b). About 80 percent of loggerhead nesting in the

southeastern U.S. occurs in 6 Florida counties (Brevard, Indian River, St. Lucie, Martin, Palm Beach, and Broward Counties) (NMFS and Service 1991b).

Green Sea Turtle

About 150 to 2,750 females are estimated to nest on beaches in the continental U.S. annually (FWC 2004). In the U.S. Pacific, over 90 percent of nesting throughout the Hawaiian archipelago occurs at the French Frigate Shoals, where about 200 to 700 females nest each year (NMFS and Service 1998). Elsewhere in the U.S. Pacific, nesting takes place at scattered locations in the Commonwealth of the Northern Marianas, Guam, and American Samoa. In the western Pacific, the largest green sea turtle nesting aggregation in the world occurs on Raine Island, Australia, where thousands of females nest nightly in an average nesting season (Limpus et al. 1979). In the Indian Ocean, major nesting beaches occur in Oman where 30,000 females are reported to nest annually (Ross and Barwani 1995).

Leatherback Sea Turtle

Recent estimates of global nesting populations indicate 26,000 to 43,000 nesting females annually (Spotila et al. 1996). The largest nesting populations at present occur in the western Atlantic in French Guiana (4,500 to 7,500 females nesting per year) and Colombia (estimated several thousand nests annually), and in the western Pacific in West Papua (formerly Irian Jaya) and Indonesia (about 600 to 650 females nesting per year). In the U.S., small nesting populations occur on the Florida east coast (100 females per year) (FWC 2004), Sandy Point, U.S. Virgin Islands (50 to 190 females per year) (Alexander et al. 2002), and Puerto Rico (30 to 90 females per year).

Hawksbill Sea Turtle

About 15,000 females are estimated to nest each year throughout the world with the Caribbean accounting for 20 to 30 percent of the world's hawksbill population (Meylan 1989). Only five regional populations remain with more than 1,000 females nesting annually (Seychelles, Mexico, Indonesia, and two in Australia) (Meylan and Donnelly 1999). Mexico is now the most important region for hawksbills in the Caribbean with 3,000 nests per year (Meylan 1989). Other significant but smaller populations in the Caribbean still occur in Martinique, Jamaica, Guatemala, Nicaragua, Grenada, Dominican Republic, Turks and Caicos Islands, Cuba, Puerto Rico, and U.S. Virgin Islands. In the U.S. Caribbean, about 100 to 500 nests per year are laid on Mona Island, Puerto Rico, and 70 to 130 nests per year on Buck Island Reef National Monument, U.S. Virgin Islands. In the U.S. Pacific, hawksbills nest only on main island beaches in Hawaii, primarily along the east coast of the island of Hawaii. Hawksbill nesting has also been documented in American Samoa and Guam (NMFS and Service 1998).

Kemp's Ridley Sea Turtle

The 40,000 nesting females estimated from a single mass nesting emergence in 1947 reflected a much larger total number of nesting turtles in that year than exists today (Carr 1963; Hildebrand

1963). However, nesting in Mexico has steadily increased from 702 nests in 1985 to over 6,000 nests in 2000 (Service 2001). Despite protection for the nests, turtles have been and continue to be lost to incidental catch by shrimp trawls (NMFS and Service 1992).

Status and Distribution

Loggerhead Sea Turtle

Genetic research involving analysis of mitochondrial DNA has identified five different loggerhead nesting subpopulations in the western North Atlantic: (1) the Northern Subpopulation occurring from North Carolina to around Cape Canaveral, Florida (about 29° North); (2) the South Florida Subpopulation occurring from about 29° North on Florida's east coast to Sarasota on Florida's west coast; (3) the Dry Tortugas, Florida, Subpopulation; (4) the Northwest Florida Subpopulation occurring at Eglin Air Force Base and the beaches near Panama City; and (5) the Yucatán Subpopulation occurring on the eastern Yucatán Peninsula, Mexico (Bowen 1994, 1995; Bowen et al. 1993; Encalada et al. 1998; Pearce 2001). These data indicate gene flow between these five regions is very low. If nesting females are extirpated from one of these regions, regional dispersal will not be sufficient to replenish the depleted nesting subpopulation. The Northern Subpopulation has declined substantially since the early 1970s, but most of that decline occurred prior to 1979. No significant trend has been detected in recent years (TEWG 1998, 2000). Adult loggerheads of the South Florida Subpopulation have shown significant increases over the last 25 years, indicating the population is recovering, although a trend could not be detected from the State of Florida's Index Nesting Beach Survey program from 1989 to 2002. Nesting surveys in the Dry Tortugas, Northwest Florida, and Yucatán Subpopulations have been too irregular to date, to allow for a meaningful trend analysis (TEWG 1998, 2000).

Threats include incidental take from channel dredging and commercial trawling, longline, and gill net fisheries; loss or degradation of nesting habitat from coastal development and beach armoring; disorientation of hatchlings by beachfront lighting; excessive nest predation by native and non-native predators; degradation of foraging habitat; marine pollution and debris; watercraft strikes; and disease. There is particular concern about the extensive take of juvenile loggerheads in the eastern Atlantic by longline fishing vessels from several countries.

Green Sea Turtle

Total population estimates for the green sea turtle are unavailable, and trends based on nesting data are difficult to assess because of large annual fluctuations in numbers of nesting females. For instance, in Florida, where the majority of green sea turtle nesting in the southeastern U.S. occurs, estimates range from 150 to 2,750 females nesting annually (FWC 2004). Populations in Surinam, and Tortuguero, Costa Rica, may be stable, but there is insufficient data for other areas to confirm a trend.

A major factor contributing to the green turtle's decline worldwide is commercial harvest for eggs and food. Fibropapillomatosis, a disease of sea turtles characterized by the development of

multiple tumors on the skin and internal organs, is also a mortality factor and has seriously impacted green sea turtle populations in Florida, Hawaii, and other parts of the world. The tumors interfere with swimming, eating, breathing, vision, and reproduction, and turtles with heavy tumor burdens may die. Other threats include loss or degradation of nesting habitat from coastal development and beach armoring; disorientation of hatchlings by beachfront lighting; excessive nest predation by native and non-native predators; degradation of foraging habitat; marine pollution and debris; watercraft strikes; and incidental take from channel dredging and commercial fishing operations.

Leatherback Sea Turtle

Declines in leatherback nesting have occurred over the last two decades along the Pacific coasts of Mexico and Costa Rica. The Mexican leatherback nesting population, once considered to be the world's largest leatherback nesting population (65 percent of the worldwide population), is now less than 1 percent of its estimated size in 1980. Spotila et al. (1996) estimated the number of leatherback sea turtles nesting on 28 beaches throughout the world from the literature and from communications with investigators studying those beaches. The estimated worldwide population of leatherbacks in 1995 was about 34,500 females on these beaches with a lower limit of about 26,200 and an upper limit of about 42,900. This is less than one-third the 1980 estimate of 115,000. Leatherbacks are rare in the Indian Ocean and in very low numbers in the western Pacific Ocean. The largest population is in the western Atlantic. Using an age-based demographic model, Spotila et al. (1996) determined that leatherback populations in the Indian Ocean and western Pacific Ocean cannot withstand even moderate levels of adult mortality and that even the Atlantic populations are being exploited at a rate that cannot be sustained. They concluded that leatherbacks are on the road to extinction and further population declines can be expected unless we take action to reduce adult mortality and increase survival of eggs and hatchlings.

The crash of the Pacific leatherback population is believed primarily to be the result of exploitation by humans for the eggs and meat, as well as incidental take in numerous commercial fisheries of the Pacific. Other factors threatening leatherbacks globally include loss or degradation of nesting habitat from coastal development; disorientation of hatchlings by beachfront lighting; excessive nest predation by native and non-native predators; degradation of foraging habitat; marine pollution and debris; and watercraft strikes.

Hawksbill Sea Turtle

The hawksbill sea turtle has experienced global population declines of 80 percent or more during the past century and continued declines are projected (Meylan and Donnelly 1999). Most populations are declining, depleted, or remnants of larger aggregations. Hawksbills were previously abundant, as evidenced by high-density nesting at a few remaining sites and by trade statistics. The decline of this species is primarily due to human exploitation for tortoiseshell. While the legal hawksbill shell trade ended when Japan agreed to stop importing shell in 1993, a significant illegal trade continues. It is believed that individual hawksbill populations around the world will continue to disappear under the current regime of exploitation for eggs, meat, and

tortoiseshell, loss of nesting and foraging habitat, incidental capture in fishing gear, ingestion of and entanglement in marine debris, oil pollution, and boat collisions. Hawksbills are closely associated with coral reefs, one of the most endangered of all marine ecosystem types.

Kemp's Ridley Sea Turtle

The decline of this species was primarily due to human activities, including the direct harvest of adults and eggs and incidental capture in commercial fishing operations. Today, under strict protection, the population appears to be in the early stages of recover. The recent nesting increase can be attributed to full protection of nesting females and their nests in Mexico resulting from a bi-national effort between Mexico and the U.S. to prevent the extinction of the Kemp's ridley, and the requirement to use turtle excluder devices in shrimp trawls both in the United States and Mexico.

Analysis of the Species/Critical Habitat Likely to be Affected

The proposed action has the potential to adversely affect nesting females, nests, and hatchlings within the proposed project area. The effects of the proposed action on sea turtles will be considered further in the remaining sections of this biological opinion. Potential effects include destruction of nests deposited within the boundaries of the proposed project, harassment in the form of disturbing or interfering with female turtles attempting to nest within the construction area or on adjacent beaches as a result of construction activities, disorientation of hatchling turtles on beaches adjacent to the construction area as they emerge from the nest and crawl to the water as a result of project lighting, and behavior modification of nesting females due to escarpment formation within the project area during a nesting season resulting in false crawls or situations where they choose marginal or unsuitable nesting areas to deposit eggs. The quality of the placed sand could affect the ability of female turtles to nest, the suitability of the nest incubation environment, and the ability of hatchlings to emerge from the nest.

Critical habitat has not been designated in the continental United States; therefore, the proposed action would not result in an adverse modification.

ENVIRONMENTAL BASELINE

In 2004, St. Lucie County accounted for about 8.6 percent of the overall sea turtle nesting activity in the state of Florida (FWC 2004). Among the Atlantic coastal counties (Nassau, Duval, St. John's, Flagler, Volusia, Brevard, Indian River, St. Lucie, Martin, Broward, Miami-Dade, and Monroe), St. Lucie County supported about 9.5 percent of the overall sea turtle nesting in 2004 (FWC 2004). Green, leatherback, and loggerhead sea turtles have the highest nesting densities from Brevard County to Palm Beach County. Hawksbill and Kemp's ridley sea turtle nest infrequently along St. Lucie County's shoreline.

Status of the Species/Critical Habitat Within the Action Area

Since 1995, approximately 2 miles of beach in south St. Lucie County have been monitored by EAI and others for sea turtle nesting activity as a control site for Martin County beach renourishment activities. The following discussion regarding loggerhead, green, and leatherback sea turtle nesting is based upon the monitoring data provided by EAI (Bob Ernest, EAI electronic mail letter, March 2, 2006).

Loggerhead Sea Turtle

The loggerhead sea turtle nesting and hatching season for south Florida Atlantic beaches (Brevard through Miami-Dade Counties) extends from March 15 through November 30. Incubation ranges from 45 to 95 days.

Between 2000 and 2005, the number of loggerhead sea turtle nests deposited in the project area that was surveyed ranged from a low of 834 nests in 2005 to a high of 1,771 nests in 2000. The average number of nests was 1,661. The number of loggerhead emergences ranged from a high of 5,264 in 2005 to a low of 1,857 in 2004 with the average number of emergences at 3,733. The number of false crawls during this period ranged from a high of 4,430 in 2005 to a low of 791 in 2004 with the average number of false crawls at 2,072 (Figure 3).

Green Sea Turtle

The green sea turtle nesting and hatching season for south Florida Atlantic beaches (Brevard through Miami-Dade Counties) extends from May 1 through November 30. Incubation ranges from about 45 to 75 days.

Between 2000 and 2005, the number of green sea turtle nests deposited in the project area that was surveyed ranged from a low of 14 nests in 2001 to a high of 229 nests in 2002. The average number of nests was 131. The number of green sea turtle emergences ranged from a high of 803 in 2005 to a low of 15 in 2001 with the average number of emergences at 348. The number of false crawls during this period ranged from a high of 671 in 2005 to a low of 1 in 2001 with the average number of false crawls at 217 (Figure 3).

Leatherback Sea Turtle

The leatherback sea turtle nesting and hatching season for south Florida Atlantic beaches (Brevard through Miami-Dade Counties) extends from February 15 through November 15. Incubation ranges from about 55 to 75 days.

Between 2000 and 2005, the number of leatherback sea turtle nests deposited in the project area that was surveyed ranged from a low of 8 nests in 2000 to a high of 35 nests in 2001. The average number of nests was 28. The number of leatherback sea turtle emergences ranged from a high of 46 in 2001 to a low of 10 in 2000 with the average number of emergences at 41. The

number of false crawls during this period ranged from a high of 26 in 2005 to a low of 2 in 2000 with the average number of false crawls at 14 (Figure 3).

Hawksbill Sea Turtle

The hawksbill sea turtle nesting and hatching season for south Florida Atlantic beaches (Brevard through Miami-Dade Counties) extends from June 1 through December 31. Incubation lasts about 60 days. Between the periods from 1979 to 2004 there has not been a documented hawksbill sea turtle nest in St. Lucie County.

Kemp's Ridley Sea Turtle

Kemp's ridley sea turtles rarely nest in the U.S., with no more than 30 nests in any one year (TEWG 2000). Between the periods from 1979 to 2004 there has not been a documented Kemp's ridley sea turtle nest in St. Lucie County.

Factors Affecting the Species Habitat Within the Action Area

In 2004, the Action Area was affected by Hurricanes Frances and Jeanne. Hurricane Frances passed through the area on September 5 destroying all of the sea turtle nests that were incubating at the time. One additional green sea turtle nest was laid after the passage of Hurricane Frances. This nest was subsequently destroyed by the passage of Hurricane Jeanne on September 26. As a result, 31.9 percent of the sea turtle nests laid during the 2005 nesting season were destroyed by the two hurricanes. Substantial changes in the beach profile and damage to dunes and dune vegetation occurred during the hurricanes. In many areas, the dune and all dune vegetation was destroyed and many beachfront structures were severely damaged.

The absence of a dune in many areas left numerous beachfront structures vulnerable to additional damage associated with erosion. To prevent further damage, the South St. Lucie County emergency berm project, was undertaken. Construction took place from March 1 through April 30, 2005. The emergency berm project involved transporting sand by truck from an inland borrow site and placing it along the beach in southern St. Lucie County. The material placed in 2005 was determined to be incompatible with beach material and was ordered by DEP to be removed and replaced with beach compatible material.

Other factors that may affect the species environment within the action area include, but are not limited to artificial lighting, man-made structures, and public and private land protection efforts. Development activities may result in avoidance or limited use of suitable nesting habitat by sea turtles as well as habitat loss, habitat fragmentation, and habitat degradation.

EFFECTS OF THE ACTION

This section includes an analysis of the direct and indirect effects of the proposed action on nesting sea turtles and the interrelated and interdependent activities of those effects.

Factors to be Considered

The proposed action has the potential to adversely affect nesting females, nests, and hatchlings within the proposed project area through the placement of sand on south St. Lucie County beaches. Wetland restoration activities are expected along 0.8 mile adjacent to suitable nesting habitat and sand placement is expected to occur along approximately 3.6 miles of suitable sea turtle nesting habitat, however construction is will not occur main portion of the sea turtle nesting season (May 1 through October 31).

Analyses for Effects of the Action

Beneficial Effects

The placement of sand on a beach with reduced dry fore-dune habitat may increase sea turtle nesting habitat if the placed sand is compatible (*i.e.*, grain size, shape, color, etc.) with naturally occurring beach sediments in the area, and compaction and escarpment remediation measures are incorporated into the project. In addition, a nourished beach or berm that is designed and constructed to mimic a natural beach system may be more stable than the eroding one it replaces, thereby benefiting sea turtles.

Direct Effects

Placement of sand on a beach in and of itself may not provide suitable nesting habitat for sea turtles. Although beach nourishment or berm creation may increase the potential nesting area, significant negative impacts to sea turtles may result if protective measures are not incorporated during project construction. Berm construction during the nesting season, particularly on or near high density nesting beaches, can cause increased loss of eggs and hatchlings and, along with other mortality sources, may significantly impact the long-term survival of the species. For instance, projects conducted during the nesting and hatching season could result in the loss of sea turtles through disruption of adult nesting activity and by burial or crushing of nests or hatchlings.

Structures placed on the beach, including debris placed landward of the dune, can result in avoidance by nesting females or entanglement of nesting females or hatchlings.

While a nest monitoring and egg relocation program would reduce these impacts, nests may be inadvertently missed (when crawls are obscured by rainfall, wind, and/or tides) or misidentified as false crawls during daily patrols. In addition, nests may be destroyed by operations at night prior to beach patrols being performed. Even under the best of conditions, about 7 percent of the nests can be misidentified as false crawls by experienced sea turtle nest surveyors (Schroeder 1994).

1. Nest relocation

Besides the potential for missing nests during a nest relocation program, there is a potential for eggs to be damaged by their movement, particularly if eggs are not relocated within 12 hours of deposition (Limpus et al. 1979). Nest relocation can have adverse impacts on incubation temperature (and hence sex ratios), gas exchange parameters, hydric environment of nests, hatching success, and hatchling emergence (Limpus et al. 1979; Ackerman 1980; Parmenter 1980; Spotila et al. 1983; McGehee 1990). Relocating nests into sands deficient in oxygen or moisture can result in mortality, morbidity, and reduced behavioral competence of hatchlings. Water availability is known to influence the incubation environment of the embryos and hatchlings of turtles with flexible-shelled eggs, which has been shown to affect nitrogen excretion (Packard et al. 1984), mobilization of calcium (Packard and Packard 1986), mobilization of yolk nutrients (Packard et al. 1985), hatchling size (Packard et al. 1981; McGehee 1990), energy reserves in the yolk at hatching (Packard et al. 1988), and locomotory ability of hatchlings (Miller et al. 1987). In a 1994 Florida study comparing loggerhead hatching and emergence success of relocated nests with nests, Moody (1998) found that hatching success was lower in relocated nests at 9 of 12 beaches evaluated and emergence success was lower in relocated nests at 10 of 12 beaches surveyed in 1993 and 1994.

2. Missed nests

Although a nesting survey and nest marking program would reduce the potential for nests to be impacted by construction activities, nests may inadvertently be missed (when crawls are obscured by rainfall, wind, and/or tides) or misidentified as false crawls during daily patrols. Even under the best conditions, about 7 percent of nests can be misidentified as false crawls by experienced sea turtle nest surveyors (Schroeder 1994).

3. Equipment

The placement of pipelines and the use of heavy machinery on the beach during a construction project may also have adverse effects on sea turtles. They can create barriers to nesting females emerging from the surf and crawling up the beach, causing a higher incidence of false crawls and unnecessary energy expenditure.

4. Artificial lighting

Visual cues are the primary sea-finding mechanism for hatchling sea turtles (Mrosovsky and Carr 1967; Mrosovsky and Shettleworth 1968; Dickerson and Nelson 1989; Witherington and Bjorndal 1991). When artificial lighting is present on or near the beach, it can misdirect hatchlings once they emerge from their nests and prevent them from reaching the ocean (Philbosian 1976; Mann 1977). In addition, a significant reduction in sea turtle nesting activity has been documented on beaches illuminated with artificial lights (Witherington 1992). Therefore, construction lights along a project beach and on the dredging vessel may deter females from coming ashore to nest, misdirect females trying to return to the surf after a nesting event, and misdirect emergent hatchlings from adjacent non-project beaches. Any source of

bright lighting can profoundly affect the orientation of hatchlings, both during the crawl from the beach to the ocean and once they begin swimming offshore. Hatchlings attracted to light sources on dredging barges may not only suffer from interference in migration, but may also experience higher probabilities of predation to predatory fishes that are also attracted to the barge lights. This impact could be reduced by using the minimum amount of light necessary (may require shielding) or low pressure sodium lighting during project construction.

5. Debris

Woody debris removed during the sand removal and red mangrove restoration in Blind Creek will likely be piled east of the excavation site. Nesting sea turtles or hatchlings may encounter the debris piles and become entangled. This impact can be reduced by relocating and disposing of the debris to the western most portions of the project site, but outside of the remaining wetlands. Burning of the debris should occur during daylight hours and completely extinguished before nightfall to avoid potential risks to sea turtles that may be attracted to the fire or smoldering embers.

Indirect Effects

Many of the direct effects of beach nourishment and berm construction may persist over time and become indirect impacts. These indirect effects include increased susceptibility of relocated nests to catastrophic events, the consequences of potential increased beachfront development, changes in the physical characteristics of the beach, the formation of escarpments, and future sand migration.

1. Increased susceptibility to catastrophic events

Nest relocation may concentrate eggs in an area making them more susceptible to catastrophic events. Hatchlings released from concentrated areas also may be subject to greater predation rates from both land and marine predators, because the predators learn where to concentrate their efforts (Glenn 1998; Wyneken et al. 1998).

2. Increased beachfront development

Pilkey and Dixon (1996) state that beach replenishment frequently leads to more development in greater density within shorefront communities that are then left with a future of further replenishment or more drastic stabilization measures. Dean (1999) also notes that the very existence of a beach nourishment project can encourage more development in coastal areas. Following completion of a beach nourishment project in Miami during 1982, investment in new and updated facilities substantially increased tourism there (National Research Council 1995). Increased building density immediately adjacent to the beach often resulted as older buildings were replaced by much larger ones that accommodated more beach users. Overall, shoreline management creates an upward spiral of initial protective measures resulting in more expensive development which leads to the need for more and larger protective measures. Increased shoreline development may adversely affect sea turtle nesting success. Greater development

may support larger populations of mammalian predators, such as foxes and raccoons, than undeveloped areas (National Research Council 1990), and can also result in greater adverse effects due to artificial lighting, as discussed above.

3. Changes in the physical environment

Beach nourishment and berm construction may result in changes in sand density (compaction), beach shear resistance (hardness), beach moisture content, beach slope, sand color, sand grain size, sand grain shape, and sand grain mineral content if the placed sand is dissimilar from the original beach sand (Nelson and Dickerson 1988a). These changes could result in adverse impacts on nest site selection, digging behavior, clutch viability, and emergence by hatchlings (Nelson and Dickerson 1987; Nelson 1988).

Beach compaction and unnatural beach profiles that may result from beach nourishment or berm construction activities could negatively impact sea turtles regardless of the timing of projects. Very fine sand and/or the use of heavy machinery can cause sand compaction on nourished beaches (Nelson et al. 1987; Nelson and Dickerson 1988a). Significant reductions in nesting success (*i.e.*, false crawls occurred more frequently) have been documented on severely compacted nourished beaches (Fletemeyer 1980; Raymond 1984; Nelson and Dickerson 1987; Nelson et al. 1987), and increased false crawls may result in increased physiological stress to nesting females. Sand compaction may increase the length of time required for female sea turtles to excavate nests and also cause increased physiological stress to the animals (Nelson and Dickerson 1988c). Nelson and Dickerson (1988b) concluded that, in general, beaches nourished from offshore borrow sites are harder than natural beaches, and while some may soften over time through erosion and accretion of sand, others may remain hard for 10 years or more.

These impacts can be minimized by using suitable sand and by tilling compacted sand after project completion. The level of compaction of a beach can be assessed by measuring sand compaction using a cone penetrometer (Nelson 1987). Tilling of a nourished beach with a root rake may reduce the sand compaction to levels comparable to unnourished beaches. However, a pilot study by Nelson and Dickerson (1988c) showed that a tilled nourished beach will remain uncompacted for up to 1 year. Therefore, the Service requires multi-year beach compaction monitoring and, if necessary, tilling to ensure that project impacts on sea turtles are minimized.

A change in sediment color on a beach could change the natural incubation temperatures of nests in an area, which, in turn, could alter natural sex ratios. To provide the most suitable sediment for nesting sea turtles, the color of the nourished sediments must resemble the natural beach sand in the area. Natural reworking of sediments and bleaching from exposure to the sun would help to lighten dark nourishment sediments; however, the timeframe for sediment mixing and bleaching to occur could be critical to a successful sea turtle nesting season.

4. Escarpment formation

On nourished beaches, steep escarpments may develop along their water line interface as they adjust from an unnatural construction profile to a more natural beach profile (Coastal

Engineering Research Center 1984; Nelson et al. 1987). These escarpments can hamper or prevent access to nesting sites (Nelson and Blihovde 1998). Researchers have shown that female turtles coming ashore to nest can be discouraged by the formation of an escarpment, leading to situations where they choose marginal or unsuitable nesting areas to deposit eggs (*e.g.*, in front of the escarpments, which often results in failure of nests due to prolonged tidal inundation). This impact can be minimized by leveling any escarpments prior to the nesting season.

Species' Response to the Proposed Action

Ernest and Martin (1999) conducted a comprehensive study to assess the effects of beach nourishment on loggerhead sea turtle nesting and reproductive success. The following findings illustrate sea turtle responses to and recovery from a nourishment project. A significantly larger proportion of turtles emerging on nourished beaches abandoned their nesting attempts than turtles emerging on Control or pre-nourished beaches. This reduction in nesting success was most pronounced during the first year following project construction and is most likely the result of changes in physical beach characteristics associated with the nourishment project (*e.g.*, beach profile, sediment grain size, beach compaction, frequency, and extent of escarpments). During the first post-construction year, the time required for turtles to excavate an egg chamber on the untilled, hard-packed sands of one treatment area increased significantly relative to Control and background conditions. However, in another treatment area, tilling was effective in reducing sediment compaction to levels that did not significantly prolong digging times. As natural processes reduced compaction levels on nourished beaches during the second post-construction year, digging times returned to background levels.

During the first post-construction year, nests on the nourished beaches were deposited significantly farther from both the toe of the berm and the tide line than nests on Control beaches. Furthermore, nests were distributed throughout all available habitats and were not clustered near the berm as they were in the Control. As the width of nourished beaches decreased during the second year, among-treatment differences in nest placement diminished. More nests were washed out on the wide, flat beaches of the nourished treatments than on the narrower steeply sloped beaches of the Control. This phenomenon persisted through the second post-construction year monitoring and resulted from the placement of nests near the seaward edge of the beach berm where dramatic profile changes, caused by erosion and scarping, occurred as the beach equilibrated to a more natural contour.

As with other beach nourishment projects, Ernest and Martin (1999) found the principal effect of nourishment on sea turtle reproduction was a reduction in nesting success during the first year following project construction. Although most studies have attributed this phenomenon to an increase in beach compaction and escarpment formation, Ernest and Martin (1999) indicate that changes in beach profile may be more important. Regardless, as a nourished beach is reworked by natural processes in subsequent years and adjusts from an unnatural construction profile to a more natural beach profile, beach compaction and the frequency of escarpment formation decline, and nesting and nesting success return to levels found on natural beaches.

CUMULATIVE EFFECTS

Cumulative effects include the effects of future State, tribal, local, or private actions that are reasonably certain to occur in the action area considered in this biological opinion. Future Federal actions that are unrelated to the proposed action are not considered in this section because they require separate consultation pursuant to section 7 of the ESA. The Service is not aware of any cumulative effects in the project area.

CONCLUSION

After reviewing the current status of the loggerhead, green, leatherback, hawksbill, and Kemp's ridley sea turtles, the environmental baseline for the action area, the effects of the wetland restoration project and proposed berm remediation, and the cumulative effects, it is the Service's biological opinion that these projects, as proposed, are not likely to jeopardize the continued existence of the loggerhead, green sea turtle, leatherback, hawksbill, and Kemp's ridley sea turtles, and are not likely to destroy or adversely modify designated critical habitat. No critical habitat has been designated in the project area for the loggerhead, green, leatherback, hawksbill, or Kemp's ridley sea turtle; therefore, none will be affected.

The proposed project will affect only 4.4 miles of the approximately 1,400 miles of available sea turtle nesting habitat in the southeastern U.S. Research has shown that the principal effect of beach nourishment on sea turtle reproduction is a reduction in nesting success, and this reduction is most often limited to the first year following project construction. Research has also shown that the impacts of a nourishment project on sea turtle nesting habitat are typically short-term because a nourished beach will be reworked by natural processes in subsequent years, and beach compaction and the frequency of escarpment formation will decline. Although a variety of factors, including some that cannot be controlled, can influence how a nourishment or berm construction project will perform from an engineering perspective, measures can be implemented to minimize impacts to sea turtles.

INCIDENTAL TAKE STATEMENT

Section 9 of the ESA and Federal regulation pursuant to section 4(d) of the Act prohibit the take of endangered or threatened species, respectively, without special exemption. Take is defined as to harass, harm, pursue, hunt, shoot, wound, kill, trap, capture or collect, or to attempt to engage in any such conduct. Harm is further defined by the Service to include significant habitat modification or degradation that results in death or injury to listed species by significantly impairing essential behavioral patterns, including breeding, feeding, or sheltering. Harass is defined by the Service as intentional or negligent actions that create the likelihood of injury to listed species to such an extent as to significantly disrupt normal behavior patterns which include, but are not limited to, breeding, feeding, or sheltering. Incidental take is defined as take that is incidental to, and not the purpose of, carrying out an otherwise lawful activity. Under the terms of section 7(b)(4) and section 7(o)(2), taking that is incidental to and not intended as part of the agency action is not considered to be prohibited under the ESA provided that such taking is in compliance with the terms and conditions of this incidental take statement.

The measures described below are non-discretionary, and must be implemented by the Corps so that they become binding conditions of any grant or permit issued to the applicant, as appropriate, for the exemption in section 7(o)(2) to apply. The Corps has a continuing duty to regulate the activity covered by this incidental take statement. If the Corps (1) fails to assume and implement the terms and conditions or (2) fails to require the applicant to adhere to the terms and conditions of the incidental take statement through enforceable terms that are added to the permit or grant document, the protective coverage of section 7(o)(2) may lapse. In order to monitor the impact of incidental take, the Corps must report the progress of the action and its impacts on the species to the Service as specified in the incidental take statement [50 CFR §402.14(i)(3)].

AMOUNT OR EXTENT OF TAKE

The Service anticipates 3.6 miles of nesting beach habitat could be taken as a result of the berm remediation project and 0.8 mile of nesting beach habitat could be taken as a result of the wetland restoration project. The take is expected to be in the form of: (1) destruction of all nests that may be constructed and eggs that may be deposited and missed by a nest survey and egg relocation program within the boundaries of the proposed project; (2) destruction of all nests deposited during the period when a nest survey and egg relocation program is not required to be in place within the boundaries of the proposed project; (3) reduced hatching success due to egg mortality during relocation and adverse conditions at the relocation site; (4) harassment in the form of disturbing or interfering with female turtles attempting to nest within the construction area or on adjacent beaches as a result of construction activities; (5) misdirection of hatchling turtles on beaches adjacent to the construction area as they emerge from the nest and crawl to the water as a result of project lighting; (6) behavior modification of nesting females due to escarpment formation within the project area during a nesting season, resulting in false crawls or situations where they choose marginal or unsuitable nesting areas to deposit eggs; and (7) behavior modification of nesting females due to the debris piles located at the mangrove restoration area resulting in false crawls or entrapment of sea turtle adults or hatchlings, and (8) destruction of nests from escarpment leveling within a nesting season when such leveling has been approved by the Service.

Incidental take is anticipated for only the 3.6 miles of beach that has been identified for sand placement and the 0.8 miles identified for wetland restoration. The Service anticipates incidental take of sea turtles will be difficult to detect for the following reasons: (1) the turtles nest primarily at night and all nests are not found because [a] natural factors, such as rainfall, wind, and tides may obscure crawls and [b] human-caused factors, such as pedestrian and vehicular traffic, may obscure crawls, and result in nests being destroyed because they were missed during a nesting survey and egg relocation program; (2) the total number of hatchlings per undiscovered nest is unknown; (3) the reduction in percent hatching and emerging success per relocated nest over the natural nest site is unknown; (4) an unknown number of females may avoid the project beach and be forced to nest in a less than optimal area; (5) lights may misdirect an unknown number of hatchlings and cause death; and (6) escarpments may form and cause an unknown number of females from accessing a suitable nesting site. However, the level of take of these

species can be anticipated by the disturbance and reestablishment of suitable turtle nesting beach habitat because: (1) turtles nest within the project site; (2) project construction will likely occur during a portion of the nesting season; (3) the project will modify the incubation substrate, beach slope, and sand compaction; and (4) artificial lighting will deter and/or misdirect nesting females and hatchlings.

EFFECT OF THE TAKE

In the accompanying biological opinion, the Service determined that this level of anticipated take is not likely to result in jeopardy to the species. Critical habitat has not been designated in the project area; therefore, the project will not result in destruction or adverse modification of critical habitat.

REASONABLE AND PRUDENT MEASURES

The Service believes the following reasonable and prudent measures are necessary and appropriate to minimize take of loggerhead, green, leatherback, hawksbill, and Kemp's ridley sea turtles:

1. Beach quality sand suitable for sea turtle nesting, successful incubation, and hatchling emergence must be used on the project site;
2. If the berm remediation project will be conducted during the period from March 1 through April 30, surveys for nesting sea turtles must be conducted. If nests are found in the area of sand placement, the eggs must be relocated;
3. If the berm remediation project will be conducted during the period from March 1 through April 30, nighttime surveys for nesting leatherback sea turtles must be conducted. If the nests are found in the area of the sand placement, the eggs must be relocated;
4. If the berm remediation project will be conducted during the period from March 1 through April 30, monitoring of sea turtle nesting success and reproductive success of relocated nests, as well as a representative sampling of the nests left in place, must be conducted for the initial nesting season and for a minimum of two additional nesting seasons. A report documenting the results must be submitted to the Service and the Corps by January 31 of each year;
5. All debris piles located between Blind Creek and Little Mud Creek must be removed from the vicinity of the existing dune line to the west side of the project area by March 30, 2006, or earlier if possible;
6. Immediately after completion of the berm remediation project and prior to the next three nesting seasons, beach compaction must be monitored and tilling must be conducted as required to reduce the likelihood of impacting sea turtle nesting and hatching activities;

7. Immediately after completion of the berm remediation project and prior to the next three nesting seasons, monitoring must be conducted to determine if escarpments are present and escarpments must be leveled as required to reduce the likelihood of impacting sea turtle nesting and hatching activities;
8. The applicant must ensure that contractors conducting the berm remediation work fully understand the sea turtle protection measures detailed in this incidental take statement;
9. During the sea turtle nesting season, construction equipment must be stored in a manner that will minimize impacts to sea turtles to the maximum extent practicable;
10. During the sea turtle nesting season, lighting associated with the project must be minimized to reduce the possibility of disrupting and misdirecting nesting and/or hatching sea turtles; and
11. A lighting survey must be conducted immediately after project completion and action must be taken to ensure that no lights or light sources are visible from the beach. A report summarizing all lights visible using standard survey techniques for such surveys must be submitted to the Service and Corps by May 1, 2006. The report must include documentation of all compliance and enforcement actions. Additional lighting surveys must be conducted monthly through August and results reported by the 15th of each month.

TERMS AND CONDITIONS

In order to be exempt from the prohibitions of section 9 of the ESA, the Corps must comply with the following terms and conditions, which implement the reasonable and prudent measures, described above and outline required reporting/monitoring requirements. These terms and conditions are non-discretionary:

1. All fill material placed must be sand that is similar to a native beach in the vicinity of the site that has not been affected by prior renourishment activities. The fill material must be similar in both coloration and grain size distribution to the native beach. All such fill material must be free of construction debris, rocks, or other foreign matter and must not contain, on average, greater than 10 percent fines (*i.e.*, silt and clay) (passing the #200 sieve) and must not contain, on average, greater than 5 percent coarse gravel or cobbles, exclusive of shell material (retained by the #4 sieve);
2. Daily early morning surveys for sea turtle nests will be required if any portion of the berm remediation project occurs during the period from April 1 through November 30. Nesting surveys must be initiated 65 days prior to nourishment activities or by April 1, whichever is later. Nesting surveys must continue through the end of the project or through September 30, whichever is earlier. If nests are constructed in areas where they

may be affected by construction activities, eggs must be relocated per the following requirements:

- 2a. Nesting surveys and egg relocations will only be conducted by personnel with prior experience and training in nesting survey and egg relocation procedures. Surveyors must have a valid FWC permit. Nesting surveys must be conducted daily between sunrise and 9 a.m. Surveys must be performed in such a manner so as to ensure that construction activity does not occur in any location prior to completion of the necessary sea turtle protection measures, and
- 2b. Only those nests that may be affected by construction activities will be relocated. Nests requiring relocation must be moved no later than 9 a.m. the morning following deposition to a nearby self-release beach site in a secure setting where artificial lighting will not interfere with hatchling orientation. Nest relocations in association with construction activities must cease when construction activities no longer threaten nests. Nests deposited within areas where construction activities have ceased or will not occur for 65 days must be marked and left in place unless other factors threaten the success of the nest. Any nests left in the active construction zone must be clearly marked, and all mechanical equipment must avoid nests by at least 10 feet;
3. If the berm remediation project will be conducted during the period from March 1 through April 30, nighttime surveys for leatherback sea turtle nests must be conducted from March 1 through April 30 or until completion of the project (whichever is earliest), and eggs must be relocated per the following requirements:
 - 3a. Nesting surveys and egg relocations will only be conducted by personnel with prior experience and training in nesting survey and egg relocation procedures. Surveyors must have a valid FWC permit. Nesting surveys must be conducted nightly from 9 p.m. until 6 a.m. The project area must be surveyed at 1-hour intervals (since leatherbacks require at least 1.5 hours to complete nesting, this will ensure all nesting leatherbacks are encountered); and
 - 3b. Only those nests that may be affected by construction activities will be relocated. Nests requiring relocation must be moved no later than 9 a.m., the morning following deposition, to a nearby self-release beach site in a secure setting where artificial lighting will not interfere with hatchling orientation. Nest relocations in association with construction activities must cease when construction activities no longer threaten nests;
4. If the berm remediation project will be conducted during the period from March 1 through April 30, monitoring of sea turtle nesting success and reproductive success of relocated nests, as well as a representative sampling of the nests left in place, must be conducted per FWC's Sea Turtle Protection Guidelines for the initial nesting season and for a minimum of 2 additional nesting seasons. Reports on nesting and reproductive success must be provided for the initial nesting season and for a minimum of two

additional nesting seasons by January 31 of each year. Monitoring of sea turtle nesting and hatching activity in the 3 seasons following construction must include daily surveys and additional measures as documented in Table 1. Reports submitted must include a summary of all the field sheets noting nesting activity, nesting success rates, hatching and emerging success rates of all relocated nests, hatching and emerging success of a representative sample of nests left in place, and dates of construction;

5. All debris piles located between Blind Creek and Little Mud Creek must be removed from the vicinity of the existing dune line and placed to the west side of the project area by March 30, 2006, or earlier if possible. The equipment used to remove the material must be staged from the landward side of the debris pile. No equipment may operate on the nesting beach. The sand left in place must not contain residual debris since it may interfere with a turtle's ability to nest. Re-sieving of the sand to remove any residual debris that gets mixed into the remaining sand may be necessary. A silt fence must be placed on top of the entire length of the existing dune at Blind Creek;
6. Immediately after completion of the berm remediation project and prior to March 1 for three subsequent years, sand compaction must be monitored in the area of restoration in accordance with a protocol agreed to by the Service, the State regulatory agency, and the applicant. At a minimum, the protocol provided under 3a and 3b below must be followed. If required, the area must be tilled to a depth of 36 inches, and each pass of the tilling equipment must be overlapped to allow more thorough and even tilling. All tilling activity must be completed prior to March 1. If the project is completed during the nesting season, tilling will not be performed in areas where nests have been left in place or relocated. An annual summary of compaction surveys and the actions taken must be submitted to the Service. (NOTE: The requirement for compaction monitoring can be eliminated if the decision is made to till regardless of post-construction compaction levels. Also, out-year compaction monitoring and remediation are not required if placed material no longer remains on the dry beach);
- 6a. Compaction sampling stations must be located at 500-foot intervals along the project area. One station must be at the seaward edge of the dune/bulkhead line (when material is placed in this area), and one station must be midway between the dune line and the high water line (normal wrack line).

At each station, the cone penetrometer will be pushed to a depth of 6, 12, and 18 inches three times (three replicates). Material may be removed from the hole if necessary to ensure accurate readings of successive levels of sediment. The penetrometer may need to be reset between pushes, especially if sediment layering exists. Layers of highly compact material may lie over less compact layers. Replicates will be located as close to each other as possible, without interacting with the previous hole and/or disturbed sediments. The three replicate compaction values for each depth will be averaged to produce final values for each depth at each station. Reports will include all 18 values for each transect line, and the final 6 averaged compaction values, and

- 6b. If the average value for any depth exceeds 500 pounds per square inch (psi) for any two or more adjacent stations, then that area must be tilled immediately prior to March 1. If values exceeding 500 psi are distributed throughout the project area but in no case do those values exist at two adjacent stations at the same depth, then consultation with the Service will be required to determine if tilling is required. If a few values exceeding 500 psi are present randomly within the project area, tilling will not be required;
7. Visual surveys for escarpments along the project area must be made immediately after completion of the berm remediation project and prior to March 1 for 3 subsequent years. Escarpments that interfere with sea turtle nesting or that exceed 18 inches in height for a distance of 100 feet must be leveled to the natural beach contour by March 1. If the project is completed during the sea turtle nesting and hatching season, escarpments may be required to be leveled immediately, while protecting nests that have been relocated or left in place. The Service must be contacted immediately if subsequent reformation of escarpments that interfere with sea turtle nesting or that exceed 18 inches in height for a distance of 100 feet occurs during the nesting and hatching season to determine the appropriate action to be taken. If it is determined that escarpment leveling is required during the nesting or hatching season, the Service will provide a brief written authorization that describes methods to be used to reduce the likelihood of impacting existing nests. An annual summary of escarpment surveys and actions taken must be submitted to the Service. (NOTE: Out-year escarpment monitoring and remediation are not required if placed material no longer remains on the dry beach);
8. The applicant must arrange a meeting between representatives of the contractor, the Service, the FWC, and the permitted person responsible for egg relocation at least 30 days prior to the commencement of work on this project. At least 10 days advance notice must be provided prior to conducting this meeting. This will provide an opportunity for explanation and/or clarification of the sea turtle protection measures;
9. From March 1 through November 30, staging areas for construction equipment must be located off the beach to the maximum extent practicable. Nighttime storage of construction equipment not in use must be off the beach to minimize disturbance to sea turtle nesting and hatching activities. In addition, all construction pipes that are placed on the beach must be located as far landward as possible without compromising the integrity of the existing or reconstructed berm system. Temporary storage of pipes must be off the beach to the maximum extent possible. Temporary storage of pipes on the beach must be in such a manner so as to impact the least amount of nesting habitat and must likewise not compromise the integrity of the berm systems (placement of pipes perpendicular to the shoreline is recommended as the method of storage);
10. From March 1 through November 30, direct lighting of the beach and nearshore waters must be limited to the immediate construction area must comply with safety requirements. Lighting on offshore or onshore equipment must be minimized through

reduction, shielding, lowering, and appropriate placement of lights to avoid excessive illumination of the water's surface and nesting beach, while meeting all U.S. Coast Guard and OSHA requirements. Shields must be affixed to the light housing and be large enough to block light from all lamps from being transmitted outside the construction area (Figure 4);

11. A lighting survey must be conducted from the constructed berm immediately after construction completion and action taken to ensure that no lights or light sources are visible from the newly elevated berm. A report summarizing all lights visible, using standard survey techniques for such surveys, must be submitted to the Service and Corps, by May 1, 2006, and include documentation of all compliance and enforcement action. Additional lighting surveys must be conducted by July 1, 2006, and results reported by July 15, 2006.
12. A report describing the actions taken to implement the terms and conditions of this incidental take statement must be submitted to the South Florida Ecological Services Office within 60 days of completion of the proposed work for each year when the activity has occurred. This report will include the dates of actual construction activities, names and qualifications of personnel involved in nest surveys and relocation activities, descriptions and locations of self-release beach sites, nest survey and relocation results, and hatching success of nests;
13. In the event a sea turtle nest is excavated during construction activities, the permitted person responsible for egg relocation for the project must be notified so the eggs can be moved to a suitable relocation site; and
14. Upon locating a sea turtle adult, hatchling, or egg harmed or destroyed as a direct or indirect result of the project, notification must be made to the FWC, Bureau of Marine Enforcement, at (800) 342-5367 and the South Florida Ecological Services Office, Vero Beach, at (772) 562-3909. Care should be taken in handling injured turtles or eggs to ensure effective treatment or disposition, and in handling dead specimens to preserve biological materials in the best possible state for later analysis.

The Service believes that incidental take will be limited to the 3.6 miles of beach that have been identified for berm remediation and 0.8 mile for wetland restoration. The reasonable and prudent measures, with their implementing terms and conditions, are designed to minimize the impact of incidental take that might otherwise result from the proposed action. The Service believes that no more than the following types of incidental take will result from the proposed action: (1) destruction of all nests that may be constructed and eggs that may be deposited and missed by a nest survey and egg relocation program within the boundaries of the proposed project; (2) destruction of all nests deposited during the period when a nest survey and egg relocation program is not required to be in place within the boundaries of the proposed project; (3) reduced hatching success due to egg mortality during relocation and adverse conditions at the relocation site; (4) harassment in the form of disturbing or interfering with female turtles attempting to nest within the construction area or on adjacent beaches as a result of

construction activities; (5) misdirection of hatchling turtles on beaches adjacent to the construction area as they emerge from the nest and crawl to the water as a result of project lighting; (6) behavior modification of nesting females due to escarpment formation within the project area during a nesting season, resulting in false crawls or situations where they choose marginal or unsuitable nesting areas to deposit eggs; (7) destruction of nests from escarpment leveling within a nesting season when such leveling has been approved by the Service, and (8) behavior modification due to interaction with debris piles at the excavation site. The amount or extent of incidental take for sea turtles will be considered exceeded if the project results in more than a one-time placement of sand on the 3.6 miles or impacts which exceed the 0.8 mile of project footprint for the wetland restoration that have been identified. If, during the course of the action, this level of incidental take is exceeded, such incidental take represents new information requiring reinitiation of consultation and review of the reasonable and prudent measures provided. The Corps must immediately provide an explanation of the causes of the taking and review with the Service the need for possible modification of the reasonable and prudent measures.

CONSERVATION RECOMMENDATIONS

Section 7(a)(1) of the ESA directs Federal agencies to utilize their authorities to further the purposes of the ESA by carrying out conservation programs for the benefit of endangered and threatened species. Conservation recommendations are discretionary agency activities to minimize or avoid adverse effects of a proposed action on listed species or critical habitat, to help implement recovery plans, or to develop information:

1. Construction activities for this project and similar future projects should be planned to take place outside the main part of the sea turtle nesting and hatching season;
2. Appropriate native salt-resistant vegetation should be established on the restored berms. The DEP, Bureau of Beaches and Coastal Systems, can provide technical assistance on the specifications for design and implementation;
3. Surveys for nesting success of sea turtles should be continued for a minimum of 3 years following berm remediation to determine whether sea turtle nesting success has been adversely impacted; and
4. Educational signs should be placed where appropriate at beach access points explaining the importance of the area to sea turtles and/or the life history of sea turtle species that nest in the area.

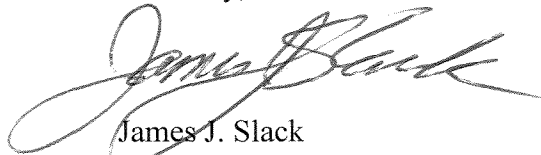
In order for the Service to be kept informed of actions minimizing or avoiding adverse effects or benefiting listed species or their habitats, the Service requests notification of the implementation of any conservation recommendations.

REINITIATION NOTICE

This concludes formal consultation on the action outlined in the reinitiation request. As provided in 50 CFR §402.16, reinitiation of formal consultation is required where discretionary Federal agency involvement or control over the action has been retained (or is authorized by law) and if: (1) the amount or extent of incidental take is exceeded; (2) new information reveals effects of the agency action that may affect listed species or critical habitat in a manner or to an extent not considered in this opinion; (3) the agency action is subsequently modified in a manner that causes an effect to the listed species or critical habitat not considered in this opinion; or (4) a new species is listed or critical habitat designated that may be affected by the action. In instances where the amount or extent of incidental take is exceeded, any operations causing such take must cease pending reinitiation.

Thank you for your cooperation in protecting fish and wildlife resources. Should you have additional questions regarding this matter, please contact Trish Adams at 772-562-3909, extension 232.

Sincerely,



James J. Slack
Field Supervisor
South Florida Ecological Services Office

cc:

Service, Atlanta, Georgia (Noreen Walsh) (electronic copy only)
Service, Jacksonville, Florida (Nicole Adimey)
Corps, South Permits Branch (Alisa Zarbo)
FWC, Office of Protected Species Management, Tallahassee, Florida (Robbin Trindell)
DEP, Bureau of Beaches and Wetland Resources, Tallahassee, Florida (Mike Barnett,
Jim Martinello)
NOAA, Habitat Conservation Division, West Palm Beach, Florida (Jocelyn Karaszia)
EPA, West Palm Beach, Florida (Ron Miedema)
Hazen and Sawyer, Fort Pierce, Florida (Billy Almaguer)
St. Lucie County, Board of County Commissioners, Fort Pierce, Florida (Ray Wazny,
Richard Bouchard)

LITERATURE CITED

- Ackerman, R.A. 1980. Physiological and ecological aspects of gas exchange by sea turtle eggs. *American Zoologist* 20:575-583.
- Alexander, J., S. Deishley, K. Garrett, W. Coles, and D. Dutton. 2002. Tagging and nesting research on leatherback sea turtles (*Dermochelys coriacea*) on Sandy Point, St. Croix, U.S. Virgin Islands, 2002. Annual Report to the Fish and Wildlife Service. 41 pages.
- Bjorndal, K.A. 1997. Foraging ecology and nutrition of sea turtles. Pages 189-121 in P.L. Lutz and J.A. Musick, eds. *The biology of sea turtles*, Boca Raton, Florida. CRC Press.
- Boettcher, R. 1998. Personal communication. Biologist. North Carolina Wildlife Resources Commission. Marshallberg, North Carolina.
- Bowen, B.W. 1994. Letter dated November 17, 1994, to Sandy MacPherson, National Sea Turtle Coordinator, U.S. Fish and Wildlife Service, Jacksonville, Florida. University of Florida. Gainesville, Florida.
- Bowen, B.W. 1995. Letter dated October 26, 1995, to Sandy MacPherson, National Sea Turtle Coordinator, U.S. Fish and Wildlife Service, Jacksonville, Florida. University of Florida; Gainesville, Florida.
- Bowen, B., J.C. Avise, J.I. Richardson, A.B. Meylan, D. Margaritoulis, and S.R. Hopkins-Murphy. 1993. Population structure of loggerhead turtles (*Caretta caretta*) in the northwestern Atlantic Ocean and Mediterranean Sea. *Conservation Biology* 7(4):834-844.
- Carr, A. 1963. Panspecific reproductive convergence in *Lepidochelys kempii*. *Ergebnisse der Biologie* 26:298-303.
- Coastal Engineering Research Center. 1984. Shore protection manual. Volumes I and II. U.S. Army Corps of Engineers Waterways Experiment Station; Vicksburg, Mississippi.
- Corliss, L.A., J.I. Richardson, C. Ryder, and R. Bell. 1989. The hawksbills of Jumby Bay, Antigua, West Indies. In Eckert, S.A., K.L. Eckert, and T.H. Richardson (compilers). *Proceedings of the Ninth Annual Workshop on Sea Turtle Conservation and Biology*. NOAA Technical Memorandum NMFS-SEFC-232, 33-35.
- Dean, C. 1999. *Against the tide: the battle for America's beaches*. Columbia University Press; New York, New York.
- Dickerson, D.D. and D.A. Nelson. 1989. Recent results on hatchling orientation responses to light wavelengths and intensities. In Eckert, S.A., K.L. Eckert, and T.H. Richardson

- (compilers). Proceedings of the 9th Annual Workshop on Sea Turtle Conservation and Biology. NOAA Technical Memorandum NMFS-SEFC-232, 41-43.
- Dodd, C.K., Jr. 1988. Synopsis of the biological data on the loggerhead sea turtle *Caretta caretta* (Linnaeus 1758). U.S. Fish and Wildlife Service, Biological Report 88(14).
- Ehrhart, L.M. 1989. Status report of the loggerhead turtle. Pages 122-139 in Ogren, L., F. Berry, K. Bjorndal, H. Kumpf, R. Mast, G. Medina, H. Reichart, and R. Witham (editors). Proceedings of the 2nd Western Atlantic Turtle Symposium. NOAA Technical Memorandum NMFS-SEFC-226.
- Encalada, S.E., K.A. Bjorndal, A.B. Bolten, J.C. Zurita, B. Schroeder, E. Possardt, C.J. Sears, and B.W. Bowen. 1998. Population structure of loggerhead turtle (*Caretta caretta*) nesting colonies in the Atlantic and Mediterranean as inferred from mitochondrial DNA control region sequences. Marine Biology 130:567-575.
- Ernest, R.G. and R.E. Martin. 1999. Martin County beach nourishment project; sea turtle monitoring and studies. 1997 annual report and final assessment. Unpublished report prepared for the Florida Department of Environmental Protection.
- Ernest, B. 2006. Email Ecological Associates, Incorporated. Jensen Beach, Florida.
- Fletemeyer, J. 1980. Sea turtle monitoring project. Unpublished report prepared for the Broward County Environmental Quality Control Board, Florida.
- Florida Fish and Wildlife Conservation Commission (FWC). 2004. Statewide nesting database. Nesting trends of Florida's sea turtles. Florida Marine Research Institute web page. Available from: http://www.floridamarine.org/features/view_article.asp?id=2377
- Glenn, L. 1998. The consequences of human manipulation of the coastal environment on hatchling loggerhead sea turtles (*Caretta caretta*, L.). Pages 58-59 in Byles, R. and Y. Fernandez (compilers). Proceedings of the Sixteenth Annual Symposium on Sea Turtle Biology and Conservation. NOAA Technical Memorandum NMFS-SEFSC-412.
- Hildebrand, H.H. 1963. Hallazgo del área de anidación de la tortuga marina "lora" *Lepidochelys kempii* (Garman), en la costa occidental del Golfo de México. Sobreiro de Ciencia, México 22:105-112.
- Hirth, J.I.F. 1997. Synopsis of the biological data on the green turtle *Chelonia mydas* (Linnaeus 1758). U.S. Fish and Wildlife Service, Biological Report 97(1).
- Hopkins, S.R. and J.I. Richardson (editors). 1984. Recovery plan for marine turtles. National Marine Fisheries Service; St. Petersburg, Florida.

- LeBuff, C.R., Jr. 1990. The loggerhead turtle in the eastern Gulf of Mexico. Caretta Research, Inc.; Sanibel Island, Florida.
- Lenarz, M.S., N.B. Frazer, M.S. Ralston, and R.B. Mast. 1981. Seven nests recorded for loggerhead turtle (*Caretta caretta*) in one season. Herpetological Review 12(1):9.
- Limpus, C.J., V. Baker, and J.D. Miller. 1979. Movement induced mortality of loggerhead eggs. Herpetological 35(4):335-338.
- Mann, T.M. 1977. Impact of developed coastline on nesting and hatchling sea turtles in southeastern Florida. M.S. thesis. Florida Atlantic University; Boca Raton, Florida.
- McDonald, D.L. and P.H. Dutton. 1996. Use of PIT tags and photoidentification to revise remigration estimates of leatherback turtles (*Dermochelys coriacea*) nesting in St. Croix, U.S. Virgin Islands, 1979-1995. Chelonian Conservation and Biology 2(2):148-152.
- McGehee, M.A. 1990. Effects of moisture on eggs and hatchlings of loggerhead sea turtles (*Caretta caretta*). Herpetologica 46(3):251-258.
- Meylan, A. 1989. Status report of the hawksbill turtle. Pages 101-115 in Ogren, L., F. Berry, K. Bjorndal, H. Kumpf, R. Mast, G. Medina, H. Reichart, and R. Witham (eds.). Proceedings of the 2nd Western Atlantic Turtle Symposium. NOAA Technical Memorandum NMFS-SEFC-226.
- Meylan, A. 1992. Hawksbill turtle *Eretmochelys imbricata*. Pages 95-99 in Moler, P.E. (editor). Rare and Endangered Biota of Florida, Volume III. University Press of Florida; Gainesville, Florida.
- Meylan, A.B. and M. Donnelly. 1999. Status justification for listing the hawksbill turtle (*Eretmochelys imbricata*) as critically endangered on the 1996 IUCN Red List of Threatened Animals. Chelonian Conservation and Biology 3(2):200-224.
- Meylan, A., B. Schroeder, and A. Mosier. 1995. Sea turtle nesting activity in the State of Florida 1979-1992. Florida Marine Research Publications Number 52, St. Petersburg, Florida.
- Miller, K., G.C. Packard, and M.J. Packard. 1987. Hydric conditions during incubation influence locomotor performance of hatchling snapping turtles. Journal of Experimental Biology. 127:401-412.
- Moody, K. 1998. The effects of nest relocation on hatching success and emergence success of the loggerhead turtle (*Caretta caretta*) in Florida. In Byles, R. and Y. Fernandez (compilers). Proceedings of the Sixteenth Annual Symposium on Sea Turtle Biology and Conservation. NOAA Technical Memorandum NMFS-SEFSC-412107-108.

- Mrosovsky, N. and A. Carr. 1967. Preference for light of short wavelengths in hatchling green sea turtles (*Chelonia mydas*), tested on their natural nesting beaches. *Behavior* 28:217-231.
- Mrosovsky, N. and S.J. Shettleworth. 1968. Wavelength preferences and brightness cues in water finding behavior of sea turtles. *Behavior* 32:211-257.
- Murphy, S. 1996. Personal communication. Biologist. South Carolina Department of Natural Resources. Charleston, South Carolina.
- Murphy, T.M. and S.R. Hopkins. 1984. Aerial and ground surveys of marine turtle nesting beaches in the southeast region. Unpublished report prepared for the National Marine Fisheries Service.
- National Marine Fisheries Service and U.S. Fish and Wildlife Service. 1991a. Recovery plan for U.S. population of Atlantic green turtle (*Chelonia mydas*). National Marine Fisheries Service; Washington, D.C.
- National Marine Fisheries Service and U.S. Fish and Wildlife Service. 1991b. Recovery plan for U.S. population of loggerhead turtle (*Caretta caretta*). National Marine Fisheries Service; Washington, D.C.
- National Marine Fisheries Service and U.S. Fish and Wildlife Service. 1992. Recovery plan for leatherback turtles (*Dermochelys coriacea*) in the U.S. Caribbean, Atlantic, and Gulf of Mexico. National Marine Fisheries Service; Washington, D.C.
- National Marine Fisheries Service and U.S. Fish and Wildlife Service. 1993. Recovery plan for hawksbill turtle (*Eretmochelys imbricata*) in the U.S. Caribbean, Atlantic, and Gulf of Mexico. National Marine Fisheries Service; St. Petersburg, Florida.
- National Marine Fisheries Service and U.S. Fish and Wildlife Service. 1998. Recovery plan for U.S. Pacific populations of the green turtle (*Chelonia mydas*). National Marine Fisheries Service; Silver Spring, Maryland. 84 pages.
- National Research Council. 1990. Decline of the sea turtles: causes and prevention. National Academy Press; Washington, D.C.
- National Research Council. 1995. Beach nourishment and protection. National Academy Press; Washington, D.C.
- Nelson, D.A. 1987. The use of tilling to soften nourished beach sand consistency for nesting sea turtles. Unpublished report of the U.S. Army Corps of Engineers Waterways Experiment Station; Vicksburg, Mississippi.

- Nelson, D.A. 1988. Life history and environmental requirements of loggerhead turtles. U.S. Fish and Wildlife Service Biological Report 88(23). U.S. Army Corps of Engineers TR EL-86-2 (Rev.).
- Nelson, D.A. and B. Blihovde. 1998. Nesting sea turtle response to beach scarps. *In* Byles, R. and Y. Fernandez (compilers). Proceedings of the Sixteenth Annual Symposium on Sea Turtle Biology and Conservation. NOAA Technical Memorandum NMFS-SEFSC-412, 113.
- Nelson, D.A. and D.D. Dickerson. 1987. Correlation of loggerhead turtle nest digging times with beach sand consistency. Abstract of the 7th Annual Workshop on Sea Turtle Conservation and Biology.
- Nelson, D.A. and D.D. Dickerson. 1988a. Effects of beach nourishment on sea turtles. Pages 125-127 *in* Tait, L.S. (editor). Proceedings of the Beach Preservation Technology Conference '88. Florida Shore & Beach Preservation Association, Inc.; Tallahassee, Florida.
- Nelson, D.A. and D.D. Dickerson. 1988b. Hardness of nourished and natural sea turtle nesting beaches on the east coast of Florida. Unpublished report of the U.S. Army Corps of Engineers Waterways Experiment Station; Vicksburg, Mississippi.
- Nelson, D.A. and D.D. Dickerson. 1988c. Response of nesting sea turtles to tilling of compacted beaches, Jupiter Island, Florida. Unpublished report of the U.S. Army Corps of Engineers Waterways Experiment Station; Vicksburg, Mississippi.
- Nelson, D.A., K. Mauck, and J. Fletemeyer. 1987. Physical effects of beach nourishment on sea turtle nesting. Delray Beach, Florida. Technical Report EL-87-15. U.S. Army Corps of Engineers Waterways Experiment Station; Vicksburg, Mississippi.
- Ogren, L.H. 1989. Distribution of juvenile and subadult Kemp's ridley turtles: preliminary results from the 1984-1987 surveys. Pages 116-123 *in* Caillouet, C.W., Jr., and A.M. Landry, Jr. (editors). Proceedings of the First International Symposium on Kemp's Ridley Sea Turtle Biology, Conservation and Management. Texas A&M University Sea Grant College Program TAMU-SG-89-105.
- Packard, G.C., M.J. Packard, and T.J. Boardman. 1984. Influence of hydration of the environment on the pattern of nitrogen excretion by embryonic snapping turtles (*Chelydra serpentina*). *Journal of Experimental Biology* 108:195-204.
- Packard, G.C., M.J. Packard, and W.H.N. Gutzke. 1985. Influence of hydration of the environment on eggs and embryos of the terrestrial turtle *Terrapene ornata*. *Physiological Zoology* 58(5):564-575.

- Packard, G.C., M.J. Packard, T.J. Boardman, and M.D. Ashen. 1981. Possible adaptive value of water exchange in flexible-shelled eggs of turtles. *Science* 213:471-473.
- Packard, G.C., M.J. Packard, K. Miller, and T.J. Boardman. 1988. Effects of temperature and moisture during incubation on carcass composition of hatchling snapping turtles (*Chelydra serpentina*). *Journal of Comparative Physiology B* 158:117-125.
- Packard, M.J., and G.C. Packard. 1986. Effect of water balance on growth and calcium mobilization of embryonic painted turtles (*Chrysemys picta*). *Physiological Zoology* 59(4):398-405.
- Parmenter, C.J. 1980. Incubation of the eggs of the green sea turtle. *Chelonia mydas*, in Torres Strait, Australia: the effect of movement on hatchability. *Australian Wildlife Research* 7:487-491.
- Pearce, A.F. 2001. Contrasting population structure of the loggerhead turtle (*Caretta caretta*) using mitochondrial and nuclear DNA markers. M.S. thesis. University of Florida; Gainesville, Florida.
- Philbosian, R. 1976. Disorientation of hawksbill turtle hatchlings (*Eretmochelys imbricata*) by stadium lights. *Copeia* 1976:824.
- Pilkey, O.H. and K.L. Dixon. 1996. *The Corps and the shore*. Island Press; Washington, D.C.
- Pritchard, P.C.H. 1992. Leatherback turtle *Dermochelys coriacea*. Pages 214-218 in Moler, P.E. (editor). *Rare and Endangered Biota of Florida, Volume III*. University Press of Florida; Gainesville, Florida.
- Raymond, P.W. 1984. The effects of beach restoration on marine turtles nesting in south Brevard County, Florida. M.S. thesis. University of Central Florida; Orlando, Florida.
- Richardson, J.I. and T.H. Richardson. 1982. An experimental population model for the loggerhead sea turtle (*Caretta caretta*). Pages 165-176 in Bjorndal, K.A. (editor). *Biology and Conservation of Sea Turtles*. Smithsonian Institution Press; Washington, D.C.
- Ross, J.P. 1982. Historical decline of loggerhead, ridley, and leatherback sea turtles. Pages 189-195 in Bjorndal, K.A. (editor). *Biology and Conservation of Sea Turtles*. Smithsonian Institution Press; Washington, D.C.
- Ross, J.P. and M.A. Barwani. 1995. Review of sea turtles in the Arabian area. Pages 373-383 in Bjorndal, K.A. (editor). *Biology and Conservation of Sea Turtles, Revised Edition*. Smithsonian Institution Press, Washington, D.C.
- Rusenko, K. 2005. *Sea Turtle Data for the Central and South Boca Project Areas*. City of Boca Raton, Florida.

- Salmon, M., J. Wyneken, E.U. Fritz, and M. Lucas. 1992. Ocean Finding by Hatchling Sea Turtles Interplay of Silhouette, Slope, Brightness as Guideposts in Orientation. Proceedings of the Eleventh Annual Workshop in Sea Turtle Biology and Conservation, NOAA Technical Memorandum. NMFS-SEFSC-302. National Marine Fisheries Service, Southeast Fisheries Center, Miami, Florida.
- Schroeder, B.A. 1994. Florida index nesting beach surveys: are we on the right track? Page 132-133 in Bjorndal, K.A., A.B. Bolten, D.A. Johnson, and P.J. Eliazar (compilers). Proceedings of the 14th Annual Symposium on Sea Turtle Biology and Conservation. NOAA Technical Memorandum NMFS-SEFSC-351.
- Spotila, J.R., E.A. Standora, S.J. Morreale, G.J. Ruiz, and C. Puccia. 1983. Methodology for the study of temperature related phenomena affecting sea turtle eggs. U.S. Fish and Wildlife Service Endangered Species Report 11.
- Spotila, J.R., A.E. Dunham, A.J. Leslie, A.C. Steyermark, P.T. Plotkin, and F.V. Paladino. 1996. Worldwide population decline of *Dermochelys coriacea*: are leatherback turtles going extinct? Chelonian Conservation and Biology 2(2):290-222.
- Talbert, O.R., Jr., S.E. Stancyk, J.M. Dean, and J.M. Will. 1980. Nesting activity of the loggerhead turtle (*Caretta caretta*) in South Carolina. I: a rookery in transition. Copeia 1980(4):709-718.
- Turtle Expert Working Group. 1998. An assessment of the Kemp's ridley (*Lepidochelys kempii*) and loggerhead (*Caretta caretta*) sea turtle populations in the western North Atlantic. NOAA Technical Memorandum NMFS-SEFSC-109.
- Turtle Expert Working Group. 2000. Assessment update for the Kemp's ridley and loggerhead sea turtle populations in the western North Atlantic. NOAA Technical Memorandum NMFS-SEFSC-444.
- Winn, B. 1996. Personal communication. Biologist. Georgia Department of Natural Resources. Brunswick, Georgia.
- Witherington, B.E. 1992. Behavioral responses of nesting sea turtles to artificial lighting. Herpetological 48:31-39.
- Witherington, B.E. and K.A. Bjorndal. 1991. Influences of artificial lighting on the seaward orientation of hatchling loggerhead turtles (*Caretta caretta*). Biological Conservation 55:139-149.
- Witherington, B.E. and L.M. Ehrhart. 1989. Status and reproductive characteristics of green turtles (*Chelonia mydas*) nesting in Florida. Pages 351-352 in Ogren, L., F. Berry, K. Bjorndal, H. Kumpf, R. Mast, G. Medina, H. Reichart, and R. Witham (editors).

Proceedings of the Second Western Atlantic Turtle Symposium. NOAA Technical Memorandum NMFS-SEFC-226.

Wyneken, J., L. DeCarlo, L. Glenn, M. Salmon, D. Davidson, S. Weege, and L. Fisher. 1998. On the consequences of timing, location and fish for hatchlings leaving open beach hatcheries. Pages 155-156 in Byles, R., and Y. Fernandez (compilers). Proceedings of the Sixteenth Annual Symposium on Sea Turtle Biology and Conservation. NOAA Technical Memorandum NMFS-SEFSC-412.

Zug, G.R. and J.F. Parham. 1996. Age and growth in leatherback turtles, *Dermochelys coriacea* (Testudineus: Dermochelyidae): a skeletochronological analysis. Chelonian Conservation and Biology 2(2):244-249.

Table 1. Sea turtle nesting and reproductive success monitoring requirements.

Characteristic	Parameter	Measurement	Variable
Nesting Success	False crawls - number	Visual assessment of all false crawls	Number and location of false crawls in fill areas and nonfill areas: any interaction of the turtle with obstructions, such as beach furniture, dune cross overs, or scarps, should be noted.
	False crawl - type	Categorization of the stage at which nesting was abandoned	Number in each of the following categories: emergence-no digging, preliminary body pit, abandoned egg chamber.
	Nests	Number	The number of marine turtle nests in filled and nonfilled areas should be noted. If possible, the location of all marine turtle nests shall be marked on map of project, and approximate distance to scarps measured using a meter tape. Any abnormal cavity morphologies should be reported as well as whether turtle encountered scarps during nest excavation
		Lost nests	The number of nests lost to inundation, erosion or the number with lost markers that could not be found.
	Lighting impacts	Disoriented sea turtles	The number of disoriented hatchlings and adults shall be documented and reported in accordance with existing FWC protocol for disorientation events.
Reproductive Success	Hatching and emerging success	Standard survey protocol	Numbers of the following: unhatched eggs, depredated nests and eggs, live pipped eggs, dead pipped eggs, live hatchlings in nest, dead hatchlings in nest, hatchlings emerged, disoriented hatchlings, depredated hatchlings



Figure 1. Blind Creek red mangrove wetland restoration area, St. Lucie County, Florida.

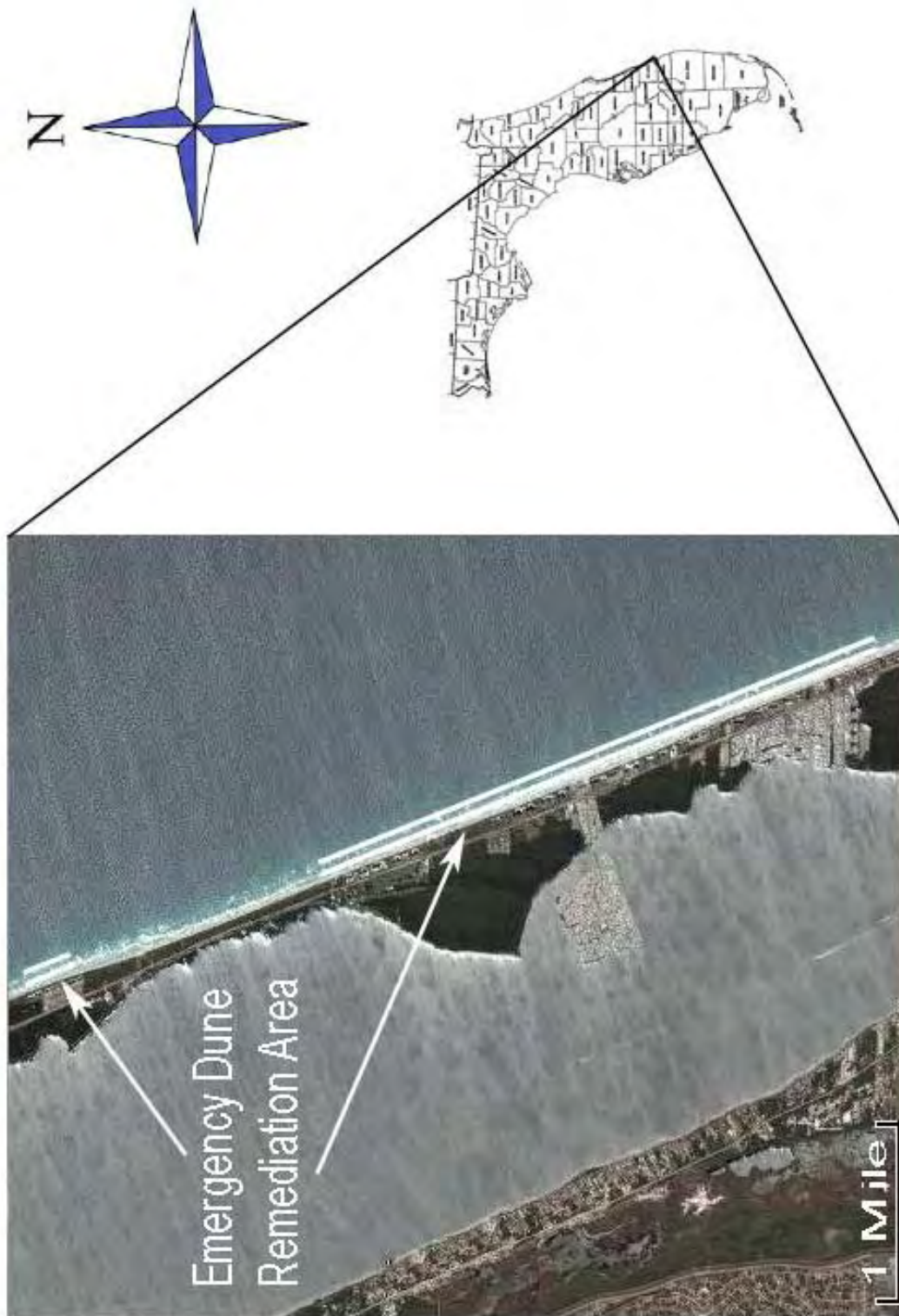


Figure 2. South St. Lucie County Emergency Dune Remediation Area, St. Lucie County, Florida.

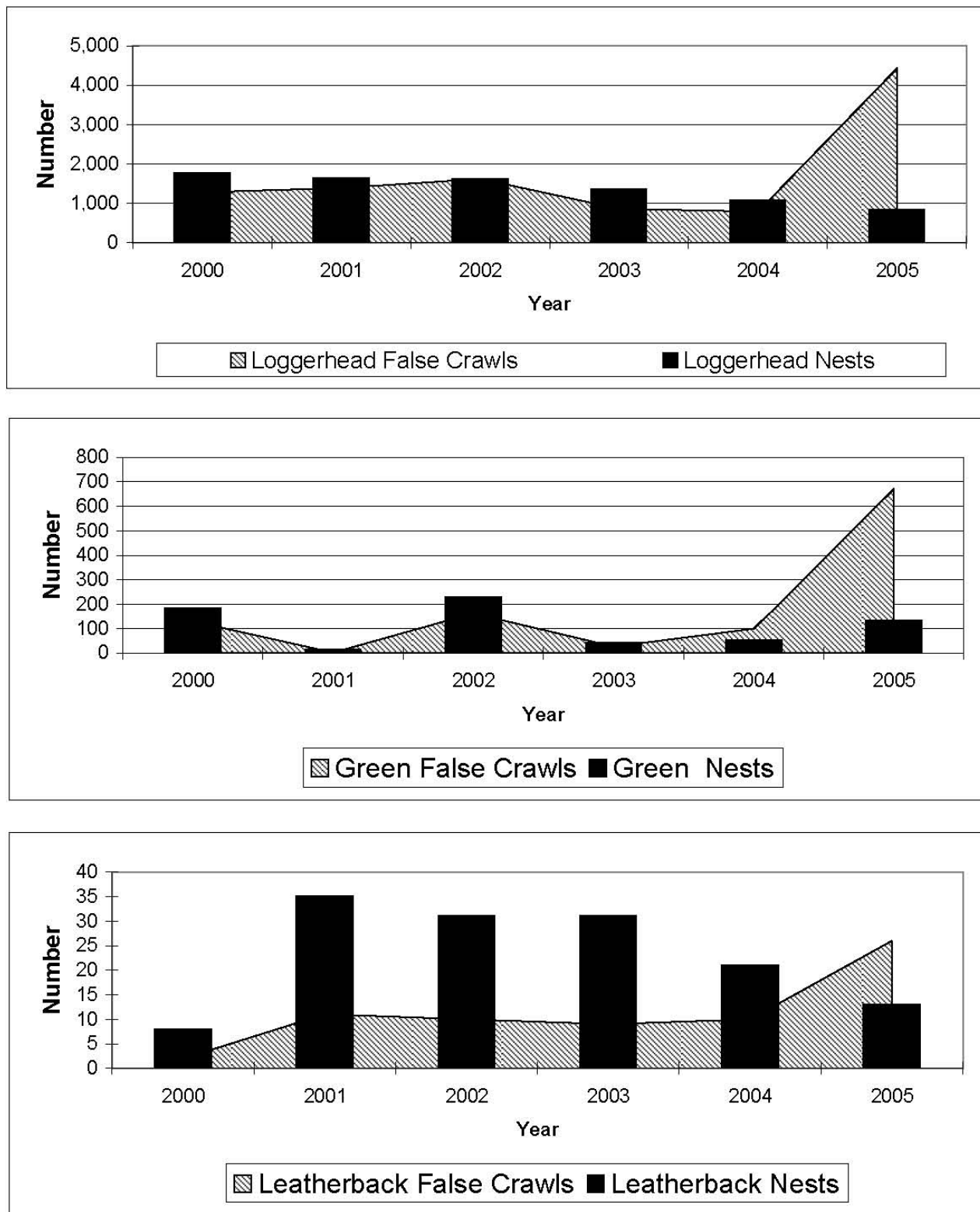


Figure 3. Number of nests and false crawls by year for loggerhead, green, and leatherback sea turtles monitored at the St. Lucie County emergency berm remediation site.

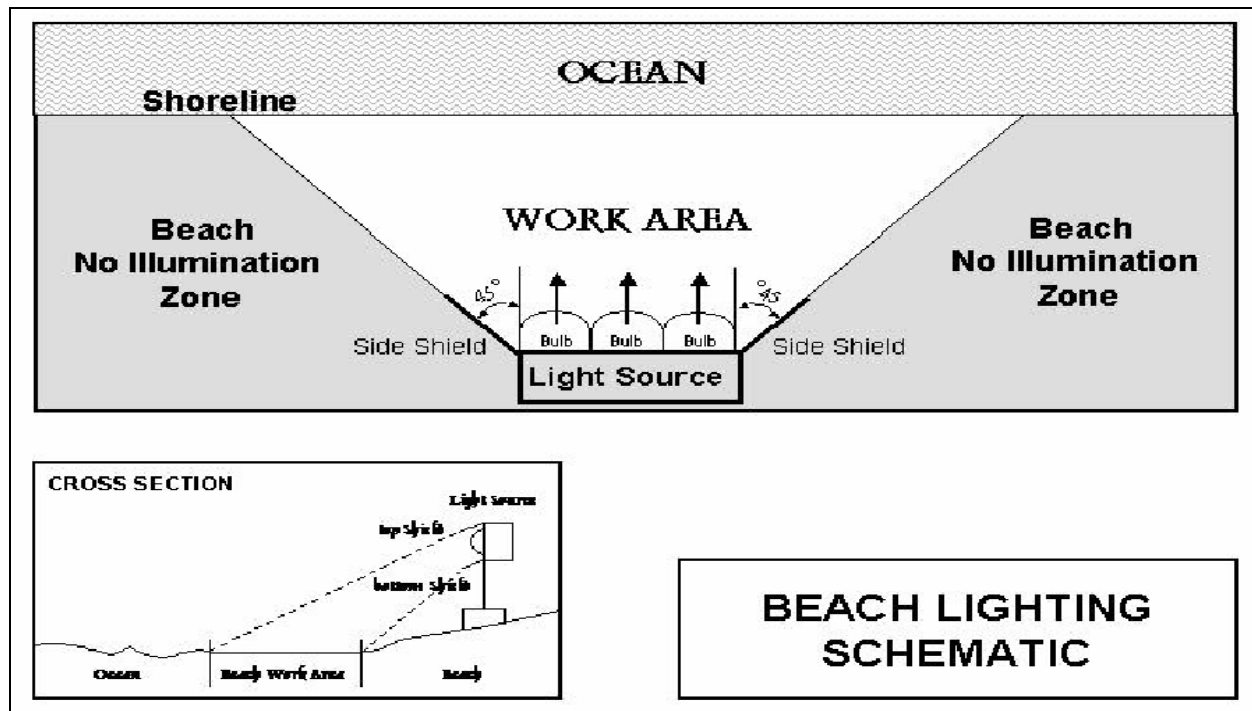


Figure 4. Lighting diagram.