January 26, 2001

Colonel James W. DeLony
District Engineer
U.S. Army Corps of Engineers
P.O. Box 1890
Wilmington, North Carolina 28402-1890

Attention: Coleman Long and Charles Wilson

Dear Colonel DeLony:

This letter and Appendix A constitute the Final Fish and Wildlife Coordination Act Report of the U. S. Fish and Wildlife Service (Service) for the Dare County Beaches (Bodie Island Portion), Hurricane Protection and Beach Erosion Control, Dare County, North Carolina. This report identifies fish and wildlife resources located in the project area and the potential impacts of the Corps' recommended project on these resources. This report constitutes the Service's report in accordance with Section 2(b) of the Fish and Wildlife Coordination Act (48 Stat. 401, as amended; 16 U.S.C. 661 - 667d) and is provided in accordance with our FY 2000 Transfer Funding Agreement and Scope of Work.

The Department of the Interior (DOI) with input from the Service provided comments on the Draft EIS on September 12, 2000. However, the Service had less than two weeks to prepare this Final FWCA Report for consideration by the Corps prior to the release of the Final Environmental Impact Statement (FEIS) in late September. While the Corps did respond to each DOI comment in the Final EIS, the Service is concerned that a period of approximately two weeks was not adequate to incorporate any of the substantial planning recommendations of the DOI.

On December 13, 2000, the Service received an e-mail list of comments to our Draft FWCA Report of July, 1999. This communication contained three general comments and 113 specific comments that requested clarification or support for Service statements. Additional discussion of the project occurred at a meeting of the Service, the Corps, and the local sponsor on December 14. The Service decided that responses to these comments and issues raised at the December 14 meeting should be included in our Final FWCA Report. On December 19, the Service informed you that our Final FWCA Report would be delayed pending completion of Service responses to the Corps' comments.

The Final Report of the Chief of Engineers was released on December 29, 2000. As a result of the Corps' planning schedule, none of our final comments were considered by the Corps in their Final EIS or Final Chief's Report (FCR). Service responses to the Corps' comments are given in Appendix A of this report. The Service requests that this Final FWCA Report be made part of the official project record. We also request that the Corps send our entire report, including Appendix A, to all individuals and organizations that received the Corps' Final EIS except the organizations in the cc list of this report.

The alternative selected in the FCR consists of a program of offshore sand mining for material to construct and maintain an artificial berm. The dune would have a 25-foot -wide crest at an elevation of +13 feet above the National Geodetic Vertical Datum (NGVD). The design storm berm would be 50 feet wide at an elevation of +7 feet NGVD. However, the berm width would be 150 to 250 feet wide when first constructed. The design berm width would be achieved after wind and waves adjust the beach profile. Two, disjunct areas totaling 14.2 miles of developed shoreline would receive sand. The project originally proposed a 3,000-foot transition zone of sand placement within the Cape Hatteras National Seashore (CHNS). Sand placement within the CHNS has now been eliminated. Sediment would be mined from two offshore areas in 30 to 60 feet of water and within the three-mile limit of state-controlled waters. The initial three-year construction would require 12.34 million cubic yards (mcy) of material and subsequent sand replacements would require 3.89 mcy over each three-year replacement cycle. The present 50-year planning period would require the mining and beach placement of 74.58 mcy and impact about seven square miles of ocean bottoms by removing 9 to 12 feet of substrate. Dredging and nourishment of some portion of the proposed project would occur during each year of the current 50-year period of Federal participation. Compensatory environmental mitigation is not proposed.

We believe that the dredging of sand and gravel mineral resources from the seafloor constitutes open-pit strip mining, and should comply with North Carolina General Statutes, Chapter 74, Article 7 (The Mining Act of 1971, as amended). The Service recommends that the Corps prepare a reclamation plan and obtain the appropriate mining permit(s) from the North Carolina Division of Land Resources, Land Quality Section.

This Final FWCA Report contains three sections: a position of the Service, our recommendations, and Appendix A. We provided a standard format for our Draft FWCA Report of July 1999 that need not be repeated here. Supporting information that customarily leads to our position statement and to our recommendations can be found in our Draft FWCA Report.

Position of the Service

The Service recognizes the increasing risk of storm damage and supports the goal of reducing such damage. The key question is not whether to seek storm damage reduction, but the best method to achieve this goal without irreparable harm to the unique and valuable habitats in the project area. The Corps, with the support of local interests, has proposed the creation of an artificial beach-dune system between the ocean and structures on the shoreline. The Service has

four fundamental concerns with the Corps' planning process for this project. These are:

1. There should be a clear statement of purpose which creates success criteria that can be periodically assessed and permits a range of alternatives;

2. Based on the project purpose, a range of alternatives should be fully developed. Alternatives that require work of agencies other than the Corps should be included;

3. The environmental impacts of all alternatives including the construction of an artificial berm and dune system should be completely described, and monitoring and mitigation measures should be integral parts of the project; and,

4. The design features and construction techniques for an artificial berm and dune system should include all feasible options to minimize adverse environmental impacts.

Clear Statement of Purpose - The Corps has not presented a clear, consistent purpose for the Dare County Project. While the goal of reducing storm damage is clear, the issue of stabilizing the shoreline, or controlling beach "erosion," is added as a co-equal goal or lumped with storm damage. The Corps' assertion that long-term shoreline recession can be considered a type of storm damage defies common sense and must be clarified. The Corps has not stated why protection is warranted against smaller storms, but not against the stronger, more destructive storms, such as hurricanes of categories 4 and 5. In responding to Service comments, the Corps states (p. C-88) that "[t]he purpose of the project is to reduce damage caused by coastal storms and beach erosion. By law, damages associated with long-term shoreline recession are included as storm damages." While other parts of the planning document make clear that the project seeks to reduce damage to structures, project goals do not specify the entities for which storm damage reduction is sought. Specific structures are considered in benefit-cost analyses, but such analyses focus on what the project will do rather than the extent to which the preferred design achieves a project purpose determined prior to the development of alternatives. Since project goals appear based on what the preferred alternative will do, it cannot fail.

Development and Evaluation of All Feasible Alternatives - A clear statement of the project purpose containing the critical elements outlined above should lead directly to the development of alternatives. The Environmental Impact Statement (EIS) should contain all reasonable alternatives. The Council on Environmental Quality considers as alternative to be reasonable (Eccleston 1999, p. 271) if:

> " . . . it is deemed to be 'practical or feasible' from a 'technical and economic standpoint and using common sense, rather than simply desirable from the standpoint of the applicant.' "

The Final EIS notes (pp. 3-1 through 3-4) that a no-action and non-structural alternatives, primarily relocation/abandonment of structures, were considered. The Service recommends two

additional approaches that could be used either singularly or in combination. The first approach is modification of existing development and infrastructure. This approach includes retrofitting existing structures to withstand storms, elevating houses, and improved placement of roads and utility lines. The second approach is improved zoning and land use planning. This approach would include greater avoidance of hazard areas by development, expanded use of setbacks for structures, and overall lower development density. These measures would reduce storm damage, the primary goal of the project.

In developing alternatives there is a fundamental difference in the long-term ramifications between constructing beaches and dunes on a mainland shoreline and the same construction on a barrier island. Sand may be added to a beach that is a part of the mainland without a threat to the long-term existence of the uplands behind the beach. Barrier islands must move landward to stay above a rising sea level. An artificial barrier along one side of an island cannot provide long-term protection against a rising sea. Such a barrier signifies a commitment to hold back the sea and protect structures in their present location. If this commitment remains unchanged, the barrier island may eventually be encircled by a continuous wall of protective structures that will destroy both the beach and the estuarine wetlands on the margins of the sound. This is a basic concern of the Service.

There are proven alternatives to constructing beaches and dunes for storm damage reduction that have not been adequately considered. Artificial berm and dune systems are less harmful than hard structures for controlling shoreline recession. However, constructed beaches are the most environmentally damaging alternative for storm damage reduction. A combined program of selective removal and relocation of structures phased in over time, strict zoning laws that fully consider the natural rate of shoreline recession, and improved building standards may actually be more economical and efficient over the long term.

Current planning has not adequately considered alternatives to constructing an artificial berm and dune system with sand mining offshore. Non-structural alternatives are not fully developed and are rejected on controversial economic analyses. Non-structural damage reduction efforts that Federal Emergence Management Agency (FEMA), the Department of Housing and Urban Development, the Small Business Administration, the Department of Agriculture, and even programs within the Corps could make in attaining project goals are not considered. The Final EIS notes (p. 3-4) that all non-structural solutions lack community support, funding, and means of implementation. However, the degree to which the funds to be spent on the structural approach could be used to achieve project goals through non-structural means was not developed. Corps planning documents do not indicate that the most recent projections of sea level rise, i.e., Titus and Narayanan (1995) and Hudgens (1999), were used in determining the feasibility of protecting structures with an artificial berm and dune. Long-term, recurring adverse impacts are erroneously judged to be temporary.

Since the Corps relies heavily on economics in the selection of the preferred alternative, the Service seeks clarification of the economic analyses performed. Surveys of beach and nearshore fishermen for year-round use data to determine economic benefits or costs to beach seining, surf

casting, nearshore sink nets and trawling, and surface fishing in pipeline and borrow areas would improve the benefit-cost ratio and further elucidate an assessment of the impacts of the project to fishermen. Research on whether surf fishing increases, decreases or remains the same on any given stretch of beach pre-, during and post-nourishment would provide data on beach construction impacts to surf fishing and surf zone aquatic resources. Contingency cost figures for supplemental dredging at Oregon Inlet due to sand movement from the project area are not included in economic analyses. While the Corps uses a computer-generated average for extra dredging at the inlet, an average does not consider extreme weather conditions which could create real economic hardships for people requiring passage through the inlet. Over 50 years supplemental dredging in certain years could require funds which the Corps has not considered. A committee of economists and emergency management personnel could prepare a report on each major storm event effecting the 20-mile "primary study area" initially studied in the Draft Feasibility Report. Within this area some beaches (approximately 14 miles) will have an artificial berm and dune while other areas will be fronted by natural beaches. Such reports would present a clear comparison between storm damage for areas with and without an artificial berm and dune system. Such reports would provide evidence of the storm damage reduction efficacy of the artificial berm and dune system.

Description of Environmental Impacts -The creation of an artificial beach-dune system from sand dredged offshore is not the innocuous procedure that it was once considered. The material presented in the Draft FWCA Report (USFWS 1999, pp. 115-131) indicates that some direct impacts may be serious, but they are usually short-lived and localized. The more serious impacts are the secondary, indirect impacts which may seem inconsequential on a year to year basis, but which accumulate over many years without allowing the affected resources to return to pre-project levels. Within the 1990s new data have been presented on the serious impacts of these projects to natural beach communities, offshore communities, nesting sea turtles, and even commercially important fisheries. Unfortunately, these findings have usually been based on only a few years of study, and the longer-term impacts have yet to be reported. The selection of a preferred alternative should be based on thorough evaluations of the best available information on the likely impacts that would occur over a period of at least 50 years.

The concerns of the Service are not new. The Service has consistently expressed concern about the adverse environmental impacts of the Corps' plans for long-term offshore sand mining and beach disposal. The Service comments (June 1993) on the Corps' January 1993 Reconnaissance Report expressed serious concerns about the general thrust of the project aimed at maintaining and managing the coastal barrier islands in the project area. The Service noted that the Corps' plan was inadequate in addressing the long-term needs of the area, and that Corps planning should fully consider the ". . . fragile ecological system and nationally significant resources." The Service's scoping letter of August 1997 stated that the environmental impacts of sand mining and beach disposal had been underestimated in the past. The Service concluded that a decision to construct and maintain an artificial berm and dune system could produce significant or irreversible adverse impacts to fish and wildlife resources.

The areas of offshore sand mining are used by marine mammals (USFWS 1999, pp. 61-63) such as whales, dolphins, and porpoises. While observers aboard dredging vessels may minimize

collisions with these species, the Corps has not considered the impacts of vessel noise, turbidity, and reductions in food resources available to these mammals that the project will produce.

Birds which depend on the food resources of natural beaches and ocean fisheries are likely to be adversely affected by preferred alternative. The Outer Banks have been designated as a Globally Important Bird Area by the American Bird Conservancy and the National Audubon Society. Project area beaches are a major migratory pathway for birds. The project would have adverse impacts on migratory shorebirds due to declines in beach invertebrate populations, a major food resource, resulting from periodic placements of sediment on the beaches. Sand placement during the warmer months will eliminate invertebrates on the beach and remove an important food resource for birds. Winter sand placement could be disruptive to offshore life stages of beach invertebrates prior to their movement onshore. Invertebrate populations eliminated by sand placement may recover in a year or more if the area is undisturbed. However, the annual placement of sand on some portions of the project area may hinder full recovery. The long-term impact of these annual disturbances over 50 years is likely to be a decline in beach invertebrate populations followed by declines in the birds and fish which feed on these organisms.

From 1990 through 1998, 24 sea turtle nests (23 loggerhead and one green sea turtle) were recorded in an 18-mile section of beach which includes the study area. Additional nests may have been unobserved. This level of nesting is comparatively low, but over 100 sea turtles nests are expected along the disposal area during the planned 50-year project life. The initial, three year construction period would include beach disposal during the summer months when sea turtle nests that are found would need to be relocated. As with any constructed beach, the deposited sand can differ significantly from natural beach material. The new material can become compacted or develop scarps which prevent sea turtle nesting. While the Corps plans to avoid the sea turtle nesting season after initial construction, the Final EIS acknowledges that ". . . encroaching into the [sea turtle] nesting season for maintenance operations would occur." Maintenance of the artificial beach has the potential to alter the physical characteristics of the beach, e.g., hardness, color, moisture, mineral content, slope, grain size, in ways that are detrimental to optimal sea turtle nesting and incubation.

The area proposed for sand mining is a major north-south migratory pathway for fish such as alewife, American shad, Atlantic sea herring, Atlantic sturgeon, blueback herring, bluefin tuna, bluefish, spiny dogfish, striped bass, summer flounder, and weakfish. The area constitutes the heart of striped bass wintering grounds. The area is a breeding ground for spiny dogfish and summer flounder, and a wintering ground for bluefin tuna, spiny dogfish, and summer flounder. Even after initial construction, some sand mining will occur every year. Over 50 years sand mining would directly impact about seven square miles of ocean bottom. Bottom depths would be increased by 9-12 feet with the deepest cuts being about 20 feet. Wave patterns in the project area will be altered by this change in bathymetry. Reduced sunlight penetration to the deeper bottoms would lower primary productivity. The wholesale removal of the benthic prey base from the sites during initial construction, as well as the reconfiguration of the bottom, is likely to have an impact on the use of the borrow sites for resting, foraging and spawning activities by adult fish and resting and foraging by juvenile fish. The long-term impact of the project may be a permanent and irreversible degradation of habitat for these important fish species. A

continuation of the project beyond 50 years would extend the area of these adverse impacts. No mitigation is possible.

The adverse impacts of sand placement are likely to extend beyond the designated placement areas. Finer (smaller-grained) material placed on the beaches will be carried eventually to the beaches of Cape Hatteras National Seashore and Pea Island National Wildlife Refuge (PINWR). Material accumulating in the Oregon Inlet area will be dredged and placed south of the inlet, either offshore of PINWR or directly on refuge beaches. The introduction of this fine grained material will fundamentally alter the existing characteristics of the refuge beaches and make them more susceptible to erosion.

The Corps has failed to consider a major impact on both the human and natural environment. Prevailing longshore currents will carry sand from the project area to the Oregon Inlet navigation channel. The closure of this channel which the Final EIS (p. C-55) declares ". . .too speculative to warrant consideration", would severely impact commercial and recreational fishermen and create a crisis that would lead to demands for construction of the dual jetty system, the Manteo (Shallowbag) Bay Project. Construction of the jetties would have serious environmental implications for the entire inlet-barrier island ecosystem.

The Corps has not fully considered the cumulative impacts of other beach disposal and construction projects from southern Virginia to northern South Carolina. Overall, 181.7 miles (56.8%) of the 320 miles of North Carolina shoreline have ongoing or proposed projects of beach disposal - either formal beach nourishment or dredged disposal operations. Some formal beach construction projects will mine offshore sand. When each project is viewed individually, it is possible to believe that offshore fish, nearshore fish, and migratory shorebirds can simply move on to an undisturbed area while construction is occurring. When these projects are viewed over their entire geographic scope, one must question whether there will be an undisturbed area to which these species can retreat. The perspective of all current and proposed sand mining and beach disposal projects in North Carolina is the basis for a thorough cumulative impact analysis.

Design Features and Construction Techniques - The FWCA states that fish and wildlife resources should receive equal consideration with all other features of water resources development projects. If offshore sand mining and beach disposal are components of the plan eventually selected, all feasible options to minimize adverse environmental impacts should be part of that plan. These options can be divided into two categories: (1) efforts to monitor the environmental impacts; and (2) plans to use the quantitative data from the monitoring effort to implement measures that mitigate the environmental damage. The Final Chief's Report states that "Compensatory environmental mitigation is not proposed." It is not clear whether this position is based on an opinion that no adverse impacts will occur or the fact that no compensatory mitigation is possible. The Record of Decision for this project should include a single sentence stating that mitigation may be implemented over the course of the project for environmental impacts determined to be a result of the project.

The Draft FWCA Report (USFWS 1999, pp. 136-149) presents conservation measures designed to benefit the fish and wildlife resources of the project area. These conservation measures

formed the basis for the Service's recommendations. Fish and wildlife conservation measures, as specified in the FWCA, consist of "...means and measures that should be adopted to prevent the loss of or damage to such wildlife resources (mitigation), as well as to provide concurrently for the development and improvement of such resources (enhancement)." For any given type, kind, or category of resource being evaluated, there must be compensation (i.e., full replacement) for all project-associated losses before any enhancement of that given resource can occur.

Recommendations of the Service

In accordance with the FWCA, the Service offers the following recommendations to avoid, minimize, and mitigate adverse impacts on fish and wildlife resources. These are the specific measures which we believe are necessary for fish and wildlife resources to achieve equal consideration with the other goals of this project.

1. A clear presentation of the steps taken in the NEPA planning process is essential. In the first step, the statement of purpose and need, the need for storm damage reduction is clear. However, the purpose of this specific project requires clarification. The Service recommends that the Corps' decision-making documentation clarify the relationship between reducing damage to structures and shoreline stabilization, i.e., beach erosion control. The Final EIS notes (p. C-116) that the Water Resources Development Act of 1986 stipulated that damage associated with long-term erosion be treated as storm damage. If shoreline stabilization is sought to reduce damage to structures, it is redundant to mention it in addition to reduction of damage caused by storms - both actual storm damage and shoreline recession are legally the same. The project could simply be designated as an effort to prevent damage to structures. If the Corps seeks to stabilize the shoreline for reasons other than property damage reduction, this goal may be independent of damage reduction, but the rationale for independently seeking shoreline stabilization reduction should be explained. This clarification is requested because the Final EIS (Table 4-3, p. 4-10) notes that a non-structural alternative would eliminate the need for future protection of structures, but that land loss would continue. This statement suggests that shoreline stabilization has some desirable feature completely independent from the reduction of property damage. Any Corps policy for preserving the subaerial (dry) area of barrier islands independent of property damage should be explained in the Record of Decision.

   A clear statement of purpose would serve to disentangle the goals of storm damage reduction and restoration of a lost recreational beach. While these goals are often viewed as two sides of the same coin, the options for each goal are different. All statements of project purpose should clearly specify the beneficiaries of the action. While project economic analysis indicates (p. 3-2) that 1,085 oceanfront homes and 63 motel and large condominiums would benefit, these beneficiaries are not identified in the formal statement of purpose. The project purpose should also show the location of these beneficiaries on a map.

2. On a dynamic coastline such as the project area, a clear understanding of major natural forces is essential in developing effective alternatives. In that regard, the Corps' decision-making documentation should incorporate the latest information on global sea level rise and the role that a rising ocean has on ocean encroachment on fixed man-made structures. Shoreline adjustment to a rising sea may simply move sediment from the ocean side of a barrier island to the back side of the island by the process of island overwash. This is a natural geologic mechanism whereby the islands are able to move to higher ground and remain above a rising sea.

3. Corps planning documents should clearly differentiate between the level of storms for which the project would provide protection and those storms of greater magnitude for which no protection would be provided. Appendix C of the Final EIS notes (p. C-33) that the project ". . .did not target any particular storm" and that " . . . the recommended plan is not intended to eliminate all damage but reduce damages to an acceptable and economic level." This objective ignores the obvious problem that damage from several small storms may be reduced only to have massive destruction produced by a single major storm. In fairness to the residents of the area, the planning document should state that many structures may be completely destroyed during the first 50 years of project implementation.

4. Corps planning should present the entire range of alternatives that achieve the desired storm damage reduction without regard for cost, social impacts, or the jurisdictional authority of the Corps. Two references (Bush et al. 1996 and Pilkey et al. 1998) should be consulted.

5. Once all alternatives have been developed, the Corps should balance the desired level of storm damage reduction against social and environmental impacts in the selection of the preferred alternative. Corps planning should discuss the factors that lead to the preferred alternative. The Record of Decision should clearly state the reasons that an artificial beach-dune system that provides protection against low intensity storms (e.g., hurricane categories 1 and 2) to a limited area of structures would be preferable to an integrated program of selective relocation, strict zoning/setback requirement, retrofitting existing buildings, and stricter building codes for new buildings. There should be a discussion of combining structural and non-structural procedures as an alternative.

6. Since economics plays a dominant role in the selection of the preferred alternative, the Service wishes to ensure that all relevant cost and benefits are fully considered. The Corps should re-evaluate the economic justification for the project to account for impacts to commercial and recreational fishing, increased shoaling at the Oregon Inlet navigational channel, uncertainty of 50 years of funding, the proportion of the project benefits that are private and not public, whether sandbags provide positive net benefits and the realism of the assumption that destroyed property is instantaneously rebuilt in place.

   The Corps should implement a pilot project to compare the economics and effectiveness

of the two broad categories for storm damage reduction, structural versus non-structural. For this comparison the North Project area would employ a combined program of phased relocation of threatened structures and retrofitting of older buildings to reduce storm damage. The South Project area would employ a structural alternative such as the proposed construction of the artificial berm-dune system. The Corps should establish and fund a committee of economists and emergency management personnel that would prepare a report after each major storm event affecting the 20-mile "primary study area" initially studied in the Draft Feasibility Report. The committee reports will present a clear comparison between storm damages within the two areas. The comparison of costs and storm damage among the two areas should extend over at least ten years.

The Service also recommends that:

6a. Surveys be conducted among beach and nearshore fishermen for year-round use data to determine economic benefits or costs that the constructed beach would produce for beach seining, surf casting, nearshore sink nets, nearshore trawling, and surface fishing in pipeline and borrow areas;

6b. Research be conducted on whether surf fishing increases, decreases or remains the same on any given stretch of beach pre-, during and post- sand placement; incorporate results into Dare County project benefits and costs prior to construction in 2004;

6c. As soon as possible the Corps should schedule a series of meetings and/or workshops for DOI staff to illustrate economic methodologies used in evaluating civil works projects;

6d. Discuss and/or present supporting data on: (1) uncertainty of achieving project benefits given unguaranteed funding; (2) a comparison of measuring benefits via the lowering of flood insurance premiums with and without project; (3) a market-based approach to measure benefits by the change in property values with and without project; (4) re-evaluation of the assumption that destroyed property is instantaneously rebuilt in place; (5) re-evaluation of the non-structural alternatives in light of project costs greatly exceeding value of structures; (6) additional analysis on implications of the purchase of easements when benefits are supposed to be public, yet easements are compensating private property owners; (7) additional analysis on whether sandbags provide positive net benefits, which should be deducted from the project net benefits since the sandbags will be lost; (8) additional analysis on the implication that private interests are not willing to fund the project on their own because there are higher returns on their investments elsewhere, making federal funding a rent to property owners; (9) the proportion of the project benefits that are actually private and not public, such as the value of property; (10) additional data on how the storm damage reductions are distributed over the project area, how the distribution is characterized, and whether or how it is conditioned on the distribution of storms; (11) a more

rigorous benefits transfer analysis to the improvement of the beach experience calculation, or application of an alternative economic methodology; and, (12) a risk analysis on the potential increase in costs to dredging the Oregon Inlet navigation channel and establishment of a contingency cost figure for supplemental dredging at the channel due to sand movement from the project area. This cost would be added to the cost of the storm damage reduction project.

7. The Corps should establish a program to monitor dredging impacts on primary productivity and benthic invertebrate community composition. The program should assess the diversity, abundance, biomass, and production of benthic and infaunal macroinvertebrates of the offshore borrow areas. The program should include pre-project baseline data and post-project data at one-, three-, five-, and ten-years after dredging. The program should use an adequate number of control sites and at least one study site within the northern and southern borrow areas, if both areas are used.

8. The beach disposal aspects of the project should include a monitoring program on beach and subtidal invertebrates that form an important food resource for shorebirds and nearshore fishes. The project should include a requirement for a pre-project assessment of beach invertebrate biomass and community composition, i.e., the number of species present. The program should have adequate control areas such as the undisturbed beaches within Cape Hatteras National Seashore just south of the project area. There should be an additional requirement to quantify changes in biomass and community composition at one-. three-, five-, and ten years after initial construction. If any assessment indicates a significant decline in either biomass or the number of species present when compared to control areas, there should be definite procedures in place to develop mitigation for this biological community.

9. The project should include a funded program to monitor shorebird usage in areas of sand placement. The program should be more intense during the first 20 years of the project, but continue through the current 50 year planned project life. The project should be comprehensive enough to detect declines in shorebird use of areas receiving sand as opposed to control areas. If significant declines in use of sand placement areas are noted, mitigation measures should be investigated and any measure found to be reasonable and feasible should be implemented.

10. An integral part of the project should be a program to assess project impacts on offshore fisheries. This program should establish the pre- and post-project diversity, abundance, and biomass of fisheries resources using the areas slated for excavation and deposition. The program should also determine pre- and post-project efforts expended in the project area for commercial and recreational fishing activities. If these comprehensive evaluations indicate that fisheries resources have been adversely affected, the Corps should work with the Service and the National Marine Fisheries Service to develop a mitigation program for the remaining decades of the project. For example, the Corps is currently funding a study to model salinity in Currituck Sound but has not committed to implement a solution to artificial salt water influx that may be illustrated by the study.

Compensatory mitigation could be the development and implementation of a solution to man-made sources of salt water input to Currituck Sound (in the form a water control structures) if their model demonstrates a problem. While direct project impacts occur in the ocean, this mitigation effort in the sound would benefit many of the fish and bird species affected in the project area.

11. The Corps' decision-making documentation should indicate the measures taken to comply with the Magnuson-Stevens Fishery Conservation and Management Act and Sustainable Fisheries Act of 1996 (Public Law 104-297). This act requires that Essential Fish Habitat (EFH) be identified. The Service believes that over the 50-year life of the project, some or all of both nearshore or offshore areas impacted by this project may be designated as EFH. The Corps must consult with the National Marine Fisheries Service regarding the impact of the proposed project on those species for which the proposed borrow sites and adjacent areas have been determined to constitute EFH (USFWS 1999, references for Appendix B, Table 1). Although the study area has not been formally designated as EFH for anadromous species, management councils are mandated to comment to the Corps regarding the impact of the proposed project on those species; therefore, the New England, Mid-Atlantic and South Atlantic Fishery Management Councils, as well as the Atlantic States Marine Fisheries Commission, should be contacted and provided with an opportunity to comment on any mitigation measures related to these species.

12. Sediment placements may extend into the sea turtle nesting and hatching season, May 1 through November 15 of any year. The Corps initiated formal consultation in accordance with Section 7 of the Endangered Species Act. On November 22, 2000, the Service issued a Biological Opinion stating that the project was not likely to jeopardize the continued existence of loggerhead and green sea turtles and the piping plover. The Corps should incorporate the reasonable and prudent measures of that opinion along with the terms and conditions into project plans and specifications. Sea turtles would benefit from the discretionary conservation measures provided in the Biological Opinion The Service recommends that the Corps incorporates these measures in project plans.

13. The Corps' decision making documentation should fully discuss: (1) the potential rates of sediment losses from the beach fill based on grain size data (the Sand Suitability Analysis); (2) the likely pathways that may carry as much as 1.3 million cubic yards of sand per year for 50 years away from the beach; and, (3) the likely locations that would ultimately receive the sediment carried away from the beach.

14. In light of the difficulties that the Corps has had in maintaining the important navigation channel at Oregon Inlet, the Corps should present a plan for dredging the additional sand that will be carried to the Oregon Inlet navigation channel. Based on present calculations (3,890,000 cubic yards would be required for each three-year renourishment cycle; Final Feasibility Report, p. 59), approximately 1.3 million cubic yards of sand would leave project area beaches every year during the first 50-years of project implementation.

Some of this sand will be carried by the predominant north-to-south longshore current to Oregon Inlet, site of the important navigation channel maintained by the Corps. In order to ensure that this project does not exacerbate maintenance of the Oregon Inlet navigation channel, the plan should consider the feasibility of adding the additional dredging costs to the storm damage reduction project. In order to avoid delays in responding to any closure of the navigation channel, the Dare County project should contain specific measures that would be employed to minimize economic hardship to commercial navigation through Oregon Inlet.

15. While the Service is pleased that the Corps has expanded the consideration of the cumulative impacts of beach construction and beach disposal operations in North Carolina, this important aspect of project planning still requires additional consideration. The authorized project limits for dredge disposal operations on beaches, for example, would more accurately represent authorized cumulative impacts than actual disposal lengths. The lengths of beach considered for proposed or potential berm and dune construction should be the study limits authorized by Congress in 1990 for Dare County. Work now under study includes portions of Bodie Island as well as Hatteras and Ocracoke Islands. The length of the feasibility study is closer to 70 miles and not the 10 miles used by the Corps. An estimation of the lengths of areas employing sandbags and beach scraping as storm protection measures throughout the Wilmington District would enhance the cumulative impact analysis by incorporating similar artificial manipulations that affect the coastal ecosystem.

If the preferred alternative of the Final Chief's Reports is ultimately implemented, several design features and construction techniques can be employed to avoid or minimize adverse impacts to fish and wildlife resources. To achieve these goals the Service recommends:

16. In order to minimize both the direct and indirect impacts of turbidity and subsequent sedimentation, the Corps should ensure that the project does not use sediment which consists of more than ten percent silt and clay particles.

17. The sediments proposed for initial construction of the North Project Area are less compatible with the native sediments, and thus 50% losses are expected from this area (Final EIS, Appendix D, p. D-13). The geotechnical data describing the N1 borrow area in Appendices E and I indicate the presence of significant quantities of mud and unsuitable materials for beach disposal. In fact, 20 of the 27 cores taken in the N1 borrow area have mud contents exceeding 10%, and only 7 are completely clean of mud. By averaging all of the cores together over the entire borrow area, the Corps generates an average mud content for N1 of 9%. With current technology, practical dredging procedures preclude a 100% mixing of all of the sediments in the borrow area before they are placed on the beach. Dredges fill to their capacity from a subset of the borrow area, then pump out those sediments to the beach. Thus the mud content within sections of the borrow area will not be mixed with clean sediments from other parts to average 9%. Localized pockets of very muddy sediments will end up on the beaches in the North Project Area. To minimize the adverse impacts to the environment, the Service

recommends elimination of borrow site N1 for sediment compatibility reasons.

18. The Corps should coordinate with the National Marine Fisheries Service to develop procedures to avoid adverse impacts to marine mammals that may occur in the area of the offshore sand mining.

19. The Corps should ensure that no hardbottom habitats are affected by sedimentation produced by the project, either as a result of offshore sand mining or sediment washing off the beach. Some mud outcrops may be the habitat equivalent of rock outcrops, and these areas should be given appropriate consideration. This goal may be accomplished by actual surveys of the borrow sites and the review of data provided by the Southeast Monitoring and Assessment Program (SEAMAP). If hardbottoms are adversely affected, the project should include specific measures to mitigate adverse impacts. The project should produce no permanent reduction in the size and distribution of hardbottom habitats.

20. Sand mining should not leave a sediment substrate that significantly differs from the existing, pre-mining substrate, e.g., mud exposed where once there was sand.

21. Since there is no single period of the year when work could be scheduled to avoid adverse impacts to all the fish and wildlife resources in the project area, the best way to minimize adverse impacts is to reduce the duration of construction. Reduced construction time can be achieved by the simultaneous use of more than one dredge. On balance, the most limited resources, e.g., an undisturbed beach, would benefit from dredging during the winter months. Therefore, the Service recommends that initial construction be accomplished by using at least two dredging vessels that commence work on or after October 1. These vessels would work as weather allows through the winter and attempt to finish initial construction by March 31. If some work remained after March 31, these vessels would continue work into the spring until work was completed. After initial construction, sediment placement operations should follow a similar pattern, but with a reduced work period. Sediment replacement operations should be limited to the period from November 1 through the end of February. Scheduling beach disposal outside the larval recruitment period of beach invertebrates will ensure better recovery of these species.

The Service has serious concerns about the ability of an artificial beach-dune system to provide long-term protection for man-made structures on a barrier island, or barrier spit, surrounded by a rising sea. The measures given above should help to avoid or minimize some of the adverse environmental impacts. While some measures may add to project costs, any additional costs should be weighed against the gains in environmental quality. Some of these gains, such as protecting offshore fisheries, would have a measurable economic benefit that should be considered in the alternative selection process. Other recommendations seek to extend the period between maintenance events and such measures would reduce overall costs. Therefore, the Service requests that these recommendations be incorporated into the Record of Decision for storm damage reduction in Northern Dare County.

The Service appreciates the opportunity to provide this Fish and Wildlife Coordination Act Report. If you have any questions or comments, please contact me (919-856-4520, ext. 11), Howard Hall (ext. 27), or Tracy Rice (ext. 12).

Sincerely,

Dr. Garland B. Pardue
Ecological Services Supervisor

cc:

Cherry Green, USFWS, Atlanta GA
Brian Cole, USFWS, Asheville NC
Wilson Laney, USFWS, Raleigh, NC
Ron Sechler, NMFS, Beaufort, NC
Gerald Miller, USEPA, Atlanta, GA
Frank McBride, NCWRC, Raleigh, NC
John Dorney, N.C. Division of Water Quality, Raleigh, NC
Melba McGee, Office of Legislative and Intergovernment Affairs, Raleigh, NC
John Morris, N.C. Division of Water Resources, Raleigh, NC
Doug Huggett, N.C. Division of Coastal Management, Raleigh, NC
Caroline Bellis, N.C. Division of Coastal Management, Raleigh, NC
Preston Pate, N.C. Division of Marine Fisheries, Morehead City, NC

Literature Cited

Bush, D. M., O. H. Pilkey, Jr., and W. J. Neal. 1996. Living by the Rules of the Sea. Duke University Press. Durham, North Carolina. 179 pp.

Eccleston, C. H. 1999. The NEPA Planning Process - A Comprehensive Guide with Emphasis on Efficiency. John Wiley & Sons. New York, NY. 332 pp +Appendices.

Hudgens, D. 1999. Adapting the national flood insurance program to relative sea level rise. Coastal Management 27:367-375.

Pilkey, O. H., W. J. Neal, S. R. Riggs, C. A. Webb, D. M. Bush, D. F. Pilkey, J. Bullock, and B. A. Cowan. 1998. The North Carolina Shore and Its Barrier Islands - Restless Ribbons of Sand. Duke University Press. Durham, North Carolina. 318 pp.

Titus, J. G. and V. Narayanan. 1995. The probability of sea level rise. U. S. Environmental Protection Agency. EPA 230-r95-008. 186 pp.

U. S. Fish and Wildlife Service. 1999 (July). Northern Dare County Storm Damage Reduction Project, Dare County, North Carolina. Draft Fish and Wildlife Coordination Act Report. Raleigh Field Office, Raleigh, NC. 173 pp +Appendices.

APPENDIX A

U. S. FISH AND WILDLIFE SERVICE (FWS) RESPONSES TO COMMENTS FROM THE WILMINGTON DISTRICT, U. S. ARMY CORPS OF ENGINEERS, ON THE DRAFT FWCA REPORT FOR DARE COUNTY BEACHES (BODIE ISLAND PORTION)

Received by the Raleigh Field Office on December 13, 2000

U. S. Fish and Wildlife Service Responses Prepared by:

Howard F. Hall, Fish and Wildlife Biologist, USFWS, Raleigh, NC
Tracy M. Rice, Coastal Geologist, USFWS, Raleigh, NC
Wilson R. Laney, Fisheries Biologist, USFWS, Raleigh, NC

January 26, 2001

CORPS' COMMENTS ON THE DRAFT FWCA REPORT
Northern Dare County Storm damage Reduction Project
Dare County North Carolina

General Comments

a. We believe the draft FWCA report is far too lengthy. Few people have the desire, or the time, to read through a report of this length and, as a result, significant concerns of the Service can be lost in the sheer size of the document. This has been a recurring problem, one we have discussed at length with your staff over the years. While the Executive Summary helps to address this issue, it is not a solution. Again, we respectfully request that the Service renew its efforts to make its FWCA reports smaller. We believe a size limit of 50 pages would be more than adequate. Any necessary supporting material could easily be placed in appendices.

> **FWS Response**: We disagree. Draft and Final Environmental Impact Statements (EIS) and Environmental Assessments along with feasibility reports for civil works projects commonly exceed several hundred pages. Arbitrarily confining Fish and Wildlife Coordination Act (FWCA) reports to 50 pages would exclude much of the scientific literature and data necessary to support our conservation measures and recommendations.
>
> The Service constantly seeks to balance brevity with providing full and complete support for our statements. Several specific comments from the Corps epitomize this concern. Where the Service has provided full and complete supporting material, the Corps comments that the given section is too lengthy. At other places where the Service minimized supporting documentation, the Corps has requested additional supporting material or clarification. We will always seek to provide the Corps with the most complete and accurate information available. Many Corps comments on our Draft FWCA Report requesting greater clarification and support point to the need for more, not less, material in our FWCA reports.

b. We believe that this report strays far from the issues intended when the Congress passed the Fish and Wildlife Coordination Act. We believe long discussions telling the Corps about coastal geology, how it should conduct its planning, what size storms it should protect against, and how it should conduct its economic analyses are clearly beyond the scope of the FWCA. The Service is a recognized member of the planning team; however, if the Service does not agree with the District's planning and analysis procedures, we believe separate discussions should be held as a part of the ongoing planning process. The draft FWCA is not the forum to first mention the Service's concerns.

> **FWS Response**: The FWCA grants the Service broad authority to address any facet of the project and its development that may impact fish and wildlife resources, including marine resources. Coastal geology is an integral part of fish and wildlife habitat and the physical parameters of coastal ecosystems and therefore is certainly appropriate for discussion. In addition, the Corps' planning process dictates what environmental information is or is not gathered, storm size determines how habitats will change and be

redistributed, and the Corps' economic analyses account for limited or no natural resource economics or environmental damages. All are appropriate for discussion of fish and wildlife concerns. The Service has consistently raised the same concerns from the scoping phase to the FWCA reporting phase of the project. These concerns have been consistently ignored or given cursory evaluation. In that sense, the Service is a member of the planning team in name only. We look forward to our recently (December 14, 2000) agreed upon quarterly meetings to be an active member of the Corps' planning process.

c. The Service appeared to have difficulty in objectively assessing the significance of potential project impacts in this report. Virtually every conceivable impact to fish and wildlife resources from beach nourishment is described as significant. Such claims are not supported by the facts. The Service refuses to recognize that such impacts have not occurred in southeastern North Carolina. At Wrightsville Beach and Carolina Beach, beach nourishment projects have been maintained for over 30 years and Service personnel have visited these areas many times. Few of the impacts forecast by the Service have occurred at these beaches. Mole crabs are abundant in the surf, juvenile fish still reside in the surf zone, shorebirds still forage, sea turtles still nest, fishermen still catch fish in the surf and from piers, and other recreational use remains high. If the Service can observe such fish, wildlife, and recreational use in the field but then refuse to recognize it in their reports, it clearly brings their objectivity into question.

FWS Response: We disagree. The Service is aware of no scientific data to evaluate the health of the Wrightsville and Carolina Beaches' ecosystems, and personal observations are not objective, defensible science. Biologists currently with the Service have no first hand knowledge of the fish and wildlife conditions on these beaches during the early 1950s prior to the earliest sediment placements. Just as the Service could not say that fish and wildlife habitat quality in the area has deteriorated over the last 50 years based on personal observations, we cannot say, based on recent observations, that there have been no adverse effects. The impacts described by the Service have occurred in other project areas. We believe these impacts are relevant to the proposed work on the Dare County Beaches. The Service will incorporate factual, scientifically supported information supporting the Corps' conclusion that none of the adverse environmental impacts discussed in the Draft FWCA Report have occurred on the constructed beaches of southeastern North Carolina.

Specific Comments

Section 2 [Study Area Description]

a. Page 8 through 19. This section contains a long discussion of the Service's views on barrier island geology. This, and all similar supporting discussions, should be placed in an appendix. This section presents a very one-sided view of barrier island dynamics wherein the Service

presents barrier island migration as a fact, not a theory. We respectfully request that all views of this issue be presented. While island over wash is recognized as an important part of barrier island ecology, recent studies indicate that it's significance in the long-term maintenance of the island may be different than is widely believed. Comparative analysis of barrier island changes dating from the mid 1800's to the mid 1940's indicates that the barrier islands did not migrate during this period. We have compared detailed maps of the barrier islands from Rodanthe south to Beaufort Inlet as well as Masonboro Island, located along the southern portion of the North Carolina coast. The comparative analysis determined changes in the shoreline position, and changes in the marsh vegetation over the approximately 75-year period. This time period was used because as it did not include the significant impacts of the artificial dune-building program on Hatteras and Ocracoke islands that began in the mid to late 1930's. The study found that all of the barrier islands, including Core and Shakleford banks which were not included in the dune-building program, are experiencing general erosion on both the ocean and sound sides. Also, the marsh vegetation line generally moved seaward. These measured changes were deemed to be consistent with the changes one would expect as a result of a 0.75 to 1.0 foot rise in sea level during the analysis period. The only area exhibiting classic barrier island retreat characteristics was the east end of Ocracoke Island that "rolled over" in response to a sediment deficit created by the opening of Hatteras Inlet in 1846. Our findings were verified by the subsequent work of Everts, Battley, and Gibson in a report entitled "Shoreline Movement" which was published as a Coastal Engineering Research Center Report TR CERC-83-1.

FWS Response: We agree that the immediate project area is not currently migrating, but adjacent areas have exhibited island migration and the project area may have migrated in the past. Godfrey and Godfrey (1976, pp. 23, 39), for example, document a wholesale retreat of the southern Outer Banks without a change in physiography in the last century. Everts et al. (1983, p. 93) state that "During migration the [Outer Banks] islands likely had alternating periods of net island narrowing and widening superimposed on the longer term landward migration. ... The optimum conditions [for migration] are a narrow island ... [and] a low island where dunes are absent, or low and discontinuous...." As described in responses (c), (d), (e) and (f) below, barrier island narrowing is consistent with island migration and the presence of artificial levees can inhibit migration. Narrowing is in fact essential for overwash to dominate. Everts et al. (1983, p. 96) agree with this position, stating that before the islands could "narrow to nothing ... overwash, if allowed, will likely begin to transport sand to the sound shoreline and island migration will commence."

Another method of island migration is incorporation of inlet shoal sediments (Godfrey and Godfrey 1976; Everts et al. 1983). Everts et al. (1983) cite the low number of current inlets along the Outer Banks (as compared to historical records) as the probable cause for an absence of visible migration during the study period in question. The authors note that Oregon Inlet is the only dominant inlet in the study area, and "significantly, the barriers adjacent to it are migrating in a westerly direction" (Everts et al. 1983, p. 95). Thus there is evidence that the Outer Banks can and do migrate, and recent records for the immediate project area likely represent a comparably quiescent period. The

information presented above supports the position of the Service, serves as part of this Final FWCA Report, and forms a basis for the recommendations given in this report.

b. Figures 3 and 4. Geologic references indicate that the modern-day barrier islands are 5,000 to 6,000 years old corresponding to a relatively stable level of sea level over the last 5,000 to 6,000 years. This geologic evidence does not support the migratory theory regarding the present islands.

FWS Response: See response (a) above. Barrier islands migrate in response to fluctuating sea levels, and sea level is currently rising at an accelerating rate (Titus and Narayanan 1995). Everts et al. (1983, p. 95) state that "Sand losses from the front and back of the islands in the recent past may have been partially caused by a rise of sea level relative to land – a vertical rise of probably 4 mm/year in the study area since 1930 (Hicks 1981)." Migration may also occur episodically during major storm events, and evidence now indicates an increase in the frequency of Atlantic hurricanes following a decline that bottomed out in the 1970s (Smith 1999). Caviedes (1991, as cited in Smith 1999) found an increase in the frequency of hurricanes since the 1770s. These changing climatic factors suggest that the islands are not going to be as stable in recent records or the near future. Therefore the evidence cited by the Corps is consistent with barrier island migration and is not necessarily representative of future expectations.

c. Page 9 3rd paragraph, 7th line. Reference is made to islands eroding on both the ocean and sound side. This supports studies by the Wilmington District and the Coastal Engineering Research Center that shows that the barrier islands of North Carolina are eroding on both sides.

FWS Response: One of the dominant processes by which barrier islands migrate is overwash. In order for overwash to dominate as the coastal process affecting an island, the island must be narrow enough for overwash materials to reach the sound shoreline. Narrowing of barrier islands is necessary before they can actively roll-over and move landward (Everts et al. 1983). Thus we agree that many islands of North Carolina are eroding on both sides, which is consistent with island migration.

d. Page 12, 1st paragraph. This paragraph contradicts the statement made on page 9 regarding erosion of the barrier islands on both the ocean and sound sides.

FWS Response: The statement on page 9 is a general description of migratory processes, while page 12 addresses site-specific information relevant to the project area.

e. Page 12, 2nd paragraph. The shoreline erosion amounts attributable to sea level rise are not supported by the historic record. During the last 150 years, sea level in the area may have risen 1 to 1.5 feet yet shoreline erosion amounts have not approached the 3,000-foot value suggested in this paragraph.

FWS Response: Underlying geology and human influence both affect measured shoreline erosion amounts. The Outer Banks are underlain by a variety of muds, sands

and gravels in a heterogeneous fashion. Some of these sediments erode faster than others, leading to highly variable erosion rates (Riggs et al. 1995). Human obstructions such as houses, roads, sandbags and artificial dune building also prevent natural recession processes. The recession figures cited are idealized and do not account for site-specific underlying geologic controls or human influence.

f. Page 12, last paragraph. Again, no evidence exists in the survey record over the last 150 years to support the claim that the islands have widened as a result of overwash.

FWS Response: Godfrey and Godfrey (1976; Fig. 23 on p. 37) describe and document overwash widening of the southern portion of the Outer Banks, so there is published evidence to support our position. The Corps' comment on Page 80, paragraph 2 (Section 6, a) below states that ". . . many acres of marsh at Topsail Beach have been 'nourished' so much by recent hurricanes [presumably by island overwash] that they are now high ground and may be lost to development in the future." While we realize that Topsail Beach is not part of the Outer Banks, this statement by the Corps suggests that sound side marshes of barrier islands can become sandy uplands, evidence that at the present time that island overwash can widen barrier islands in North Carolina.

g. Figure 5. The concept of shoreline erosion as a function of sea level rise and the slope of the coastal plain is not supported by documented changes in shoreline position.

FWS Response: The Service believes that shoreline erosion as a function of sea level rise and the slope of the coastal plain is supported by documented changes in shoreline position as described in responses (b) and (e) above.

h. Page 15, Table 1. Data for which no period of record can be provided should not be included in this table. A shoreline recession rate without a period given is meaningless, it could be 6 days or 6 years. The fact that the shoreline is receding can be made well enough without including incomplete data sets.

FWS Response: The erosion rates cited in Pilkey et al. (1998) are derived from the North Carolina Division of Coastal Management's "Long Term Average Annual Shoreline Change Rates Updated Through 1992", which is measured over the previous 50 year period. Therefore the data presented in the table are available with a period of record.

i Page 31, 2nd paragraph. The active beach profile in Dare County extends to depths of -27 feet.

FWS Response: We disagree. The Service is not aware of any documentation supporting this determination. Our position is that the active beach profile changes depending on wind, wave, and current energies.

j. Page 31, paragraphs 2 - 3. These paragraphs are not biology and do not belong in a description of the wet beach biological community.

FWS Response: The two paragraphs in question discuss the definition of a beach. While this discussion is not biological, the Service believes that the proper definition of terms - especially terms that have different meanings to scientists and the general public - is a valid part of our description of the biological communities of the project area. The information presented above supports the position of the Service, serves as part of the Final FWCA Report, and forms a basis for the recommendations given in this report.

k. Page 30, paragraph 5. The wet beach community is one that could be heavily impacted by the proposed project. A description of this community, using a field guide as the only reference, seems to underplay the importance of this community. Please reference other more recent studies performed in North Carolina to more completely describe this community.

FWS Response: While Ruppert and Fox (1988) carries a subtitle of "guide to common shallow-water invertebrates of the Southeastern Atlantic coast," the work, published by the University of South Carolina Press, is more than the simple picture guides used to identify species. At the time of publication the authors were professors of zoology/biology at institutions in South Carolina. This work covers the physical description, taxonomy, habitat preferences, and basic ecology of 740 common marine invertebrates. Literature on the meiofauna (0.1-0.4 mm in size) and macrofauna (>0.4 mm) of sandy, Atlantic beaches is limited. A 1996 review and synthesis of data (Hackney et al. 1996) on surf zone invertebrates in the South Atlantic Bight was prepared for the Wilmington Corps District. The sole reference (Hackney et al. 1996, pp. 10-11) for the general meiofauna and macrofauna of open, sandy beaches was Levinton (1982), a textbook on marine ecology. A recent publication (Peterson et al. 2000) released after the Service's report discusses beach invertebrates on Bogue Banks, North Carolina. This paper focuses on the dominant species such as the mole crab (*Emerita talpoida*) and coquina clams (*Donax* spp.). The discussion of other species notes that the intertidal beach and shallow subtidal bottoms are populated by several species of amphipods and polychaetes that make only a small contribution to total biomass due to their small body sizes. The citations for these smaller species are from the early 1940s and late 1960s. The Service considers Ruppert and Fox (1988) to be worthwhile reference and information from this source is incorporated into our Final FWCA Report. The Service will continue to incorporate more recent information, such as Peterson et al (2000), into future reports.

l. Page 30, last paragraph which continues on to page 31. We question the description that states that vegetation of this community is "primarily" by sea rocket and seabeach amaranth. Seabeach amaranth, a federally listed threatened species, is a very minor component of this community. Please revise.

FWS Response: The entire sentence in question states that "Vegetation [of the dry, subaerial beach] consists primarily of a few annual, succulent species, including sea rocket (*Cakile edentula*) and seabeach amaranth (*Amaranthus pumilis*)." This sentence was based on vegetation characteristics given by Schafale and Weakly (1990, p. 261-263) for the upper beaches in North Carolina. They state that "The vegetation is sparse,

characterized by a small number of species, many of them succulent, which are adapted to the environmental characteristics of these sites. Annuals are most prevalent, including *Cakile edentula* (a winter annual), *Chamaesyce* (*Euphorbia*) *polygonifolia* [seabeach sandmat], *Chamaesyce bombensis* [southern seabeach sandmat], *Amaranthus pumilis*, *Polygonum glaucum* (seabeach buckwheat], *Salsola caroliniana* (kali) [Carolina beach thistle], *Atriplex arenaria* [seabeach orach], and *Sesuvium maritimum* [slender sea-purslane]." In the Service's report, the term "primary" refers to a group of species, i.e., succulent, annual plants, and the two species given are selected examples from this group. The two species given are not intended to represent the dominant vegetation of project area beaches. While we consider our original statement to be accurate, the information provided above serves as part of the Final FWCA Report, and forms a basis for the recommendations given in this report. Service will include more detailed information from Schafale and Weakly (1990) in future reports.

m. Page 32, paragraphs 3. Again, this section is supposed to be a description of Biological Communities. This paragraph does not seem to belong.

FWS Response: This paragraph serves to define that portion of the dry beach known as the berm. It also mentions some of the physical forces (waves and currents) that influence the area. These forces, in turn, influence the organisms that can utilize this habitat. The Service believes that proper definitions and the physical forces shaping a specific habitat are appropriate for this section of the FWCA report. The information presented above answers the question posed.

n. Page 32, paragraph 4. This paragraph describes the beneficial attributes of dunes such as sand sharing, storage center for beach sediments, dissipating storm energy, etc. All of the attributes described in this section are shared by the "artificial dunes" that were alleged throughout the report to destroy barrier islands. It appears that the Service is walking a very thin conceptual line between "good" dunes and "bad" dunes. If there are design characteristics that should be incorporated into project design that will make a "bad" dune "good," they should be explained elsewhere in the report and referenced here.

FWS Response: There are several sedimentological, stratigraphic, and geomorphological differences between natural and artificial dunes. While both share sediment storage and storm buffering functions, bulldozed dunes lack the internal stratigraphy of natural dunes, consist of a poorly sorted mix of grain sizes, and frequently contain shells and other materials not found in natural, aeolian dunes. Burrowing macrofauna such as ghost crabs cannot maintain burrows in such poorly consolidated sediments. Artificial dunes constructed with bulldozers or sand fencing are often built in locations on the beach where man determines they should be, not where nature would necessarily put them. Their size and dimensions commonly exceed those of natural dunes in the area, they form a continuous dune ridge rather than intermittent dunes of various heights and spacings, they prevent overwash where it would otherwise occur, and stabilizing with vegetation creates an artificial monoculture. Nordstrom (1994) notes that the dune built by the Corps in Long Beach Island, New Jersey, after the 1962 Ash Wednesday storm ". . . was linear and shore-parallel, and bore little resemblance to the

hummocky dune that characterized many areas prior to development and that would have characterized natural dune growth adjacent to overwash channels created during the storm." The inhibition of overwash sediments naturally nourishing the interior and sound-side of barrier islands along with the artificially accelerated plant succession occurring behind artificial dunes alter the natural integrity of the barrier island. In this way artificial dunes are in actuality levees, or "man-made dikes" as Godfrey and Godfrey (1976, p. 14) describe them. Thus there is a clear difference between natural and artificial dunes in terms of geological and ecological attributes.

o. Page 33, paragraphs 2 & 3. Do any overwash flats actually exist in the project area? If so, please state where they occur. If they do not, please so state.

FWS Response: As noted in responses (n) above and Section 5 (g) below, recognized overwash fans or flats are minimal to non-existent in the project area due to maintenance of the artificial dune line and clearing of overwash sediment following storm events. The Service stated (U. S. Fish and Wildlife Service [hereafter USFWS] 1999, p. 33) that the overwash flat community is usually absence or temporary in developed areas such as the project area.

p. Page 24-39. The discussion of Biotic Communities neglects to mention the residential and commercial areas of the island. These habitats probably occupy more acreage than any other habitat type present in the study area.

FWS Response: While these communities could be discussed as separate sections, the Service believes that residential and commercial areas have been superimposed on the natural communities discussed in this section, and that human dominated areas represent disturbed subsets of such natural areas. For example, a certain subset of birds which use natural low shrub/grassland communities would also occur in the remnant shrubs and grassland areas of a housing development built in such an area. It would be possible to discuss some unique habitat features created by man-made structures, e.g., shorebirds nesting on flat roofs of building, bats roosting under building eaves, or gulls feeding in fast food restaurant parking lots. However, the Service has no information at this time that the natural fauna of the Outer Banks makes significant use of such artificial habitats. Commercial and residential areas may create artificial population imbalances such as when high predator populations are sustained by feeding on garbage. A goal of the Service is to maintain sufficient natural habitat so native species are not forced to use artificial substitutes that are often deficient in habitat value. For these reasons the Service does not discuss artificial communities in this section on biotic communities. The information presented above answers the question posed.

Section 3 [Fish and Wildlife Concerns and Planning Objectives].

a. Page 40, paragraph 2, last sentence. The Wrightsville Beach and Carolina Beach projects have been in place for several decades and are still proving very effective at providing protection.

FWS Response: The Service is not aware of any scientific documentation supporting the Corps' statement. If the Corps can provide such documentation, we will gladly incorporate it into future reports.

b. Page 40, paragraph 3, lines 6 - 8. We are unclear about what is meant by "sensitive natural areas." Please clarify. We are also unclear about what is meant by "In the past, these manipulations were smaller and impacted a smaller geographical area." What manipulations are intended? Please clarify.

FWS Response: The first sentence of this paragraph states that the Service recognizes estuarine sounds, barrier island uplands, beaches, and the nearshore ocean as "unique and valuable habitats" for fish and wildlife resources. The second sentence states that the first concern of the Service is that these habitat values not be eliminated or degraded. The second sentence implies that the habitat values of areas given in the first sentence can be degraded or eliminated. Therefore, these areas can be considered "sensitive" to disturbances. The statements in question, lines 6-8, states, in part, "Any manipulation of sensitive natural areas will be harmful[.]" "Natural areas" refers to the broad ecosystems mentioned in the first sentence, and "sensitive" refers to the ideas that these ecosystems can be degraded by human alterations of magnitudes both large and small. This information should clarify the phrase in question.

The past "manipulations" mentioned refer primarily to offshore sand mining for constructing artificial beaches, but would also include such activities as beach bulldozing and sandbag protective barriers. In this section on general concerns of the Service, we take a broad view of habitat alterations, or manipulations, along the coastline of the entire state. Manipulate may be defined as an action to influence or manage something or someone. The present project would move 12.3 million cubic yards (mcy) of offshore sand for initial construction of 14.2 miles of artificial berm and dune system. Over the planned life of 50 years, 74.6 mcy would be removed from seven square miles of offshore bottoms. A similar beach construction operation is being planned for approximately 19 miles of the Brunswick County shoreline, and early planning has started for a beach construction project on Bogue Banks that may exceed 15 miles. These projects are larger than entire completed or current beach construction work in North Carolina. Current beach construction projects at Carolina Beach and Wrightsville Beach are 6.8 and 3.0 miles, respectively. One option for handling beach quality material dredged during routine maintenance of the Atlantic Intracoastal Waterway is to place the material on nearby beaches rather than the upland disposal sites used in the past. The Wilmington Harbor enlargement project was changed in the late 1990s to redirect up to six million cubic yards of material from an offshore disposal site to a one-time beach construction effort along beaches that may total approximately 15 miles. The geographic scope and magnitude of beach construction in North Carolina and the mining of sand to construct these temporary beaches is increasing. This information provides clarification for the statements in question.

c. Page 41, paragraph 3. The Service makes a case that an artificial dune would lead to increased development and secondary impacts to natural resources. Yet, on page 79, paragraph 2, it states that in a future without a project, the project area will be fully developed. We are not aware of any evidence that storm damage reduction projects induce development. If the Service believes greater development will occur, please provide examples to support this contention given that high-density development has already occurred in many areas without beach nourishment projects.

FWS Response: The Service does believe that constructing and maintaining an artificial berm and dune system will produce greater development than that which would occur without such construction. The artificial beach is one aspect of a suite of government efforts to reduce the risk of flooding and substrate loss to oceanfront structures. The Corps notes (2000b, p. C-25) that ". . . structures protected by these [beach protection] projects are subject to less risk and less damage than structures located in unprotected areas." Other programs to reduce the risk of coastal residents include the National Flood Insurance Program (Heinz Center 2000, pp. 33-54), a federal program to provide affordable flood insurance not offered by the private sector, and Federal Disaster Assistance (Heinz Center 2000, pp. 101-102).

It may be difficult to relate the suite of federal risk reduction programs to the level of coastal development. Some developers may ignore all risks of beachfront development. However, other developers and their financial backers are concerned that beachfront structures could be totally destroyed at any time. It is the latter group that will carefully consider the entire range of risk reduction programs, including a commitment to build and maintain an artificial berm and dune system, prior to embarking on costly development projects. For this group, a lower risk of future losses justifies greater expenditures for development. A high risk of complete loss (an island subject to periodic overwash, no government subsidized insurance, and uncertain post-storm relief) will cause some developers not to build on barrier islands or to locate development away from the ocean. The early settlers of the Outer Banks who bore the entire risk of all their financial undertakings, built their homes on the soundside of the islands until about the mid-1880s (Frankenberg 1995, p. 118). The Service believes that it is logical to assume that by reducing the risk of property destruction and major financial loss, constructing an artificial beach along with other federal risk reduction programs would facilitate more development on barrier islands.

The Service believes that the existing artificial dune in the project area facilitated some of the development which exists today. Pilkey et al (1998, p. 139) state that one of the most important events leading to the development of the Outer Banks was the construction in the 1930s of a continuous dune line from the Virginia border to the western end of Ocracoke Island. The large, artificial frontal dune changed the Outer Banks from an area dominated by overwash to a dune island. The authors conclude that "[D]evelopment became possible in the protective lee of the artificial dune where it would once have been impossible because of frequent overwash." In light of the Corps' comment, it is proper to ask the rhetorical question, what would the level of development

be in the project area if the 1930s' artificial dune had not been built? It is likely that movement along the shore-parallel roads such as NC 12 and US 158 would be more sporadic with extended period of closure due to overwashes. It is also likely that the protection of these roads and the general reduction in risk of property destruction produced development that would not otherwise exist today. Since the Service believes that some development in the project area would not exist but for the artificial dune built in the 1930s, we conclude that one of the secondary impacts of that artificial dune has been greater development. The Service would say that if there had been a question as to whether the construction of the artificial dune in the 1930s would directly contribute to increased development on the barrier islands, the answer would be yes. Since the proposed construction of the artificial berm-dune system is meant, in part, to replace the first artificial dune, the Service sees no reason that the secondary impacts of the current project will be different.

The ability of an artificial beach to induce development can also be considered by evaluating development patterns in areas without such beaches and other risk reduction programs. The Heinz Report on coastal erosion evaluated the role of flood and erosion mitigation measures on development (Heinz Center 2000, pp. 134-135). For this report a team of researchers at George Washington University reconstructed 35-year development histories of 120 blocks of homes within seven coastal counties, four of which were on the Atlantic coast. The researchers used statistical regression methods to examine whether the amount of land developed in each block was related to the risk of erosion and flooding. The study found that shoreline recession (erosion) has an effect on development density. Within the blocks that could be impacted by erosion within zero to thirty years, development density was lower than areas that would be impacted in 31 to 60 years. Development density in areas that would be impacted by shoreline recession (erosion) within zero to 15 years was 10 percent lower than areas that would be impacted in 16 to 30 years. Part of the federal interest for the Dare County Project is to "arrest erosion" (USACOE 2000b, p. 9) Therefore, by creating the perception that erosional losses will be delayed or eliminated, i.e., reducing the risk of property damage by erosion, the construction of an artificial berm and dune would extend the area of greater development density oceanward. In fact, some developers may assume that all areal losses associated with shoreline recession have been eliminated, and the higher development density characterized by the zone expecting impacts in 31 to 60 years could extend all the way to the landward side of the artificial dune. In this regard, constructing the artificial berm and dune system, by creating a perception that all erosional losses would cease, is likely to generate greater shoreline development.

There was also a statistical association between the risk of flooding and development density (Heinz Center 2000, p. 135). In the absence of flood insurance and other programs (which may include artificial beaches), development density would be about 25% lower in V-zones (an area with a 1% chance of flooding in a given year and subject to high velocity waves greater than three feet high) than in areas less susceptible to damage from coastal flooding. Turning this statement around, government programs to artificially enlarge the area with a reduced the risks associated with flooding and storm

waves have resulted in a 25% increase in development in the area that was formerly the most hazardous coastal zone. A goal of the Dare County project (USACOE 2000b, 9-10) is to "protect against wave action." This goal implies that the demarcation line between the V-zone and the A-zone would be moved seaward and the areal extent of the V-zone would be reduced. At the same time the area of the A-zone, an area subject to less storm damage, would be increased. The A zone, landward of the V-zone, also has a one percent chance of flooding in a given year, but wave action either does not occur or is less than three feet high. By moving land from the dangerous, less developed V-zone into the more developed A-zone, a secondary impact of the proposed construction of a berm and dune system is greater development within the project area.

The information presented above supports the position of the Service, serves as part of the Final FWCA Report, and forms a basis for the recommendations given in this report.

d. Page 39, 4th paragraph. The current proposal for Dare County beaches does not include the removal of sediment from hard bottom areas.

FWS Response: We could not find the reference to Page 39, 4th paragraph. Page 39 has only one paragraph and is located in Section 2, not Section 3. Since this comment is listed after those on Pages 40 and 41, the Service checked Page 49. Page 49 is in Section 5 and the 4th paragraph describes avian resources in the project area. Please clarify the citation as neither of the two obvious locations pertain to hardbottoms.

Section 4 [Evaluation Methods]

No Comments.

Section 5 [Existing Fish and Wildlife Resources]

a. Pages 47 through 60, Tables 2 - 7. We do not need or require long species lists. Unless the Service needs them, we suggest that they be dropped from the report.

FWS Response: The lists of species that may occur in a given project area serve two purposes. First, they provide a concise format for presenting the scientific names of these species. This procedure reduces the need to scatter scientific names throughout the text, and provides readers with a single place to find scientific names for common names given later in the text. For this reason the Service prefers to places these lists in the text rather than as appendices. Second, these lists provide a general indication of the species diversity within the project area. If the Service should later comment that the area has a wide diversity of birds, the reader will have a general appreciation of this fact simply be remembering that the list of species occupied eight pages of the report. Both purposes can be achieved without reading the entire table, line by line, for each vertebrate class. The information presented above supports the position of the Service, serves as part of the Final FWCA Report, and forms a basis for the recommendations given in this report. The Service does not intend to eliminate these species lists from our FWCA reports.

b. Page 61. There is no mention of state listed species in any of the subsequent sections of the report. This is normally provided in a FWCA report. If such species occur in the project area they should be included in a discussion immediately following federally listed species. If there are none, please so state.

FWS Response: The Service appreciates this recommendation. In recent years the Service has not included a separate discussion of state protected species. While many federally listed species have the same designation at the state level, there are species which carry only a state designation. State protected species are monitored by the North Carolina Natural Heritage Program (NCNHP). Current data may be accessed at the web page of this program (www.ncsparks.net/nhp/), and species searches may be made by county or topographic quad sheet.

A review of two quads in the Dare County Project area, Kitty Hawk and Roanoke Island NE, revealed that the state status of the loggerhead sea turtle, manatee, Atlantic (Kemp's) ridley sea turtle, and the shortnose sturgeon was the same as the federal status. While the bald eagle has been proposed for federal delisting, the species is still designated as endangered by the state. The black rail (*Laterallus jamaicensis*), a marsh bird, is state listed as significantly rare (SR). Two vascular plants are listed as SR. The woolly beach heather (*Hudsonia tomentosa*) may be found on dunes and blowouts. The maritime pinweed (*Lechea maritima* var. *virginica*) may be found on barren dunefields, sometimes in association with woolly beach heather.

Corps project planning should determine whether the state listed species are present in the project area and develop specific plans to ensure that these species are not adversely impacted by the project. The Service would be happy to assist in the review and development of such plans.

c. Page 63, paragraph 3. It is unclear what dolphin foraging behavior in the Chesapeake Bay has to do with this project. Please explain or delete.

FWS Response: The Service wished to present some basic biology of the bottlenose dolphin as a prelude to discussing potential project impacts to the species. In order to add clarity, the sentence in question will be replaced by material given by Mead (1999). The revised material will state that:

> Mead (1999) noted that the Atlantic coastal population of *Tursiops* feeds mainly on fish of the genera *Cynoscion* (sea trout), *Micropogonia* (croaker), and *Leiostomus* (spot). The offshore population feeds on deep-water fish and squid. Coastal animals are frequently seen swimming just off the surf line. Dolphins normally enter bays and rivers and some populations are resident in those waters.

This revised material constitutes part of the Final FWCA Report, and forms a basis for the recommendations given in this report.

d. Page 69. The discussion of fish and wildlife resources by community type only discusses vertebrate animals. The reason for this is unexplained. Elsewhere in the report, the Service stresses the importance of invertebrates to the ecosystem but here they do not even merit mention. This appears to be a very artificial segregation of significant resources. Please include invertebrates into this discussion or provide a clear reason why they are excluded.

FWS Response: The Service's Fish and Wildlife Coordination Act Reports follow a standard format developed by the Southeastern Region in 1987. In that format there are separate sections for describing the study area and existing fish and wildlife resources. Section 2 of the Dare County FWCA Report notes (USFWS 1999, p. 24) that the discussion of biotic communities will include the plants and major invertebrate fauna which form the base of the food chain. At this point, the report notes that vertebrates will be covered in Section 5. The Service believes that this a logical approach. The plants and invertebrates discussed in Section 2 are more easily separated among the biological communities discussed. Once these communities have been described, the vertebrate species, which may range over several communities, can be described by reference to the earlier community descriptions without undue repetition. While any division of complex material will have positive and negative aspects, we believe the current format is the best manner for the material required by the FWCA. The information presented above answers the question posed.

e. Page 70, paragraph 4. This paragraph seems to have no connection to the paragraph's subject matter. Please revise or delete.

FWS Response: This one-sentence paragraph states that there are two species of small coastal sharks in the waters of North Carolina. The sentence is placed in the discussion of fish and wildlife resources in the nearshore pelagic area. The citation for the statement is Huntsman (1994) who included a section on sharks in his paper entitled "Managing the Coastal Oceans for the 21st Century: North Carolina's Role." The Service believes this statement is accurate and appropriate for this section. Since the short statement seems to lack continuity with the rest of the section, the Service will expand the discussion of Huntsman for the Final FWCA Report as follows:

> "The sharks of the Atlantic Coast and those off North Carolina are divided into two groups. There are small coastal sharks, such as dogfish and spiny dogfish, and pelagic sharks. There seems to be little concern about the first two groups. But large coastal sharks are intensely fished, perhaps overfished. There are about 20 species of them. To manage these species, we've reduced fishing mortality by about 30 percent. This should give us a 5 percent growth in population per year."

This information serves as part of the Final FWCA Report, and forms a basis for the recommendations given in this report.

f. Page 71, paragraph 6. This discussion implies that colonial water birds nest in certain portions of the project area. If this is the case please provide site-specific data.

FWS Response: The principle sentence in question states that "In certain areas, colonial waterbirds such as least tern and black skimmers nest along the upper beach." This section discusses the general habitat potential of the various biological communities in the project area. At the time this report was written (July 1999), the project included sand disposal on the undeveloped beaches of the Cape Hatteras National Seashore (CHNS). This sentence did not state that shorebirds were known to nest in the specific area targeted for sand placement. The primary reference for this statement is Parnell et al. (1995) who state that the gull-billed tern (p. 34), least tern (p. 46), and black skimmers (p. 50) nest on barrier beaches among other locations. Parnell et al (1986, Figures 6 and 9) give four beach nesting sites (designated as 08-0101, 08-0106, 08-0107, and 08-02) on Hatteras Island between Oregon Inlet and Cape Hatteras. These sites on the barrier island have been used by such colonial nesting waterbirds as the black skimmer, least tern, common tern, and gull-billed tern (Parnell et al. 1986, Table 1, Sheet 3 of 9). Parnell et al (1992) state that "[c]olonial waterbirds nest in several habitats within the Cape Hatteras National Seashore. Most least terns, common terns (*Sterna hirundo*), gull-billed terns and black skimmers nest on open beaches between the high-tide line and the base of the foredune, on overwash fans or on sand spits adjacent to inlets." These species are part of a group that typically nests in areas consisting of bare sand or shell, i.e., areas with little vegetation. While these sites may no longer be used, these data support the position that some colonial waterbirds would nest on the beach habitats that occur within the project area defined in 1999, primarily the undeveloped section of CHNS that was part of the project area when this FWCA report was drafted. The information presented above answers the question posed. Sand placement within CHNS has been dropped from the project, and it is unlikely that the project would have a direct impact on shorebird nesting. The Final FWCA Report incorporates this change in potential project impacts, but this information remains appropriate for the potential use of various biological communities (Section 5) where the paragraph in question occurred.

g. Page 72, paragraph 7. This paragraph does not indicate whether overwash fans are present in the project area. Page 33 indicates that they are usually absent in areas like the project area. If they are absent from the project area it seems incorrect to discuss them as if they were present. Please revise.

FWS Response: Minor overwash fans and/or sheets have formed in response to major storms (e.g., Dennis at vehicle access points), but the common practice of bulldozing the sand back to the beach or dune ridge prevents their persistence. In the absence of a continuous, artificially maintained dune ridge, overwash fans would exist in the project area. The project as proposed would prevent their occurrence for the planned project life, prohibiting habitat for wildlife species that used this early successional community. Everts et al. (1983) also conclude that overwash is not allowed. We believe it is important to note that overwash areas would occur except for continual artificial manipulation to prevent them from forming.

h. Page 75, paragraph 1. Does the use of the term "essential habitat" mean that these areas have been designated Essential Fish Habitat by the NMFS? If so, please clearly identify them as such. If not, please use a different term to avoid unnecessary confusion.

> **FWS Response:** The sentence in question states "Salt and brackish marshes are considered essential habitat for many fish species." In this statement, the term "essential habitat," without capital letters, does not refer to the formal Essential Fish Habitat (EFH) subject to the protective measures established by the Magnuson-Stevens Fishery Conservation and Management Act and associated rules of the National Marine Fisheries Service (Public Law 94-265; 16 U.S.C. 1801 et seq.). The Service plans to use the complete term of EFH - in capital letters - for all references to habitat protected under the Magnuson-Stevens Act. The Service wishes to avoid any possibilities of confusion, and will change the term used in sentences such as the one in question to adjectives such as "critical" or "important." The Service apologizes for the use of this adjective.

i. Page 76, paragraph 4. Please revise this paragraph to identify the most common species of birds first then move on to the rare species. The way this paragraph is currently structured, it makes piping plovers, Lapland longspurs, snow buntings appear to be as common as dunlins. Also, please check your source to make sure that all of these species have actually been reported from the project area.

> **FWS Response:** The sentence in question refers to birds that may use intertidal mudflats or sandflats. The Service sees no compelling reason to list species utilizing a particular habitat in a strict order of frequency of use. More detailed information of avian use of such areas is provided by Peterson and Peterson (1979). This report discusses the species which use North Carolina intertidal flats, their abundance, diet, and residency status in the state. The report includes over 70 species in six guilds (Peterson and Peterson 1979, pp. 50-52). All the species listed are included in "Birds of the Outer Banks" (Fussell and Lyons 1990). Unless the Corps has information to the contrary, the Service believes that all these species occur in the project area. Future FWCA Reports will incorporate information on relative abundance among species if such data are available. In preparing the recommendations for this Final FWCA Report, the Service considered the relative abundance of the birds in this paragraph.

Section 6 [Future Fish and Wildlife Resources Without Project]

a. Page 80, paragraph 2. We believe that this discussion is overly simplistic. From the discussion presented, it would appear that the Service believes that the salt marshes of the project area occur on sandy soils provided by prior overwash events. In fact, these marshes are underlain by muck soils created over hundreds of years. Recent hurricanes have shown that the addition of sediments to a marsh from overwash events seems to be very localized and, since such sediments are sands, they tend to just fill the marsh at the location of the overwash, not spread out to "nourish" it. Granted that given enough years of sea level rise, these areas would become marsh again. But in reality, many acres of marsh at Topsail Beach have been

"nourished" so much by recent hurricanes that they are now high ground and may be lost to development in the future. Is there any reason to believe this would not also happen in this project area in the future without a project scenario? In reality, most salt marshes in southeastern North Carolina tend to maintain themselves by adding additional organic and sediment from estuarine sources – ocean derived sediment sources are seldom needed. If the Service is actually concerned about the marshes of the project area needing additional sediment, perhaps we should begin looking at thin-layer disposal of dredged material for our waterway dredging. Please revise this discussion.

FWS Response: Godfrey and Godfrey (1976) document overwash reaching sound side marshes along the southern Outer Banks, allowing the marshes to transition to uplands and new marshes to form on the sound side of the overwash deposits. At the Atlantic Coast Guard Station on Core Banks, for example, the marshes were documented to be growing into the lagoon at a rate of 1 meter per year. Everts et al. (1983, p. 98), however, conclude that "overwash probably did not significantly affect the sound shoreline [from Cape Henry to Cape Hatteras] during the period from 1850 to 1980." Instead, inlets are given more dominance as a migration method for their study area, and the number of inlets currently existing is much lower than at times in the past. Thus overwash may dictate migration patterns of the southern Outer Banks while inlet shoals govern migration in the Dare County Beaches (Bodie Island Portion) project area. New inlets are partially inhibited from forming by the artificial dune line, which would be enhanced and maintained by the project. It is reasonable to assume that in the absence of the proposed project, the sound-side shoreline would benefit in the long term from the addition of overwash and/or inlet shoal materials and persist during a period of rising sea level.

It is interesting to the Service that this comment by the Corps states ". . . many acres of marsh at Topsail Beach have been 'nourished' so much by recent hurricanes that they are now high ground and may be lost to development in the future." This is exactly the point that the Service has been making about the role of island overwash, i.e., there is natural compensation for land lost on the oceanfront with land created on the backside of the islands. The many acres of new land for development on the sound is, in part, land that seems to be washing away on the beach. The masses of sand recently carried across the island may subsequently be washed gradually or blown into the sound. The new sand will form a substrate where new marsh can develop. The point is that over the long term it may be possible to move development slowly back from a rising sea. If there was an orderly movement of structures back from the oceanfront to newly created uplands on the sound side of the island, there is no reason why the same amount of natural habitats that exists today could not be maintained. In regard to this comment, the Service would ask whether there is a contradiction with the Corps' comment on Page 82, Summary Section (Section 6, h) below which states ". . . the idea of island overwash in the project area is, in most places, almost mythical. The island is simply far too wide for the sand to reach and 'nourish' the salt marsh." While the Service realizes that Topsail Beach is in Pender County and the project area is in Dare County, we would appreciate an explanation of why the island overwash process that appears so successful in creating new land at

Topsail Beach could not do the same on the Outer Banks if the artificial dune line was removed.

The Service does not support sediment disposal in estuarine shallows. With the exception of periodic island overwashes, sand naturally moves gradually from the beaches, across the island, and into the estuarine shallows. A formal dredged material disposal operation would not replicate this natural movement of sand. Artificial channels might need to be excavated to create access for dredges. Such work would be harmful to estuarine areas. Furthermore, natural sand for the estuarine shallows comes across the island from the beaches. Dredged material from estuarine navigation channels may not have the proper physical characteristics.

The information presented above supports the position of the Service, serves as part of this Final FWCA Report, and forms a basis for the recommendations given in this report.

b. Page 80, paragraph 3. This discussion seems in direct conflict with the future without a project scenario provide on page 79, paragraph 2. There is no reason to dispute your previous assessment that all available uplands in the project area will be totally developed even without a Federal project. Indeed, events at Myrtle Beach and Atlantic Beach, neither of which had a Federal beach nourishment project before they were totally developed, seem to bear this out. The Service should provide some basis for its contention that development will be greater with a beach nourishment project than without one. Time and again in this report it is stated as a fact without any supporting documentation. Please provide supporting documentation or delete this discussion.

FWS Response: The first two sentences of second paragraph on page 79 state "The Outer Banks in the northern part of Dare County, between the towns of Duck and South Nags Head, will continue to urbanize with limitations imposed by the availability of suitable land, soil constraints, water supplies, and local land use regulations, zoning regulations, and ordinances. It is likely that all available uplands which are not protected by designation as a conservation area within local LUP [Land Use Plan] will be developed." The third paragraph on page 80 states:

> "Tropical hurricanes and northeasters will periodically hit the project area. Without the project, development associated with the tourist industry may gravitate to the more protected areas of the island. Some development might relocate to the mainland. The limitation of development would alleviate pressure on habitats near the beach and could allow some habitats, such as overwash fans, that have been greatly diminished to return naturally. The threat to the natural freshwater supply would be reduced and the extent of freshwater wetlands would remain stable or increase. Overall, the future of the area without the project could be less pressure on existing natural areas and the possible recovery of some natural areas which have been lost."

The Service does not see the "direct conflict" between these paragraphs. Uplands areas without development restrictions will continue to be developed. Without the project, personal residences and tourist facilities could move away from the beach toward the less hazardous uplands on the sound side of the island or to the mainland. As areas subject to periodic flooding and the gradual loss of substrate on which structures have been built, beaches are not considered uplands in these discussions. While overall development would continue on the barrier islands, development without the protective berm and dune system is likely to move away from the more hazardous beachfront and areas of potential overwash. The "existing natural areas" mentioned on page 80 refer to beach and dune habitats and the recovery of natural areas that have been lost refers to overwash fans that are presently pushed back toward the ocean.

The Service is not certain about the point to be made by mentioning that Myrtle Beach, South Carolina, and Atlantic Beach (NC?) were developed without an artificial beach serving as a protective barrier. Shoreline recession is a gradual long-term process. Buildings constructed decades ago were fairly safe at the time of construction, but are now threatened by the encroachment of a rising sea. Coastal communities that began development in the 19th century could become essentially fully developed in what might be considered a safe manner, but such safety would remain only if the shoreline was stationary. As the shoreline moves landward, buildings that were once fairly safe become threatened. Furthermore, protective measures involve more than constructing an artificial beach. Pilkey and Dixon (1996, p. 104) note that by 1988, 25 percent of South Carolina's developed shoreline was lined with coastal armoring, all of which occurred after World War II. The Service does not consider these two areas as examples of development that occurred with a complete disregard for the natural dangers to oceanfront structures.

The point is that some developers, perhaps a majority, do consider the risk of destruction when planning coastal development. Older communities may have been rather fully developed before the risk of shoreline recession was fully understood. Other communities may have become fully developed in the absence of a federal beach construction project by employing alternative protection measures. The Service does not accept the idea that coastal communities have been or will be completely developed without any consideration of destruction by shoreline recession or coastal storms. A federal commitment to build and maintain an artificial berm and dune system creates the perception that coastal development will be protected. Therefore, by creating the perception of reduced risk, the proposed beach construction will encourage development within the project area. More information on the relationship between risk and development in coastal communities is given in the Service's response to the Corps' comment on Page 41, paragraph 3 (Section 3, c) above. The information presented above supports the position of the Service, serves as part of the Final FWCA Report, and forms a basis for the recommendations given in this report.

c. Page 81, paragraph 1. We are unaware of any data to support the contention of this sentence that offshore dredging is harmful to marine and anadromous fishes. Please provide us with the data or revise the sentence.

> **FWS Response:** The first sentence of this paragraph states "In the absence of the proposed project, marine and anadromous species would not be periodically harmed by offshore dredging required to maintain the beach-dune system." The Service statement is based on best professional judgment of experienced fishery biologists. It appears intuitively obvious that no project means no impact to fishery resources resulting from the proposed project. Regardless of whether the impacts of the proposed project are temporary and ephemeral as claimed by the Corps, or permanent and long-term as claimed by the Service, it is clear that the alteration of seven square miles of sand bottoms and associated benthos, with accompanying noise and turbidity, and subsequent deposition on the beach, will result in some level of harm to fishery resources. Food resources will be reduced. See the Service's response below to the Corps' comment on Page 116, paragraph 5 (Section 10, h) regarding the adverse impacts of turbidity on fish. We would anticipate maximum impact on those species such as Atlantic sturgeon which feed primarily on benthos. There will also be interference with both commercial and recreational fishing activities, since fishermen generally will not be able to occupy the same space as the dredge, pipelines and associated equipment. The Service stands by the statement and this portion of the Final FWCA Report remains unchanged. If the Corps has data which would refute the opinion, they should share it. The Service will consider any information supplied by the Corps in preparing future FWCA reports.

d. Page 81, paragraph 1. We do not concur that no action is a benefit to marine fishes. How is this conclusion derived? Under a future without the project condition, the Service can expect beach bulldozing of virtually the entire strand on an annual basis, temporary sand bagging, spilled septic systems, trucked-in fill, etc. Has the Service done an analysis that leads them to believe that these events, some of which are uncontrolled, are less disruptive than controlled placement of sand every three years? If so, please provide it in this report.

> **FWS Response:** The Corps provides no data to document their contention that the Service "...can expect beach bulldozing of virtually the entire strand on an annual basis, temporary sand bagging, spilled septic systems, trucked -in fill, etc." They should provide documentation for their statement regarding the frequency of occurrence of these activities in the study area. These activities, even if they occur with the magnitude the Corps asserts, are certainly nowhere nearly as disruptive as the activities proposed by the Corps. Further, none of them entail disruption of the offshore system, i.e. mining of seven square miles. Since the Service supports the stated project goal of reducing storm damage, we believe that the absence of a federal commitment to build and maintain an artificial berm and dune system would lead to the implementation of certain non-structural alternatives (USFWS 1999, pp. 95-97). If some houses are relocated or dismantled to provide more land for public use, the beach bulldozing, sandbagging, and sanitation problems mentioned by the Corps would be reduced. The Corps appears to

assume that the only action to reduce storm damage is the construction of an artificial beach. There are other options. The information presented above supports the position of the Service, serves as part of the Final FWCA Report, and forms a basis for the recommendations given in this report.

e. Page 81, paragraph 1. Our observations are that estuarine fishes do not benefit from island overwash events. Instead, salt marshes and tidal creeks tend to get filled up. If the Service has actual examples of overwash benefitting fishes, please provide it in the text.

FWS Response: The sentence in question states "Estuarine fish would benefit from island overwashes that maintain the sound side marshes as important nursery areas." Plants of the estuarine shoreline are generally adapted to periodic overwash events when a long-term perspective is taken. Areas of underwater vegetation, or submerged aquatic vegetation (SAV), are recognized as very important habitat for fish. As noted in the statement below, areas of SAV can benefit from island overwashes. While in the short-term, island overwash appears to be destructive, these events can be beneficial in the long run. In discussing the role of island overwash on the Outer Banks, Godfrey (1970, p. 30) states:

> ". . . sand brought into the sounds becomes salt marsh as long as marsh grass is present. Some of the most productive and luxurious salt marsh stands have developed in recent years on overwash fans. Sand carried beyond the limit of salt marsh and into deeper waters will be colonized by underwater vegetation, particularly widgeon grass (Ruppia maritima). In some cases, beds of underwater vegetation may be buried, but are soon recolonized by marine plants or salt marsh grass. Such burial is rarely deep and is a means whereby the bay bottom can keep rising as the sea level rises. In this way, suitable shallow water habitats in the estuary are maintained."

The Service believes these observations from the Outer Banks provide adequate support for our statement. The information presented above supports the position of the Service, serves as part of the Final FWCA Report, and forms a basis for the recommendations given in this report. However, the Service will incorporate the factual observations of the Corps mentioned above when they are provided to the Service.

f. Page 81, paragraph 4. This discussion is oversimplified. None of the species in the project area are endemic to barrier islands therefore it is highly unlikely that they have "adapted" to island overwash and hurricanes. Instead, populations of these species will be adversely impacted as these natural forces disturb their habitat. Moreover it is unclear how the Service believes that the populations of amphibians and reptiles will remain similar to present conditions when the future without a project condition is projected to be total development of all available upland areas.

FWS Response: The paragraph in question regards the amphibians and terrestrial reptiles of the project area and the first two sentences states: "All amphibian and reptile

populations will continue to experience periods of severe stress, such as droughts, island overwashes, and hurricanes. However, these are natural forces to which the species have adapted, and populations should recover." Individual animals are killed by major natural disturbances, but the population recovers. The Service would appreciate a statement of the Corps' justification for assuming that only endemic species of the barrier islands are adapted, on a population basis, to hurricanes and overwashes.

The long term survival of all the amphibians and terrestrial reptile species given in Table 5 (USFWS 1999, p. 52) cannot be assured in the face of increased development outside the Cape Hatteras National Seashore. However, several considerations favor the Service's contention that current species diversity may continue. These reptile and amphibians are relatively small and can go unnoticed in developed areas. Some species, such as the Carolina water snake, northern water snake, diamondback terrapin, and snapping turtle, use wetlands that have some protection from development. There are protected areas such as Jockeys Ridge State Park, Nags Head Woods, and CHNS within or adjacent to the project area. These protected area would serve as refuges for these species and young individuals would continue to move out of such refuges to repopulate more disturbed habitats. Furthermore, the fact that none of these species is endemic to the Outer Banks indicates that repopulation from mainland areas such as Alligator River National Wildlife Refuge will remain a possibility. Overall, the Service believes that future development in line with current restrictions and natural disturbances would not necessarily doom any of the present amphibians and terrestrial reptiles to permanent extirpation. The Service considers this paragraph in question to be clear, concise, and accurate, and we believe the information presented above answers the question posed.

g. Page 82, paragraph 2, 3rd and 4th sentence. Given the state's ban on hard structures, these sentences seem overly alarmist and without foundation. Please delete these sentences or provide some logic for why they should remain.

FWS Response: The sentences in question state "The overall impact of measures to keep existing buildings in their present location does not bode well for the future of any beach. If this commitment remains over the coming decades, the rising sea level in combination with the ever rising cost of continuously placing sand on the beach may lead to a decision to use a more permanent structure to protect buildings, such as a seawall." North Carolina's policy against hard shoreline stabilization structures is not without variances (e.g., Oregon Inlet terminal groin, Fort Fisher revetment) and could be modified in the future just like any policy or law. A rock revetment was constructed at the northern end of Carolina Beach in the wake of Hurricane Fran in 1996 after the storm removed the nourished beach (Pilkey et al. 1998, p. 189, Figure 7.17). Human nature and political administrations are not uniform or constant. Given the fifty year planning time frame, a rising sea level and the political climate that favors oceanfront development, it is not unreasonable to consider the potential conversion of a beach nourishment project to one backed by a seawall as the risk persists or increases over the project lifespan. Based on the ideas given above, the Service will retain the sentences in question.

h. Page 82, summary section. In general, the future described in Section 6 shows a lack of understanding of the realities of the project area - the analysis presented appears to be little more than an academic exercise. If no beach nourishment is provided certain things are quite likely; continued loss of homes, breaches of the roadway, continued annual beach bulldozing, temporary sand bagging, etc. All of these have ecosystem impacts yet nowhere in this discussion of the future without a project are any of these real world day-to-day issues being faced by the sponsor even recognized. Moreover, the idea of island overwash in the project area is, in most places, almost mythical. The island is simply far too wide for the sand to reach and "nourish" the salt marsh. It will simply end up in the road or yards of the residents and it will be removed. It has no more value in these places than any other truckload of fill material. We suggest that this section be totally rewritten and that, before doing so, the Service come to the project area and spend some time meeting with the project sponsors and developing a first hand understanding of the project area.

FWS Response: The Service is completely aware of the realities of the Outer Banks. Service personnel working on Pea Island National Wildlife Refuge constantly deal with the natural forces that may impact roads, buildings, water control structures, and other man-made infrastructure. Our sister agency, the National Park Service, faced the same problems in dealing with the Cape Hatteras Lighthouse. Where these agencies of the Department of the Interior (DOI) may differ from some development interests of the project area is a general DOI belief that the best course of action is to respect the force of natural processes and adapt the human presence to these forces. This belief led to the withdrawal of the lighthouse from a receding shoreline where it is now safe for many years.

The Service also has a mission to preserve fish and wildlife resources and their habitats. Our mission is often best accomplished by working with natural forces, accommodating the changing shape of the Outer Banks, and above all remaining flexible in an ever changing environment. Some of the "real world day-to-day issues being faced by the sponsor" may occur as a result of the basic geologic and hydrologic forces shaping the Outer Banks. All residents of North Carolina's barrier islands must understand the implications that sea level is rising and may rise at an increasing rate for many decades, perhaps centuries, to come. The rise in global sea level represents a tremendous threat to maintaining the status quo of fixed man-made buildings and roads on barrier islands. An oceanfront lot on the Outer Banks faces a fundamentally different future from a building site on the mainland. It is doubtful that the threats of a rising sea and powerful hurricanes can be controlled by beach bulldozing and sandbag barriers. It will require massive amounts of public money to maintain the status quo, and in the end all the artificial protective measures may fail. That is why the Service supported the decision to move the Cape Hatteras lighthouse back from the sea rather than wage a costly and perhaps futile effort to hold back the sea.

The Service position on island overwash is given in our response to comments on Pages 8-19, Figures 3and 4, Page 9 (3rd paragraph), and Page 12. The information presented above supports the position of the Service, serves as part of the Final FWCA Report, and

forms a basis for the recommendations given in this report. The Service finds no reason to rewrite this section.

Section 7 [Alternatives Considered]

a. Page 83, 4th paragraph. The FWS obviously does not understand the plan formulation process that the Corps of Engineers must follow to determine the size of the project available for Federal cost sharing in a particular area. We would welcome the opportunity to meet with personnel of the FWS and explain our plan formulation requirements and the rules and regulations that govern this activity.

FWS Response: Please contact Howard Hall or Tracy Rice at (919) 856-4520, extensions 27 and 12 respectively, to schedule such a briefing. Design storms were commonly used in assessing hurricane protection projects in older Corps projects and easily communicated to the public what to expect from the projects. We welcome the opportunity to work with the Corps in any outreach efforts to better understand how projects are planned.

b. Page 89, 4th paragraph. High water mark surveys for Topsail Island following Hurricane Fran found high water marks averaging between 8.9 and 9.2 feet above mean sea level. There is no evidence that Fran produced a storm surge of 12 to 14 feet. Please provide additional documentation to support this.

FWS Response: Maximum high water marks following Fran were 15.4 feet above mean sea level at Kure Beach, 12.7 feet on Figure Eight Island, and 11.5 feet on Topsail Island (Federal Emergence Management Agency [FEMA] 1997). In considering potential hurricane damage it is often the maximum impact of a certain aspect of the storm which is the most useful in considering property damage. With regard to wind speed, the maximum wind speed is often more destructive than the average wind speed. In this case the use of average high water marks may be misleading to the public in planning for future storms. At the least, when average data are used, it would be beneficial to include maximum and minimum values.

c. Page 93, 3rd paragraph. The last paragraph in this paragraph expresses what appears to be a personal belief and has no place in an official Government document.

FWS Response: The Service assumes this comments relates to the last sentence of the paragraph which states "There may be reasons to wonder whether creating an artificial beach-dune system represents a means to an end (i.e., reducing storm damage) or is actually an end itself (i.e., replacement of the recreational beach lost to shoreline recession in the face of a rising sea)." While this sentence could be stated differently, it reflects the uncertainty of the projects goals. While formal statements of project goals appear limited to the reduction of structural damage, the creation of a recreational beach

that is presently being diminished as a rising sea approaches fixed beachfront structures seems to play a major role in the selection of the preferred alterative.

The Service does wonder exactly what role the preservation of a recreational beach plays in the overall project. If such preservation is a project requirement, it should be part of the project purpose. The improved recreational quality on an expanded beach was considered in the selection of the preferred alternative (USACOE 2000b, p. 4-10). Furthermore, the dollar value of recreational benefits plays a role in the overall benefit-cost analysis of the project (USACOE 2000b, p. 50). If on the other hand, the creation of a recreational beach is truly incidental to the project goal of reducing storm damage, discussion of the recreational beach should be excluded from the Corps' development and evaluation of alternatives. The Service will consider replacing this paragraph in question with a more detailed discussion of this issue which was part of our September, 2000, comments on the Draft Feasibility Report and EIS. The revised discussion would state:

> Regarding the needs within the project area, the Service recommends that the Corps clarify the relationship between reducing damage to structures and shoreline stabilization, i.e., beach erosion control. If the Corps seeks to stabilize the shoreline for reasons other than reducing property damage, the rationale for seeking shoreline stabilization independent of damage reduction should be explained. If shoreline stabilization is sought to reduce damage to structures, it is redundant to mention it in addition to damage reduction. This clarification is requested because the DEIS notes (p. 8-3) that non-structural plans can be beneficial at reducing some types of damage, but would not halt shoreline recession which is a concern of the project's sponsor. This statement suggests that shoreline stabilization is sought for reasons other than reduction in property damage.
>
> An important issue related to needs in the project area is the continued existence of the recreational beach. Table 4-3 of the DEIS indicates that no action will result in the "continued deterioration of the existing beach." The DFR (p. 34) notes that "[t]he recreational beach that remains by 2004 is expected to be very narrow or nonexistent at high tide." There is a fundamental, unstated assumption in this position that beachfront structures must remain in their present position. On the other hand, geologists contend that natural, coastal processes do not destroy barrier island beaches. As with the barrier islands themselves, if the ocean destroyed the beaches, they would have disappeared thousands of years ago. In North Carolina, Core Banks, an undisturbed barrier island which was spared the artificial dune building of the 1930s, has a beautiful, wide beach that has never been nourished. When natural processes are allowed to operate, wide natural beaches will continue to exist.

The real reason for the shrinking recreational beach in the project area is that it is trapped between fixed man-made structures to the west and a rising sea to the east. The artificial dunes block most attempts for natural processes to move the beach to higher ground. As noted above, the artificial dune has acted like a seawall. Seawalls have invariably led to the disappearance of natural beaches (Pilkey and Dixon 1996, p. 40). Storms that carry sand landward as overwash fans are actually creating a beach properly positioned for the current level of the ocean. The overwash fan is a higher and wider beach, but unfortunately beachfront property owners do not want the beach landward of their property. Earth moving equipment is brought in and the new beach is picked up and moved back to the rising shoreline.

The Service is also concerned that constructing artificial beaches is often presented as the only way to save a recreational beach. This is clearly a false argument. The real issue is not whether barrier islands will have recreational beaches, but where these beaches will be located. Powerful hydrologic and geologic forces are trying to move the beaches to higher ground as sea level rises. Beachfront property owners want the beach in front of their homes, not under or behind them. A truly impartial observer might conclude that it is the beachfront property owners that are destroying the recreational beaches by pushing the sand back into the sea every time an ocean overwash moves the beach landward. If the fact of barrier island migration was widely accepted, recreational facilities would adapt and tourists would continue to enjoy the beaches with little regard for the fact that the beach moved a few yards every year. Overall, the preservation of recreational beaches and the tourist economy which they support provides no justification for constructing artificial beaches.

The discussion given above serves to clarify the paragraph and sentence in question. This material represents the position of the Service in the Final FWCA Report and was considered in our final recommendations.

d. Page 93-956. The discussion of alternatives makes no reference to the North Carolina coastal management policies that prohibit the use of hard structures.

FWS Response: We agree. North Carolina coastal management policies currently prohibit the use of hard shoreline stabilization structures (with a few exceptions for historic structures and bridged inlets). The feasability of implementing hard stabilization alternatives should be an evaluation criteria, and the present ban would preclude their consideration as a practical alternative.

e. Page 95, 5th paragraph. The Town of Nags Head has officially adopted beach nourishment as the preferred shoreline management alternative. This preference is included in its recently adopted land management plan approved by the Coastal Resources Commission.

FWS Response: The first two sentences of this paragraph state "Abandonment was the choice in some locations following the 1962 Ash Wednesday Storm (National Research Council [hereafter NRC] 1995, p 28). The Towns of Nags Head and Kitty Hawk have used the retreat option by gradually removing individual buildings; either by their owners or through destruction in relatively small storms (NRC 1995, p. 28)." While this policy changed in the mid- to late 1990s, the Service will continue to use this former policy as an example of the application of a non-structural alternative to the construction of an artificial berm and dune system.

f. Page 98, paragraphs 4 and 5. Effective protection for Carolina Beach and Wrightsville Beach has been provided for over 35 years. During the recent series of 5 severe storms (Bertha and Fran in 1996, Bonnie in 1998, and Dennis and Floyd in 1999) the two projects have performed exceptionally with nourishment requirements either equal to or less than the nourishment requirements experienced during recent renourishment operations. This holds true for the Kure Beach project that was exposed to the last three of these storms without any measurable increase in nourishment requirements over what was predicted. With regard to the design of the fills, the volume of material needed to construct and maintain the fills is based on providing sufficient sand to move the entire active profile (from the berm crest seaward to closure depths of 20 to 25 feet below mean sea level) seaward by the design beach fill width.

FWS Response: Noted. However, it should also be noted that the Corps constructed a rock revetment at the northern end of Carolina Beach in the wake of Hurricane Fran in 1996 after the storm removed the nourished beach (Pilkey et al. 1998, p. 189, Figure 7.17).

g. Page 99, Figure 17. This figure totally misrepresents the actual design of beach fills.

FWS Response: The only difference between this figure and fill designs within the NEPA documents (e.g., Figure 7 of the Final Feasability Report) is the absence of a rock revetment.

h. Page 99, Figure 17. We know of no place in North Carolina where an entire beach fill has eroded away in only 3 years. Carolina Beach was nourished in 1998 following Hurricane Fran. After placement of that fill, hurricanes Dennis and Floyd hit the area yet nourishment was needed only over the northern 6000' feet of the project and only 500,000 yd^3 of replacement fill was necessary. We think Figure 17 is unrealistic and request that the Service either provide an example of where this has occurred in the state or delete the figure.

FWS Response: Figure 17 does not illustrate that all of the fill is eroded, only that the sediment moves off the beach and the subaerial portion narrows nearly back to its original position. If the fill is not eroded, why does the beach need to be renourished every 3 years?

i. Page 98, paragraphs 6 & 7. We believe both of these paragraphs are incorrect. The active beach width in the project area is generally about 0.5 mile and closure depths are approximately -27' This position is supported by the quote provided on page 100, which notes that 2-km is "well seaward of the depth of closure." When nourishing these projects, we account for offshore adjustments. Funding has been adequate to fully nourish such projects in the past. Please revise these paragraphs.

> **FWS Response**: See the Service's response to the Corps comment on Page 31, paragraph 2 (Section 2, i) regarding closure depth. Regarding long-term funding, the State of North Carolina recently notified the communities of Kure and Carolina Beaches that funding for the state's share of the upcoming renourishment was not available, illustrating the uncertainty of continuous funding that is subject to annual appropriations at all levels.

j. Page 101, paragraph 4. What was the nourishment technique used? How was its superiority measured and determined? Please revise this paragraph to explain these things or delete it. It is too brief to be anything but misleading or confusing.

> **FWS Response:** The paragraph in question states, in part, that:
>
> > "Pilkey and Dixon (1996, p. 83) recount the beach nourishment experience of Virginia Beach, Virginia, less than 50 miles north of the project area. In 1972 a study committee, which included the Corps, concluded that the small annual renourishment technique that had been used was superior to large nourishment projects spaced several years apart. This was due, in part, to a determination that larger volumes of sand disappeared more rapidly. However, by 1995, without evidence that would contradict the 1972 report, the Corps chose to put large volumes of sand on the beach at three year intervals."
>
> The Service does not believe that these statements are confusing or misleading. This paragraph presents a very simple idea: that beach restoration may be more efficiently achieved by a series of small sand placements at shorter time intervals than a single large sand placement at longer intervals. The Service did not mean to advocate the former strategy, but to suggest that it be evaluated. Initially, Virginia Beach replenished its beaches with sand from land sources that was carried to the beaches by truck. The superiority mentioned by Pilkey and Dixon (1996, p. 83) refers to a committee determination that a series of smaller sand placements would require less sand and therefore cost less money over time. The city had a flexible replenishment program that it was able to fund without financial or engineering help from the Corps. However, as these authors note, this approach was rejected by the Corps and the ultimate efficiency of this approach was not given a chance for validation.
>
> The additional material given above serves as part of the Final FWCA Report. Future reports will provide the details given above on the experience of beach construction at Virginia Beach.

k. Page 102, paragraph 2. It is a stretch to say that the transfer mode or use of booster pumps influences the impacts of the project. The real issue is project timing. It doesn't matter how the material is brought to the beach.

> **FWS Response**: We disagree. Both the timing of the project and the method of transfer of the fill influence the environmental impacts. Hopper dredges, for instance, are known to suck up sea turtles in the water column more than pipeline dredges and are restricted accordingly. The Department of the Interior (U. S. Department of the Interior [hereafter DOI] 1999) determined that type of dredging equipment influences the recovery rate of the benthic community in the borrow area; overflows of hoppers and barges cause localized turbidity in between the borrow and fill sites; and pipeline dredges are likely to cause turbidity where the pipeline breaks or needs to be lengthened or shortened. Therefore impacts are influenced by how the material is brought to the beach.

l. Page 102, section on Modification of Development and Infrastructure. This whole section implies that the local communities of the project area are managing their building codes and utilities incorrectly. Does the Service believe that this is true? If the Service has no basis for including this discussion it should be removed.

> **FWS Response:** The Service finds nothing in the three paragraphs of this section to imply that buildings codes are not being properly implemented. The section speaks in a general manner about the ways in which improved design and construction techniques can reduce storm damage in coastal communities.
>
> Pilkey et al (1998, pp. 215-216) discuss the evolving building codes for coastal construction in North Carolina. Revisions generally apply only to new construction and exempt existing buildings. This procedure results in older building not benefitting from improved construction standards. The Corps' Final EIS (USACOE 2000b, p. 3-1) noted that retrofitting existing buildings- presumably by applying new technology to older buildings that were in compliance at the time of construction - was one measure that would be ". . . beneficial in reducing some types of damage." We feel that this statement of the Corps reflects the opinion of the Service given in this section of the FWCA Report which addresses "modification" of development rather than any suggestion of shoddy construction or inadequate enforcement of building codes. The information presented above supports the position of the Service, serves as part of the Final FWCA Report, and forms a basis for the recommendations given in this report. The Service finds no reason to remove this section.

m. Page 102, paragraph 4, 3rd sentence. Does the Service mean to imply that all of these utilities may be improperly installed in the project area? What is the basis for including this statement?

> **FWS Response:** The context of the sentence in question reads "Pilkey et al (1998, pp. 213-257) devote an entire chapter to construction regulations and techniques that would

result in less storm damage. Their discussion covers such diverse topics as the type of house, strengthening the exterior envelope, structural integrity of buildings, and retrofitting an existing house (Figure 18). These authors also write that damage to water, sewage, electrical, telephone, and cable TV utilities can often be avoided by proper installation (Pilkey et al. 1998, p. 221)." The Service sees no suggestion that utilities damaged by hurricanes have, by definition, been improperly installed. Massive hurricanes can obviously destroy even the most carefully constructed utility infrastructure. The Corps should take on face value this sentence that merely states that proper installation of utility infrastructure helps "avoid" storm damage. The information presented above answers the question posed.

n. Page 103, Figure 18. Both the Corps and the local sponsors understand construction techniques to reduce storm damages. Please delete.

FWS Response: The Service believes that Figure 18 provides important illustrations of construction techniques that may reduce storm damage. While these techniques may be known to the Corps and to some individuals in the project area, the FWCA Report is widely distributed to other parties that are not as knowledgeable. The Corps should not assume that just because engineers are aware of these techniques, these illustrations have no value for other readers of the Service's report. The information presented above supports the position of the Service, serves as part of the Final FWCA Report, and forms a basis for the recommendations given in this report. The Service will retain this figure.

o. Page 104, paragraph 2, last sentence. Is the Service saying that the communities of the project area do not stick with their land use plans? If so, please provide supporting documentation. If not, please delete this sentence.

FWS Response: The content of the sentence in question states "Table 11 gives several actions by which zoning and land use planning, a fourth major option, may be employed to reduce storm damage. Bush et al. (1996, pp. 137-143) discuss these measures, but the overriding message is to identify hazard areas and avoid developing them by proper planning. These authors note that the real world provides very few good examples of planned development on barrier islands, primarily because developers and communities do not stick with their plans." This paragraph refers to coastal developments in general and the Service finds no suggestion that the statement refers to communities in the Dare County project area. These authors do provide several examples of barrier development which started with a good plan that was later modified in ways that increased the risk of storm damage. The examples include Kiawah Island, South Carolina; the interior of Hilton Head Island, South Carolina; and Bald Head Island, North Carolina. In the latter case, an initial plan of moderate density development with no cars allowed eventually resulted in the seaward incursion of development, the disruption of dunes and vegetation, and landward incursion of the shoreline (Bush et al. 1996, p. 138). The point of the Service's comment is not to criticize a particular barrier island development, but to note that sound zoning and land use plans, one approach to reducing storm damage, must not

be altered over time. The information presented above supports the position of the Service, serves as part of the Final FWCA Report, and forms a basis for the recommendations given in this report.

Section 8 [Selection of the Preferred Alternative]

a. Page 106, paragraph 1. In the past, particularly prior to passage of the WRDA of 1986, beach fill or beach restoration was frequently considered an erosion control measure, and erosion control was treated as a project output or project purpose. As a result of enactment of that law, however, erosion control has no separate status as a project purpose or as a project output. Thus erosion control measures such as beach fill are now treated as means to the ends of hurricane and storm damage reduction.

FWS Response: The Service continues to find that the control of progressive, long-term shoreline recession appears sporadically throughout project documentation as a project goal that is both separate and somewhat equal with the reduction of storm damage. The Final Feasibility Report states (USACOE 2000b, p. 9) that berm and dune construction is the only technically feasible solution found by the Corps to "arrest erosion and protect against wave action." Arresting long-term shoreline recession is most likely to appear as an independent goal when there is a discussion regarding the relocation of structures away from the hazardous beachfront. In considering several non-structural alternatives, the Draft EIS (USACOE 2000a, p. 3-1) states that:

> "While these actions are beneficial in reducing some types of damage, they do not inhibit erosion. Beach erosion control is one of the project sponsor's concerns and is an **important study objective** [emphasis added] identified in the congressional resolution authorizing this study."

In a response to a Service comment, the Final EIS notes (USACOE 2000b p. C-40) that a non-structural plan ". . . does not address the loss of property to erosion, and lacks funding and social support." These statements suggest that the failure of a non-structural alternative to halt long-term shoreline recession, a process totally independent of storms, was a factor in the elimination of this group of actions. These statements also suggest that controlling shoreline recession does have a separate status as a project purpose especially whenever the idea that there would be less structural storm damage if there were no beachfront structures to be damaged is discussed.

b. Page 107, Table 12. This table is very biased and unbalanced in its presentation of the facts. Since it adds nothing of value to the report it should be deleted.

FWS Response: The Service disagrees with the Corps' assessment. The simple ranking of environmental impacts associated with major categories of efforts to stabilize beaches and reduce storm damage seems clear and concise. The Service does not understand the Corps' contention that the presentation is "unbalanced." If the Corps could provide the

Service with specific examples of how these data are unbalanced, the Service would work to create a better presentation. The Service does not intend to delete this table. The information presented above supports the position of the Service, serves as part of the Final FWCA Report, and forms a basis for the recommendations given in this report.

c. Page 106, paragraph 4. Our records show that our predictions of sand requirements for Wrightsville Beach have not been exceeded since 1970. We do not believe that constitutes a record of consistent underestimating sand requirements. If the Service has data showing we are in error, please provide it. Please delete this sentence.

FWS Response: Figure 19 of the Draft FWCA Report (USFWS 1999, p. 108; based on Pilkey et al., 1998, p. 98) and Figure 2 of Trembanis et al. (1998) show data indicating an increasing need for sediment at Wrightsville Beach, not a constant or decreasing need. These sources support the position of the Service, and we will retain the statement in question.

d. Page 108, Figure 19. The comparison of predicted versus actual nourishment requirements for the Wrightsville Beach project are based on pre-construction planning estimates made in the late 1950's. While actual periodic nourishment requirements have exceeded this early estimate, nourishment requirements since the early 1970's have been accurate.

FWS Response: The Service disagrees as noted in response (c) directly above. If the Corps has data stating otherwise, the Service will incorporate that information into future reports.

Section 9 [Description of the Preferred Alternative]

a. This should be updated to describe the preferred alternative as described in FEIS.

FWS Response: The project description given in this Final FWCA is based on the Final Report of the Chief of Engineers released on December 30, 2000.

Section 10 [Impacts of the Preferred Alternative].

a. Page 115, section entitled "Impacts of the Preferred Alternative." This entire section is loosely organized, tends to ramble, and frequently repeats itself. Please try to consolidate and be precise.

FWS Response: The Service believes that there is always room for improvement in the text of our FWCA Reports, but we do not concur that this section is loosely organized or rambling. Regarding repetition it is possible that the discussion of turbidity and sedimentation as both short-term, direct impacts and long-term, indirect impacts gave the impression of repetition. However, we believe that different time frames for these classes of impacts warranted a separate discussion. Similarly, the discussion of turbidity at the offshore mining site and the beach disposal sites may appear repetitious, but

actually refers to two distinct parts of the project area. We hope that this information provides an explanation for portions of this section, and future reports of the Service will strive for greater organization and precision.

b. Page 115, paragraphs 4 and 5. The Service seems to believe that significant turbidity from dredging will occur at the borrow sites. Our experience has been that turbidity is not a significant issue when dredging in coarse sands. This position is supported by DOI's own studies (DOI 99).

FWS Response: The Service agrees that turbidity is not a significant issue for clean, coarse sands. Geotechnical data contained within the FEIS indicates a high mud content in the borrow area, however. Hurme and Pullen (1988) note that significant fines can be suspended and create siltation impacts near the borrow area. They recommend dredging only when currents will not carry suspended sediments to adjacent sensitive areas. Furthermore, DOI (1999, p. 3-24) found that "excessive siltation and increased turbidity associated with offshore dredging and nourishment processes can result in impacts to marine [resources]... . Siltation and burial of benthic organisms ... is an issue of concern, and the increase in turbidity affects both filter-feeding organisms and fishes." Siltation decreases with distance from the borrow site, and may be insignificant beyond 150 meters from the dredger (DOI 1999).

c. Page 115, paragraph 6, We seriously doubt that borrowing material from an offshore source will "jeopardize the spawning stock" of any marine species. Please provide supporting information to justify this contention.

FWS Response: The paragraph in question states:

> "The nearshore waters off the northern portion of the North Carolina Outer Banks, north of Cape Hatteras, are important wintering areas for migratory fish populations (Appendix B). The mining of offshore sand in areas used for wintering by striped bass, summer flounder, and weakfish could adversely affect these species. The project could jeopardize the spawning stock biomass of these three interjurisdictional species which provide recruits for much of the mid-Atlantic coast. Fish in the area would be disturbed by the turbidity caused be initial construction and periodic dredging for replacement of sand. Dredging may remove habitat used by these species, such as underwater sand berms or mounds that provide shelter. Dredging would destroy benthic prey organisms and could cause mobile prey species to move out of the work area. Appendix B provides a detailed discussion of the importance of benthic or benthic-consuming prey for offshore fisheries."

The Service believes that the information provided in this paragraph along with additional information in Appendix B supports our concems. The offshore areas that will be mined may be unique in some respect and provide some habitat values which are not

replaceable elsewhere within the range of the affected species. The Corps now proposed to permanently remove 74,580,000 cubic yards of sediment from these areas over 50 years. Additional material would be removed if the project is extended beyond 50 years. The noise, removal of benthic food resources, turbidity, and sedimentation associated with this sand mining would occur every year in some part of the area. Sediment removal would permanently alter the bottom topography and overlying wave patterns. Over 50 years the depth in these areas would be increase between 9 and 12 feet over approximately seven square miles. The massive sand removal effort may result in a permanent alteration of bottom substrate characteristics, reduced primary production, and changes in the abundance and species composition of benthic epifauna and infauna. In light of these major changes over such a large area, it is entirely reasonable to anticipate that maintaining the spawning stock at its present level could be jeopardized. This could happen either through reduction of productivity in the area, which would reduce the carrying capacity for wintering species, or reduce their fitness for reproduction on the spawning grounds, either case resulting in loss of future recruitment. It is highly likely that not every square mile of habitat off the coast of North Carolina is of equal value to all species. The information presented above supports the position of the Service, serves as part of the Final FWCA Report, and forms a basis for the recommendations given in this report.

d. Page 116, paragraph 6,rd and 4th sentences. We are unclear what constitutes fish "disturbance." Please clarify.

FWS Response: The Service was unable to determine the context of this comment. Page 116 has only four complete paragraphs, and none contains the term "disturbance." If the Corps will provide additional information on the source of the comment, the Service will respond.

e. Page 116, paragraph 2. We have no reason to expect high turbidity when suitable material is placed on the beach therefore, we do not understand the contention that turbidity "may be high." Furthermore, we are not aware that post-placement turbidity has been a problem on North Carolina beach nourishment projects. If the Service has information indicating there is a problem in North Carolina, please provide it. If the Service cannot support the contentions of this paragraph, it should be deleted.

FWS Response: The second sentence of this paragraph states "[w]hile dredging turbidity may be high, it is generally a short-term phenomenon." The Service used the phrase "may be high" in reference to turbidity at the dredging site, not the disposal site. This was followed by the statement that the placement of fine material on the beach may produce turbidity for a long time after placement. The Service acknowledges that use of beach quality sand would minimize the risk of excessive turbidity from the placement site (see response above to Page 115, paragraphs 4-5; Section 10, b). However, there is always a risk that pockets of silt and clay particles may occur in a large amount of sand.

This finer grain material cannot always be economically excluded by dredging equipment and some silty material may be placed at a disposal site.

Riggs (1994, p. 17) reports on studies that indicate that sand placed on Wrightsville Beach, a formal beach nourishment project, washed off the beach and buried extensive hardbottoms on the inner continental shelf. These hardbottoms were prime fishing locations, but were put out of production due to a covering of two to six inches of sand. Riggs (1994, p. 17) concludes that "[t]he business of beach nourishment and hardbottoms represents a very serious conflict, and a problem that's going to get much bigger." The Service realizes that some of this sand may have moved along the ocean bottom from the beaches to the hardbottoms, but a part of this problem may be attributable to sand suspended at the beach and carried offshore. This information clarifies the position of the Service, and serves as part of the Final FWCA Report. There is no reason to delete this paragraph.

f. Page 116, paragraph 3. We do not understand the relevance of Florida turbidity standards. Please remain focused on this project area. Correct or delete this paragraph.

FWS Response: The purpose of this paragraph is to introduce the standard used to measure turbidity, the nephelometric turbidity unit (NTU), and provide some examples of the use of this measurement with beach construction work. The Service will try to use more examples from North Carolina, but we feel that the examples given from Florida and South Carolina properly illustrate the issues of turbidity and the NTU. The Service will retain the examples given in this paragraph.

g. Page 116, paragraph 4. Please be careful in using the work of Reilly and Bellis. The work they examined was <u>not</u> beach nourishment, it was beach disposal of sediments obtained while deepening Morehead City Harbor. There is no beach nourishment project at Atlantic Beach. By today's standards, the sediments removed from that harbor deepening were not suitable for placement on the beach as they had a significant amount of anoxic muck. Accordingly, using this data to describe potential impacts of beach nourishment using suitable material is very questionable. Also, please check your reference to USACOE, 1990. We do not believe this document discussed these issues.

FWS Response: The Service understands that the sediment placement studied by Reilly and Bellis was a disposal operation and not a beach construction project. The second sentence of this paragraph starts by stating "[b]each disposal of dredged material at Atlantic Beach, North Carolina. . . ." However, beach disposal operations do indicate potential problems that can occur with more formal beach construction projects. As noted in the Service's response above to the Corps' comment on Page 115, paragraphs 4 and 5 (Section 10, b) the borrow areas for the Dare County Project may include areas of high mud content not unlike the material from Morehead City Harbor Project.

The Environmental Assessment of Morehead City Harbor Improvements (U. S. Army Corps of Engineers [hereafter USACOE] 1990, p. EA-24) does discuss turbidity. The report states:

> "Beach disposal of dredged material from either the stockpile at Brandt Island or directly from Morehead City Harbor will cause temporary and localized increases in nutrient concentrations and turbidity and reductions in dissolved oxygen concentrations in the Atlantic Ocean. Beach disposal of 3.9 million cubic yards of material dredged from the Brandt Island stockpile during the summer of 1986 produced turbidities as high as 250 NTU in the Atlantic Ocean in the vicinity of the discharge pipe."

The Service believes that we have properly characterized the work of Reilly and Bellis and documented our concerns regarding nearshore turbidity. Therefore, the paragraph in question will serves as part of the Final FWCA Report and provide a basis for the recommendations given in this report.

h. Page 116, paragraph 5. We are unaware of any documented cases of fish smothering in an oceanic environment. Please provide a reference.

The first three sentences of this paragraph state that "[f]ish and invertebrates may smother when gills are clogged due to high levels of suspended solids. Reduced light penetration decreases primary productivity. Planktonic larvae of both vertebrates and invertebrates found in the surf zone may be adversely affected by high turbidity levels (National Research Council [hereafter NRC] 1995, p. 114)". Based on three references, the report states (NRC 1995, p. 114):

> "Biological resources that be most adversely affected by elevated turbidities include many of the sessile species typically found in hard-bottom reef habitats or seagrasses. High turbidities and silt loads can smother these organisms, inhibit filter-feeding processes, or significantly decrease photosynthetic activity, potentially resulting in long-term damage to these resources. . . "

A recent study has indicated that fish are vulnerable to turbidity. This study (DOI 1999, p. 3-24) on offshore sand mining in the mid-Atlantic States notes:

> "Siltation and burial of benthic organisms and reef/hard bottom habitat is an issue of concern, and the increase in turbidity affects both filter-feeding organisms and fish. Larval and juvenile fish, in particular, are especially sensitive to dredging-induced turbidity, as **their gills may become clogged or abraded by floating particulates** [emphasis added]. Feeding ability of larval and juvenile fishes is decreased due to a reduction in available light."

Pullen and Naqvi (1983) state that those aquatic animals that do not leave an area of high turbidity are susceptible to suspended sediments and can be killed by coating their gills leading to anoxia. The reference for this statement is a Corps report by O'Connor et al. (1976).

The Corps' specific concern regards fish. In assessing impacts to fish it is necessary to consider all the life stages of nearshore fish and not just the highly mobile adult stage. Lindeman and Snyder (1999) studied the impacts of a "beach restoration" project at Jupiter, Florida, on fish that use nearshore hardbottoms. One focus of this work was the life stage designated as "newly settled." This stage occurs when planktonic larvae drop out of the water column and occupy bottom habitats. This stage occurs before the early juvenile stage. Newly settled stages of over 20 fish species were recorded on nearshore hardbottom structures among three sites examined. The project involved the direct placement of sand on the hardbottoms and there was a significant reduction in the abundances of species and individuals. While a comparison of impacts associated with direct habitat burial with those of long-term burial as a result of sedimentation is not appropriate, several issues raised in this work are important. First, the majority of individuals displaced by hardbottom burial in southeast Florida are early stages of economically and ecologically valuable fish species. Second, the early life stages of fish that depend on these hard substrates may be unable or unwilling to leave these areas as they become covered by sediment. Lindeman and Snyder (1999) state that:

> "Because of behavioral and morphological constraints on flight responses, high mortalities are probably unavoidable for many cryptic species, newly settled life stages, or other site-associated taxa subjected to direct habitat burial (Table 4.10 in Lindeman 1997[a])."

For those species or early life stages that remain in a particular habitat that is buried, either directly or indirectly by construction of an artificial beach, smothering is one mechanism to account for the high mortality mentioned above.

The information presented above supports the position of the Service, serves as part of the Final FWCA Report, and forms a basis for the recommendations given in this report.

i. Page 117, paragraph 2. We question whether the Service has thoroughly researched the issue discussed in this paragraph. In discussing placement of fill on the beach, Donoghue (1999) states "Evidence suggests that the organisms are not being killed or buried." And she provides additional references to support this contention. Please review these works and revise this paragraph as appropriate.

FWS Response: The Service believes that this issue has been adequately evaluated. The National Research Council states (NRC 1995, p. 110) that the "temporary loss of infaunal communities through sand burial is expected and largely unavoidable during beach nourishment operations." This is similar to statement in the Final EIS (USACOE 2000b, pp. 6-14/15) that beach disposal of dredged material may have negative impacts

on intertidal macroinvertebrates through direct burial, increased turbidity in the surf zone, or changes in the sand grain size or beach profile.

Donoghue (1999) studied several aspects of the beach invertebrates on Pea Island, including both population responses to storms and beach nourishment. Her work suggested that *Emerita* (mole crabs) and coquina clams (*Donax* spp.) may be able to leave beach areas prior to storms (Donoghue 1999, p. 178-179). Her work also suggested that beach invertebrates may be able to detect large-scale sand placements and leave the beaches prior to burial (Donoghue 1999, p. 182). If some beach invertebrates are able to detect approaching sand placement operations and move offshore, such behavior would indeed prevent the organisms from being killed, but would still result in their elimination from suitable habitat. In certain cases it may not be possible to determine whether beach invertebrates were killed by sand disposal or left the area. However, the overall effect on higher organisms that feed on these invertebrates would the same: the loss of a major food source. Less mobile invertebrates would not be able to avoid sand placement.

Donoghue's work does show that beach invertebrate populations are adversely affect by sand placements. The abundance of *Emerita*) is depressed in nourished regions immediately following most disposals (Donoghue 1999, p. 34, Figure 2.8). Ghost crab (*Ocypode quadrata*) populations that are not directly impacted by sand placements were also observed to decline following declines of their prey species that inhabited the area of placement (Donoghue 1999, p. 38). The work found that if a disturbance occurs when organism abundances are peaking in the swash, the immediate impact of a nourishment is likely to be large (Donoghue 1999, p. 183). If nourishment takes place in October, soon after the final *Emerita* larval recruitment has occurred, it will eliminate the new recruits and overwintering female, and the area will not be repopulated until late the following summer (Donoghue 1999, p. 183). A nourishment in March or April will depress the coquina population in the region of nourishment for at least a full year (Donoghue 1999, p. 183).

Overall, the Service finds three major points from Donoghue's work:

1. Some beach invertebrates may be able to leave an area prior to sediment disposal, but as she notes for *Emerita* (Donoghue 1999, p. 126) the issue of "[w]hether they can sense and respond to a disturbance in a manner efficient enough to avoid harmful affects remains unclear."

2. The extent to which some beach invertebrates are buried by sediment placement cannot be assessed with the considerable effort of searching for carcasses under the layer of newly deposited material. Beach invertebrate were sampled with cores and rakes to a depth of only 10 cm (3.9 inches) (Donoghue 1999, pp. 57, 105, 136). While this was adequate to perform surface carcass counts before and after storms (Donoghue 1999, p. 132), there is no evidence that such carcass counts were made following sediment placement. In the absence of such data, a

conclusion that mortality of beach invertebrates following sediment disposal is either non-existent or minimal is unjustified.

3. Not all beach invertebrates have the mobility of *Donax* and *Emerita* studied by Donoghue. Peterson et al. (2000) cite the work of Pearse et al (1942) and Dexter (1969) indicating that the beaches of Bogue Banks and other North Carolina barrier islands are populated by several species of amphipods and polychaetes. Some of these species may be less mobile and subject to greater risk of burial.

A recent publication has assessed the impacts of dredged material placement on the ocean beaches of Bogue Banks, North Carolina (Peterson et al. 2000). Core sampling on this beach revealed "dramatically lower densities of both *Donax* spp. and *Emerita talpoida* on nourished beaches. . . " The average density on *Donax* spp. were reduced 86 percent, and the densities of Emerita declined 99 percent. Two to three weeks after sand placement the average densities of the two populations were still 97 percent lower on the placement beaches. The authors concluded that the transfer of energy of higher trophic levels on the placement beach was ". . . almost certainly dramatically reduced by nourishment." Furthermore, the reduction of beach invertebrate populations at a time when they should be playing the valuable ecosystem function of feeding surf fish implies that nourishment may have caused the loss of a full season of energy transfer to surf zones fishes at the nourishment site. Longer-term impacts are also possible from persistent modifications of the physical environment, either of the topography or the sedimentology

Regarding the paragraph in question, the Service believe the first parts of the paragraph should be revised. The new sentence should state that placement of sediment on a beach has been shown to significantly reduce macroinvertebrate populations. These populations may be reduced by either direct mortality or the abandonment of the area. In either case, higher trophic levels that feed on the macroinvertebrates, e.g., shorebirds and nearshore fish, will be adversely impacted. The material given above will be integrated into future discussions of this issue.

In regard to proper documentation of beach disposal impacts on macroinvertebrates, the Service will continue to search for the most recent and relevant material. The Service expects the same from the Corps. The Final EIS concludes (USACOE 2000b, p. 6-16) that the adverse impacts of 50 years of sand placement on beach invertebrates would only be "localized, short-term, and reversible." The Service questions whether the existing literature supports this conclusion over the entire 50 years of sand placements. The Service has taken the position that the repetition over many decades of an action known to produce adverse impacts and require wide variations in recovery time is likely to produce serious, long-term adverse impacts. The Service requests that the Corps provide support for the contention that beach macroinvertebrate populations in 2050 will be essentially similar to those that exist today. If the long-term health of these populations cannot be predicted, the Corps should acknowledge that magnitude of this environmental impact is unknown.

j. Page 117, paragraph 3. See previous comment Page 116 paragraph 4. This work was not beach nourishment. Also, please note, as per comment g above, Reilly and Bellis did not observe dead mole crabs and clams. It is far more likely that changes in physical conditions simply made the beach uninhabitable immediately after the work.

FWS Response: See the Service's response to the Corps comment on Page 117, Paragraph 2 (Section 10, i) above. It would be more accurate to say that these researchers found a complete absence of beach invertebrates rather than complete mortality. The text of Reilly and Bellis (1978, p. 51) states:

> "No living organisms were found in any of the tidal zones on the day of nourishment, however, this situation was expected since the entire intertidal macrofauna had just been buried by up to 2 meters [6.56 feet] of sediment and the effective intertidal zone had been transposed 75 meters [246 feet] seaward of its former location. Colonizers would have had insufficient time to become established."

For purposes of this Final FWCA Report, the Service will modify the last sentence of this paragraph to indicate that there was an absence of beach invertebrate rather than "mortality." However, we would add that mortality cannot be considered unless there is a systematic search for evidence of mortality. The Service can find no evidence that either Reilly and Bellis (1978) or Donoghue (1999) dug through the layer of deposited sand to search for dead organisms.

k. Page 117, paragraph 5. These sentences make the statement that if beach invertebrate populations are reduced, shorebird may also be adversely affected. The Service should support such a contention with data. Available studies indicate that much shorebird foraging actually takes place on the backsides of barrier islands at low tide and that few species are actually dependent on the swash zone to meet all of their food needs. Please see Smith (1988), Burger et al (1977), and Connors et al (1981). It should be noted that Smith's (1988) field work was done one year after beach nourishment at Carolina Beach.

FWS Response: The sentence in question appears to be one that states "[v]ertebrate consumers, such as fish and shorebirds, may also be adversely affected by a reduction in prey species." This refers to the loss of the macroinvertebrates of the beach. The National Research Council acknowledged that the indirect effects of temporary losses or alterations in the benthos on the foraging activities of marine and avian predators should be part of future studies (NRC 1995, p. 110). However, the NRC report states that ". . . many shore bird species actively feed in the intertidal zone and may be adversely affected by nourishment operations."

Peterson and Peterson (1979, pp. 49-58) present information on the shorebirds of North Carolina. They divide these birds into six categories or ecological "guilds." Among the shallow-probing and surface-searching shorebirds, most can be found on estuarine,

intertidal flats. However, they note that the pectoral sandpiper and solitary sandpiper feed almost exclusively on sandy beaches. It is a different guild, the deeper-probing shorebirds, that are most often found feeding on ocean beaches. The deep-probing shorebirds of North Carolina include the marbled godwit, willet, long-billed curlew, and whimbrel. Peterson and Peterson (1979, p. 55) state that willets are more often found feeding on sandy beaches, as opposed to estuarine flats, where they can gather mole crabs during the warmer month. Only during colder months when mole crabs migrate from beaches to the ocean are willets likely to be found on estuarine flats. Among the shallow-probing shorebirds, the sanderling follows a feeding pattern similar to the willet, a strong preference for beach habitats during the warmer months where the birds more often feed on beach hoppers (*Talorchestia* and *Orchestia*). Peterson and Peterson (1979, p. 56) note that estuarine flats may be critically important to the deep-probing guild during the winter when the mole crab is unavailable on ocean beaches.

The observations of Peterson and Peterson (1979) on shorebird feeding indicate several very important points. First, feeding sites may vary over the year with certain areas being more critical at certain times. As indicated above, it would be extremely misleading to assess the ocean beaches as feeding sites during the winter when the major food sources are gone. Second, some shorebirds, for whatever reason, are dependent on the food resources of ocean beaches.

In regard to shorebirds, the food resources of estuarine, intertidal flats may not be able to provide complete compensation for the loss of food resources on ocean beaches, especially during warmer months. Therefore, this Final FWCA Report retains the statement made in the draft report, and this position has been considered in our final recommendations. The Service will review the papers listed by the Corps and adjust our discuss of this environmental impact accordingly in future FWCA Reports.

l. Page 117, paragraph 6 to page 118. The referenced study was performed in Florida where dozens of nests can occur on a given stretch of beach in a single night. Conditions for locating and assessing nests are less confusing in North Carolina as our nesting densities are far lower. Given the more favorable survey conditions in North Carolina, does the Service really believe that 7% of nests are misidentified as false crawls in the project area? Does it have data to support this contention? Misidentification clearly implies that given a certain set of facts or conditions, a wrong decision was made. Does the Service believe the local observers be better trained to reduce their misidentifications? The project sponsoring beach communities all have ongoing sea turtle programs and they are trying very hard to benefit the sea turtles through their actions. If the Service has knowledge of how things could be improved, it should be shared with these communities.

FWS Response: It is generally acknowledged that beach surveys to locate sea turtle nests are not perfect. We are not sure exactly what the Corps means by indicating that such beach surveys are "less confusing" in North Carolina. The figure of seven percent misidentification does come from a Florida study, but this figure should only be used to suggest that some sea turtle nests are not detected by even the most experienced

observers. Aside from the issue of misidentifying an actual nest as a false crawl, there is the problem that waves or tides can completely wash away the traces of a successful nesting. The fact that nests where the traces of the crawl have been washed away are missed does not suggest that observers are untrained or unmotivated. Service recommendations for minimizing the impacts of a beach construction project were given in the reasonable and prudent measures, terms and conditions, and conservation recommendations of the Service's Biological Opinion for this project dated November 22, 2000.

m. Page 118, paragraph 3. Please use data from North Carolina, not Florida.

FWS Response: The Service believes that Florida data on sea turtle hatching success and emergence success are relevant to beach construction projects in North Carolina. As North Carolina data becomes available regarding these issues, such information will be incorporated into our reports.

n. Page 118, paragraph 5. This paragraph should be qualified to state that these impacts would only occur if construction or maintenance occurs during the nesting season.

FWS Response: The Service agrees that disorientation by artificial lighting would only occur during the nesting season and during the period of hatching, emergence, and return to the ocean of hatchlings. For the purposes of this Final FWCA Report, the paragraph in question has been so qualified and future FWCA Reports will include this qualification.

o. Page 119, paragraph 1. We do not question that lighting can disorient sea turtles, but we do question the contention that a hydraulic dredge offshore will adversely impact orientation as described. It would seem that a sea turtle being drawn back into the sea after nesting is not really an impact - that is what they do anyway. A similar case could be made for attracting hatchlings to the ocean. Why does the Service think this is an impact? Has it been observed anywhere? Is a dredge considered to be worse than shrimp trawlers and menhaden ships, both of which work at night with lighting and much closer to shore?

FWS Response: The paragraph in question states "[a]nother impact to sea turtles is disorientation (loss of bearings) and misorientation (incorrect orientation) of hatchlings from artificial lighting. Visual cues are the primary sea-finding mechanism for hatchlings (Mrosovsky and Carr 1967, Mrosovsky and Shettleworth 1968, Dickerson and Nelson 1989, Witherington and Bjorndal 1991). Artificial beachfront lighting is a well documented cause of hatchling disorientation and misorientation on nesting beaches (Philbosian 1976; Mann 1977; Florida Department of Environmental Protection, unpubl. data). In addition, research has also documented significant reduction in sea turtle nesting activity 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, disorient females trying to return to the surf after a nesting event, and disorient and misorient 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."

The Service should have made a better effort to differentiate between the impacts that artificial lighting has on adult females and the impacts on hatchlings. Hatchling appear to be at greater risk from all artificial lighting. Lights on a lone offshore vessels would probably not hinder hatchlings from entering the ocean if the vessel were directly seaward of the nest. That is, if a line between the ship and the nest was roughly perpendicular to the shoreline, hatchlings would not be misoriented in their crawl to the ocean. However, vessels at a sharp angle to such a perpendicular line - on the Outer Banks, vessels either to the north or south - could draw the hatchlings along the beach for a greater distance than would be necessary for a direct crawl to the ocean. For example, Witherington and Martin (1996, p. 68) state that lights on piers may cause hatchlings from adjacent beaches to crawl greater distances toward the lights. Witherington and Martin (1996, p. 5) state that delaying the entrance of hatchlings into the ocean can result in death due to exhaustion, dehydration, or predation. Furthermore, the presence of several lighted vessels in different directions could cause confusion among the hatchlings about the proper direction to follow. Offshore lights are detrimental to hatchling even after they reach the ocean. Witherington and Martin (1996, p. 15) discuss a report by Limpus (1991) off the nesting beach at Raines Island, Australia. Thousands of green sea turtle hatchlings were seen swimming in circles next to a brightly lighted boat anchored off the nesting beach. Hatchlings affected by such lighting may linger in the lighted water and be preyed upon by fish that are also attracted to the lighted area. Witherington and Martin (1996, p. 15) note that such hatchling mortality at sea would leave little or no evidence.

The impact of offshore lights on adult females may not be as serious. If the vessel is close enough to the shore to illuminate the beach, females can be deterred from nesting and forced to choose a less desirable location (Witherington and Martin 1996, p. 2-4). Lights may also disrupt the return of the female to the ocean after nesting. As with hatchlings, lighted vessels far up or down the coast may cause misorientation in returning to the ocean. A female that does not follow the most direct route back to the sea may encounter natural and man-made obstacles that require extra energy or result in injury.

The Service should not have singled out dredges as the only example of vessels with lights that can be detrimental to both adult and hatchling sea turtles. Our review of Witherington and Martin (1996) indicates that factors such as brightness, color, and shape are important, but that the type of vessel is not. The Service will change the phase to read ". . . and vessels in the ocean . . ."

p. Page 119, paragraph 4, 6th sentence. Please provide a reference for this potential problem. We have never heard about this concern until this report. If this is speculation, please remove it from the report.

FWS Response: The entire paragraph in question states "Removal of sand from the offshore borrow areas may permanently alter the physical characteristics of the areas and impact the benthic flora and fauna adapted to existing conditions. The long-term physical alterations produced by sand removal from marine habitats have not been well documented (NRC 1995, p. 118). The majority of follow up studies from offshore borrow sites have shown decreases in the mean grain size, including, in some cases, increases in the percentage of silts and clays in the borrow site (NRC 1995, p. 118). Offshore holes may fill with finer grain material (NRC 1995, p. 118). The finer material or other significant alterations in the physical characteristics of the substrate may not be suitable for the organisms that formerly occupied bottom sediment of the borrow area."

The "potential problem" mentioned by the Corps in the 6th sentence is the filling of offshore borrow areas with finer grained material. The primary references are the general statements of the National Research Council. One example is given in a Corps report on offshore dredging near Panama City Florida (Saloman et al. 1982). This report concluded that:

> "A comparison of sediments from undredged bottom and borrow pits showed that most deviations from normal properties appeared in experimental samples. Major sedimentological differences could be identified due to accumulation of loosely packed, darker, and siltier sediments in the pits shortly after dredging. These distinctions became more subtle with time, and by the following year, the surface samples (in nearly filled pits) were very similar to sediments on the adjacent undisturbed sea floor. When compared to base-line samples, specific differences included the following: (1) lower sand content, (2) higher silt-clay content, (3) poorer sorting, (4) more finely skewed, (5) more variation in both directions from a leptokurtic condition, and (6) higher content of organic carbon."

The Corps' monitoring program for a beach construction project in New Jersey summarizes several prior studies on the characteristics of offshore borrow sites. Results appear to vary from site to site with some areas showing recovery while other areas showed changes. Information suggesting that adverse impacts may occur include (USACOE 1999b, pp 8-5 and 8-6):

- Saloman (1974) reported that borrow pits created three years prior to a study on the west coast of Florida (Treasure Island) had filled with gelatinous mud and contained a depauperate benthic community.

- Van Dolah et al. (1994) followed changes in a borrow area at Folly Beach, South Carolina, and found that the new pit filled with fine sediments with the result that

the infaunal assemblage changed from one dominated by haustoriid amphipods (pre-dredging) to one dominated by capitellid and nepthyid polychaetes and the clam *Mulina lateralis* (post-dredging).

- In the case of the Coney Island study (Coastal Ecology Branch, 1997), there were persistent differences in the borrow area and reference site benthic communities due to altered sediment texture at the borrow area.

The report concludes (USACOE 1999b, p. 8-6) that there appears to be two different infaunal responses to the dredging of borrow pits: rapid recovery (~1 year) or development of a depauperate, soft-bottom assemblage. The first response, rapid recovery, seems to occur at new borrow areas (e.g., Saloman et al. 1982; Scott and Kelley, 1998) where the pits are relatively shallow or where sand movement acts to refill the pit. Wilber and Stern (1992) have challenged the results of such studies after re-analysis of much of the data from Florida-based studies. They point out that while diversity and abundance recover quickly, the functional structure of the assemblages can take longer to recover. Specifically, large, deeper-burrowing infauna can require as much as 3 years to reach pre-disturbance abundance.

The Corps' report also notes (USACOE 1999b, p. 8-6) that the development of a depauperate soft-sediment community occurs in older, presumably deeper pits. If there is little sand movement, the pit can become a depositional area for fine sediments which, in turn, support a community that is qualitatively different from the surrounding undisturbed sands. If water movement within the bathymetric depression is sufficiently restricted, poor water quality conditions may develop, causing a periodic deterioration in the benthic community.

The information given above provides sufficient support to suggest that pits left by offshore sand mining may fill with finer material than the original substrate. The long-term productivity of these areas that will be mined to depths of 9 to 12 below the existing surface will depend on many factors. In summary, the Service does not consider this impact to be speculation. The discussion of the Draft FWCA Report is retained for this Final FWCA Report and serves as a basis for our final recommendations.

q. Page 119, paragraph 3, sentences 1 and 2. These sentences are so general as to be meaningless. We are not aware of any evidence that dredging and beach nourishment are "disruptive" to "normal travel routes" of marine mammals, or that such activities cause them to move to "less disturbed areas." If the Service has such information, please provide it, if not, please delete these sentences.

FWS Response: The sentences in question state "Marine mammals are highly mobile and range widely along the Atlantic coast. While dredging and beach disposal may be disruptive to normal travel routes and foraging patterns, these animals are likely to move to less disturbed areas." First, the Service notes that the Corps' Final EIS states (p. 5-20)

that "[t]he only potential threat to the right whale is from collisions with boats navigating in the ocean." The Service assumes that such boats would include ocean certified dredges involved in sand mining. Second, the Service notes that the Office of Protected Resources of the National Marine Fisheries Service discusses the possible threats to recovery by cetaceans on its web page (www.nmfs.noaa.gov/prot_res/species/Cetaceans/). On October 24, 2000 and in January 2001, this web contained the following information:

> "Collisions with vessels, oil spills, and other changes in water quality, coastal development, and increasing noise created from the use of oceanic resources may all affect whales' lives. . . . One area of marine science that is increasingly being focused on is the potential effects of anthropogenic (manmade) noise in the marine environment on marine mammals. Noise from seismic explosions, military exercises, **and boat traffic may cause cetaceans to alter their natural behavior [emphasis added]**. In fact, there is evidence that humpback whales in Hawaii may have changed their use of near-shore waters where calves are raised by their mothers because of increasing human activity and that migrating bowhead whales may move further offshore to avoid human-caused noise."

The Service regrets that we did not provide supporting evidence for our statements. We will continue to gather more detailed information on the effects that offshore dredges have on marine mammals. We recommend that the Corps also seek out this information for inclusion in future EIS that require offshore sand mining and include such information in project impacts. The information presented above supports the position of the Service, serves as part of the Final FWCA Report, and forms a basis for the recommendations given in this report.

r. Page 119, paragraph 2, 3rd sentence. Responsibility for such determinations lies with the NMFS, not the Service. Please do not speak for another agency. It causes unnecessary confusion.

FWS Response: The sentence in question states " However, the dredging vessels must avoid hitting marine mammals and special observers may be necessary to watch for marine mammals." The Service apologizes for any confusion, but the Service maintains that the FWCA gives us authority to speak for a broad range of fish and wildlife resources. The Act authorizes funding transfers to the Service and we do often provide recommendations for species under the authority of other agencies which do not receive such funding. During the preparation of FWCA reports the Service coordinates with other agencies and attempts to incorporate their concerns and recommendations into our reports. Draft FWCA reports are widely distributed to other agencies in order for them to provide additional information to the Service on resources under their jurisdiction. If the Corps can provide more specific information on the "confusion" generated by this statement, the Service will work to provide greater clarity in the future.

s. Page 119, paragraph 5 - page 120 paragraph 1. The presentation in these paragraphs is very unbalanced. Please present conclusions from DOI (1999) and from Appendix C of the FWCA report for the Brunswick County Beaches Draft FWCAR which may more closely reflect this project area than studies done in Florida.

FWS Response: We disagree. NRC (1995) is a national synthesis on beach nourishment by the National Academy of Sciences. Johnson and Nelson (1985) and Bowen and Marsh (1988) [a Corps study] were studies conducted in Florida, Van Dolah et al. (1992, 1993) were studies conducted in South Carolina, and Wilbur and Stern (1992) analyzed four projects on Florida's Atlantic coast. The majority of the research that has been done on borrow areas has been done in Florida. The Service is not aware of similar studies from North Carolina. DOI (1999) is from New Jersey, Maryland, Delaware and Virginia and focuses on Federal waters, which are three or more miles offshore. USACOE (1999b) [in Appendix C of the Brunswick County draft FWCA Report] is from New Jersey.

DOI (1999, p. 3-26) concluded that "dredging significantly impacts the benthic organisms living in the sediment of the area being dredged. Recolonization of borrow areas begins almost immediately following dredging. In the long-term, the borrow area will recover to original densities of organisms, but not necessarily to its original species composition." The study also stated that recovery takes 1 to 5 years provided the area is "not impacted by continued dredging, unusually high sedimentation rates, or some other disturbance" (DOI 1999, p. 3-25). Recovery may be lengthened to 2 to 8 years if currents are weak in the borrow pit. Since the Dare County Beaches (Bodie Island Portion) project proposes to dredge the borrow area on an annual basis, the Service does not expect the benthic community to fully recover.

USACOE (1999b, p. 8-6) notes that the New Jersey borrow areas studied "differ fundamentally from those of previous studies" since they are topographic high points. Otherwise, they conclude "that immediate impacts to borrow area infauna were substantial [with declines in abundance, biomass and taxa richness], but recolonization had progressed significantly by Spring 1998" (USACOE 1999b, p. 8-7).

We believe that all of the studies listed above provide a basis of general comparison useful in estimating the benthic impacts of the proposed action, support the position of the Service, serve as part of this Final FWCA Report, and form a basis for the recommendations given in this report.

t. Page 120, paragraph 2. This paragraph appears to be based solely on unrealistic speculation. There is absolutely no basis for the contention that this project will lead to "unsuitable or unusable" fisheries habitat offshore. At worst, only a temporary impact would be expected. Nowhere on the Gulf or Atlantic coasts has a fishery collapsed from a project such as that being proposed. Does either the NMFS or the NC Division of Marine Fisheries share the Service's view on this issue? Again, read DOI (1999) and Appendix C of the Brunswick County FWCA report. Please revise or delete this paragraph.

FWS Response: The paragraph in question states that "The cumulative effects of the project on offshore fisheries may be the transformation of formerly preferred habitat into unsuitable or unusable habitat (Appendix B). This change could occur as a result of altered substrate characteristics, depth, or other physical parameters. In addition to harming commercial and recreational fishermen, the loss or degradation of this important fish habitat would adversely impact marine birds, such as the northern gannet and eastern brown pelican, and marine mammals, such as the humpback whale." The Service does not suggest that a fishery has collapsed as a result of offshore sand mining. The Corps extrapolation from the actual phrases of the Service to such an extraordinary statement does not promote a constructive dialog. Support for the Service actual position may found in our response to the Corps comment on Page 115, paragraph 6 (Section 10, c).

On August 18, 2000, the National Marine Fisheries Service provided the Wilmington Corps District with comments on the Draft EIS for the Dare County Project (see USACOE 2000b, pp A-33 to A-38). The NMFS recommended that the Corps eliminate dredging from offshore borrow area N1, one of the two proposed borrow areas, to avoid impacts to overwintering habitat for the federally managed spiny dogfish and summer flounder. The Service believes that this recommendation indicates the serious nature of the impacts that are likely to occur.

On August 15, 2000, the NC Division of Marine Fisheries commented on the Draft EIS (see USACOE 2000b, pp. A-113 to A-114). This letter stated that the NCDMF is ". . . concerned with the adverse impacts that will occur from the project. Biological resources will be affected by dredging of material for initial project construction and by placement of material on the beach. These impacts will reoccur as the area is nourished."

The only revision that the Service considers necessary for this paragraph is the inclusion of more data supporting the Service's position. Such information is contained in the Service's response to the Corps' comments on Page 119, paragraph 4 (Section 10, p.) and Page 119, paragraph 5 (Section 10, s). Both responses refer to Appendix C (USACOE 1999b) mentioned in this comment. Overall, the material presented in the Draft FWCA, as augmented by this response and the two previous responses cited in this paragraph, serves as the Final FWCA Report and serves as a basis for the recommendations contained in this report.

u. Page 120, paragraph 3. This paragraph again cites Florida studies that are of questionable relevance to the project area. Please use local information if available.

FWS Response: The paragraph in question refers to problems associated with nearshore turbidity and sedimentation following beach construction. The Service believes that these data from Florida indicate a potential problem that merits consideration. The Service has noted that Riggs (1994, p. 17) reports on studies indicating that sand placed on Wrightsville Beach, a formal beach nourishment project in North Carolina, washed off the beach and buried extensive hardbottoms on the inner continental shelf. These

hardbottoms were prime fishing locations, but were put out of production due to a covering of two to six inches of sand. Riggs (1994, p. 17) concludes that "[t]he business of beach nourishment and hardbottoms represents a very serious conflict, and a problem that's going to get much bigger." The Service realizes that some of this sand may have moved along the ocean bottom from the beaches to the hardbottoms, but a part of this problem may be attributable to sand suspended at the beach and carried offshore. The Service will continue to seek information on project closer to the actual project site.

v. Page 120, paragraph 5, 2nd sentence. Please see comment g, above.

FWS Response: The sentence in question states "Beach invertebrate populations are eliminated or greatly reduced." Comment g refers to the fact a beach disposal project may use less suitable sediment than a formal beach nourishment project. See the Service's responses to Corps comments on Pages 117, Paragraphs 2 and 3 (Section 10, i and j) above and the next response (Section 10, w). These three responses support this statement by the Service.

w. Page 120, paragraph 6. Where does the Service draw the line for significance? Is it the several centimeters height, over a meter height, or both? Please provide supporting information describing how increasing beach height affects feeding by beach invertebrates.

FWS Response: The paragraph in question states "[s]and flowing onto the lower portion of the beach during the nourishment operation can increase the beach height in the intertidal zone from several centimeters to more than a meter (NRC 1995, p. 109). This significant change in the character of the intertidal zone can affect habitat suitability and feeding by beach invertebrates beyond the immediate impact of sediment placement." The Service acknowledges that "significant" is inappropriate in this context since "significant change" can be interpreted to mean the result of an analysis that has undergone formal statistical tests. Since changes in the intertidal zone have not be analyzed statistically, a better adjective would be "major."

The Service notes again the report of Reilly and Bellis (1978, p. 51) on a sediment disposal project on Bogue Banks that states:

> "No living organisms were found in any of the tidal zones on the day of nourishment, however, this situation was expected since the entire intertidal macrofauna had just been buried by up to 2 meters [6.56 feet] of sediment and the effective intertidal zone had been transposed 75 meters [246 feet] seaward of its former location. Colonizers would have had insufficient time to become established."

While the use of such adjectives as major versus minor needs to be made on a case by case basis, the Service considers the example above as a major change to the habitat of intertidal macrofauna.

x. Page 121, paragraphs 3 and 4. Please see comments g and j above.

FWS Response: These paragraphs discuss impacts to beach invertebrates. Please see the Service's earlier responses to the Corps' comments on Page 116, paragraph 4 (section 10, g), Page 117, paragraph 3 (Section 10, j), and the response directly above (Section 10, w).

y. Page 121, paragraph 5. This paragraph simply contains more research results from Florida that add nothing new to the discussion. Please delete.

FWS Response: Until more information becomes available from North Carolina, the Service will continue to use research from Florida and other states to support concerns regarding the types of environmental impacts that should be considered in North Carolina.

z. Page 122, paragraph 2, sentence 1. Does the Service really believe this? Please see general comment c.

FWS Response: The Service believes this comment relates to the first sentence of the first full paragraph on Page 122 that states "Each episode of dredging and sand placement over the 50 years of project life would create all the direct impacts considered above." Direct impacts refer to those that are immediate and short-term such as dredging turbidity and burial of beach invertebrates. Such impacts will recur with each effort to maintain the artificial berm and dune system. While each maintenance episode will move less material than the original construction, the types of direct impacts given in the FWCA will occur time and time again.

Please see the excerpt from the August 15, 2000 letter of the NC Division of Marine Fisheries commenting on the Draft EIS (see USACOE 2000b, pp. A-113 to A-114). This letter states that the NCDMF is ". . . concerned with the adverse impacts that will occur from the project. Biological resources will be affected by dredging of material for initial project construction and by placement of material on the beach. These impacts will reoccur as the area is nourished."

aa. Page 122-128. This text deals principally with non-fish and wildlife issues. It should be deleted or moved to an appendix.

FWS Response: Physical parameters such as bathymetry, topography, beach profile, sediment substrate, wave and current energies and patterns, water depth, and sediment transport are essential components of the coastal ecosystem. These variables determine the physical and hydrologic forcing mechanisms to which many coastal fish and wildlife resources are attuned. Changes in development patterns influenced by a proposed project will create secondary, indirect impacts to fish and wildlife resources. Future reports will

explicitly link these parameters to fish and wildlife issues so general readers can understand them more clearly.

bb. Page 124, paragraph 5 - page 126 paragraph 1. We believe this paragraph is inappropriate and question whether it truly represents the position of DOI. If it does not, a disclaimer should be added.

FWS Response: It is the position of the Service that in North Carolina, long, continuous dune ridges that are artificially created and maintained in place functionally act as artificial levees, narrow the subaerial beach over time, and protect infrastructure in the same fashion as a seawall. Everts et al. (1983, p. 97) agree that the shoreline will retreat, stating that "Dune-building may be a factor in the increased shore erosion between Oregon Inlet and Cape Hatteras between 1917 and 1949." This Corps report also states (Everts et al. 1983, p. 98) that "overwash probably occurred frequently in the study area before dune construction; however, it likely had only a minor effect on the ocean and sound shoreline." No disclaimer is needed.

cc. Page 129, paragraph 2. Mention needs to be made in this paragraph that these studies were performed in Florida, where offshore sediments can contain a higher fraction of pulverized coral. Direct comparisons of such sites to North Carolina may be misleading.

FWS Response: We agree. Until such time as similar studies are conducted in North Carolina, the Service must use the best available information. Florida has completed much of the scientific research on the impacts of constructing artificial beaches, and all references to such studies should be clearly distinguished.

dd. Page 129, paragraph 2. Since sea turtles dig their nest by using their back flippers to apply shear force to move the sand, we do not believe the use of a cone penetrometer, which measures compressive strength of soils is the proper tool to use. Standards should be developed to measure the shear strength of the sand and develop acceptable limits for this factor.

FWS Response: We agree. The Service is aware of the problems associated with using the cone penetrometer as a measure of beach compaction. These issues were discussed at a meeting of Service biologists and personnel from the Corps' South Atlantic Division in Jacksonville, Florida in December 2000. Service biologists agree that when a better tool is developed and tested, the use of the cone penetrometer can be discontinued.

ee. Page 129, paragraph 3. Does the Service have any reason to believe that any beach compatible sand source in Dare County will have sands of the wrong color? If so, please provide the information.

FWS Response: Native sediments in the placement area vary in coloration but are commonly an orangish color, indicating iron staining. Appendix I of the Final EIS indicates that sediments in the borrow area are olive, olive-gray, grayish-olive, gray, yellowish gray, greenish gray, dark gray, tan, brown, and dusty-yellow, and contain

muds, silts, sands, gravels, shells and organic materials. It is unknown if the borrow materials contain significant heavy minerals, which are black at Pea Island to the south. We therefore believe there is a reasonable probability that the borrow materials will differ in color from the native sediments in the project area.

ff. Page 130, 3rd paragraph, 2nd sentence. This sentence seems to be stating that closing inlets would be good for piping plovers. Is this what the Service means to say?

FWS Response: The entire paragraph in question states "[b]arrier island beaches preferred by piping plovers are dynamic, storm-maintained ecosystems. Natural coastal processes, such as overwash fans and accreting spits, are important for creating piping plover habitat. The construction and maintenance of artificial dune systems along with efforts to prevent the closure of barrier island inlets appear to lead to a reduction in piping plover nesting habitat. Dune maintenance conducted to protect an access road on Island Beach State Park in New Jersey may be one of several factors contributing to very low density of piping plovers (USFWS 1996, p. 35). On Cape Lookout National Seashore, a roadless area, piping plovers have nested at several closed inlets, a habitat type that is not present on Hatteras Island which is traversed by a state highway protected by an artificial dune system (USFWS 1996, p. 35)."

The sentence in question appears to be the third sentence, and recently closed inlets do provide good piping plover nesting habitat. The position of the Service is that the natural closing of barrier island inlets creates piping plover nesting habitat and is therefore good for the species. Inlets generally close only after a new inlet has formed and "captured" the tidal flow between ocean and sound, the tidal prism Without the previous tidal flow to sweep sediment out of the old inlet, the natural longshore transport system deposits sand in the old inlet, and the inlet closes. This is a perfectly natural event. The newly deposited sand, without vegetation is good piping plover nesting habitat. As vegetational succession proceeds, the site of the old inlet becomes less desirable as nesting habitat.

In 1995, the Service noted that Drum Inlet (Carteret County) separates two barrier islands--North Core Banks (or Portsmouth Island) and South Core Banks--within the Cape Lookout National Seashore. At that time North Core Banks represented perhaps the best piping plover habitat in North Carolina as reflected in breeding pair estimates (in 1994, North Core Banks hosted 67 percent of the State's breeding population). The barrier island has several "old" inlets, or inlets that have filled in, such as Old Drum Inlet, Kathryn Jane/Whalebone Inlet, and Swash Inlet. Piping plovers have nested in each of these inactive inlets which consist of large moist sandflats and sparse vegetation.

Artificial efforts to prevent the natural closure of barrier island inlets can lead to a reduction of piping plover nesting habitat. Efforts to keeping inlets open or stabilize an inlet allows plant succession to proceed that might not occur in natural circumstances. The increase in vegetation can decrease and eventually eliminate suitable piping plover nesting habitat.

gg. Page 130, paragraph 3, 3rd sentence. This sentence does not provide enough information. Please explain what type of dune maintenance was done and why it contributed to low density of piping plovers.

FWS Response: The sentence in question (the 4th) from the paragraph given in the previous response states "Dune maintenance conducted to protect an access road on Island Beach State Park in New Jersey may be one of several factors contributing to very low density of piping plovers (USFWS 1996, p. 35)." The reference for this sentence is the Service's piping plover recovery plan. The recovery plan also notes that intentional stabilization of beaches at some traditional breeding sites has led to decreased incidence of overwash and blowouts, thus reducing favored habitat for nesting plovers in Nova Scotia (see Austin-Smith et al. in Canadian Wildlife Service 1994). "Dune maintenance" refers to continuous straight line fencing, vegetation plantings, and filling in dune gaps after storm events (D. Jenkins, pers. comm., 1/17/01). These protection measures prevent the formation and persistence of overwash habitat and alter the beach habitat by dictating where dunes are located, which can reduce the dry beach width available for avifauna. The recovery plan notes (USFWS 1996, p. 35) that in the early 1990s, piping plovers were not nesting on Pea Island where they once occurred. The artificial dune line along Pea Island to protect NC Highway 12, a corridor that has required considerable dune maintenance similar to that in New Jersey, has reduced the occurrence of overwash fans and thus habitat for piping plovers.

hh. Page 130 paragraph 4 –page 131. These are not fish and wildlife issues. This type of discussion should be placed in an appendix.

FWS Response: See response (aa) above.

Section 11 [Comparison of Alternatives]

a. This section is oversimplified. It contains nothing of value for the plan formulation process or for the analysis of alternatives. It should be completely revised or eliminated.

FWS Response: The Service strongly disagrees. As noted previously in response to comments on page 69 (Section 5, d), the Service's Fish and Wildlife Coordination Act Reports follow a standard format developed by the Southeastern Region in 1987. A standard section in that format is one to "evaluate and compare alternatives." The Service believes this section provides a clear and concise presentation of the direct and indirect environmental impacts of the two major alternatives, structural versus non-structural, for the reduction of storm damage. This section should interest the Corps since the Final Feasibility Report (USACOE 2000b, p. 9) states that "[t]he Federal Objective in water resource planning is to contribute to the National Economic Development in a manner consistent with protection of the nation's environment."

The Service sees no reason to either revise or delete this entire section. The Service would welcome the opportunity to discuss specific parts of the section. This section

remains as part of this Final FWCA Report and forms a basis for the recommendations given in this report.

b. Page 133, Table 13. See general comment c. Please present a more balanced presentation of the impacts of alternatives.

FWS Response: Table 13 is a clear and concise summary of data presented in earlier sections of the report. The Service will respond to more specific criticisms on the balance of the information presented.

c. Page 133, Table 14. See general comment c. Please present a more balanced presentation of the impacts of alternatives. Also, it is unclear how any of the alternatives under consideration would create navigation problems at Oregon Inlet. Please explain or remove this "impact."

FWS Response: Table 14 presents the Service's determination of the indirect environmental impacts of the beach construction alternative and a combination of non-structural alternatives. Support for the determinations can be found in Section 10 of the Draft FWCA Report (USFWS 1999, pp. 119-128). The Department of the Interior has repeatedly expressed concerns that the fill material from the proposed project will be transported via the littoral drift, or longshore transport system, to Oregon Inlet, and increase shoaling in the navigational channel. These concerns are summarized in the Draft FWCA Report (USFWS 1999, pp. 126-127). The problem is best stated by the Corps (USACOE 1999a, p. 2-2):

> "The intense wave action in the area also transports large amounts of sand toward Oregon Inlet. Much of this sand is trapped in the inlet environment, resulting in the development of massive shoals and concomitant severe erosion of the adjacent shoreline. The presence of the sand shoals, in combination with waves and tidal currents, creates an extremely hazardous zone for the passage of commercial and sport fishing craft."

Current estimates indicate that 3,890,000 cubic yards of sediment would need to be added to the beach-dune system every three years for the 50-year life of the project. This is essentially an estimate of the amount of sediment that will be lost from the beaches and dunes. The simple average annual loss would be 1,300,000 cubic yards. Some of these losses would occur as sediment is blown inland or washed out to sea. Other sand will end up in the longshore transport system that predominantly flows north to south. The amount of sand carried south will vary greatly from year to year. A recent estimate of the net amount of material carried in the longshore current at Oregon Inlet is 862,000 cubic yards of sediment moved to the south (USACOE 1999a, EIS, p. 3-2). If approximately two-thirds of the sand lost from the artificial beach washed south, the proposed project could double the amount of material carried to Oregon Inlet.

Dean (1999, p. 60-61) describes the movement of nourishment sand away from Hunting Island State Park, South Carolina. After a sand-pumping operation placed sand on the narrowing beaches of the park, the sand washed away and moved southward to the beaches of Fripp Island. In 1968 approximately 650,000 cubic yards of sand were placed on park beaches, but almost all this material was gone within 18 month (Dean 1999, p. 107-108). While this sand movement provided a brief respite for the beaches of Fripp Island, sand washed off any created beach may hinder navigation through inlets downdrift of the placement area.

Over the 50 years of the storm damage reduction project, the Corps would place approximately 74.58 million cubic yards of sand directly updrift from the Oregon Inlet navigation channel that is currently subject to "massive shoaling" that "creates an extremely hazardous zone for the passage of commercial and sport fishing craft" (USACOE 1999a, EIS, p. 2-2). Pilkey and Dixon (1996, p. 92) write that "Based on comparisons before and after replenishment, the erosion rate of replenished beaches appears to be almost always greater than the natural beach's erosion rate. The assumption that pre- and post-replenishment erosion are the same is an important reason predictions of beach replenishment durability are optimistic more often than not." Down current drift of sediment may accelerate the filling of navigation channels in down current areas, which would increase the frequency of dredging required to maintain the channel (NRC 1995, p. 113). Sand placed on the beaches of Kitty Hawk, Kill Devil Hills, and Nags Head will be carried south to Oregon Inlet. Therefore, a potentially significant indirect impact of the beach construction alternative is blockage of navigation through Oregon Inlet.

Section 12 [Conservation Measures]

a. Page 137, paragraph 2, 6th and 7th sentences. These sentences seem overly dramatic and unrealistic. If all of the natural amenities were gone as predicted, no one would want to live in the area and the construction of ring dikes "dozens of feet high" would not be warranted. Please try to be more realistic and keep the evaluation period within the context of a 50-year planning horizon.

> **FWS Response:** The sentences in question state "In the distant future, development must either accommodate the movement of the islands or permanent development will survive on isolated slivers of sand completely ringed by dikes dozens of feet high; there would be no beaches or estuarine marshes as we know them now. The latter scenario would be devastating to the fish and wildlife resources that depend on habitats associated with natural barrier islands." The Service's statement does not seem to differ greatly from a statement by the Corps in the Final EIS (USACOE, 2000b, p. C-28):
>
> > "Recently, Dr. Stan Riggs of East Carolina University, has put forth a new theory regarding the future of the barrier islands that appears to agree with the historic changes that have taken place over the last 150 years. Dr. Riggs hypotheses that the islands will gradually erode and become so narrow that the advent of a category 4 or 5 hurricane in the next 20 to 30 years will breach the islands in

several places, resulting in a series of islands from Oregon Inlet south to Cape Hatteras. While we do not necessarily agree with the timing of Dr. Riggs' predictions, Dr. Riggs apparently recognizes the threat that ocean and sound side erosion poses to the barrier islands. His predictions are not unlike what occurred to the Isle Dernieres off the Louisiana coast between 1978 and 1983 ([U. S.] Department of Energy 1988) in which the island responded to an accelerated rate of relative sea level rise by deteriorating into a series of 5 small islands."

The statements of the Service regarding the future threats to barrier islands are no more dramatic than those presented by the Corps. The critical question is the degree of protection that residents will demand from the federal government. If sound side erosions accelerates due to a rising sea, residents may not be content with only the artificial beach along the ocean. Since inlets can be created by an ebb tide surge from the sound, the realization of a threat from the sound could lead to protective measures along the estuarine coastline. Overall, the major issue remains the measures that will be taken to protect human structures on barrier islands surrounded by a rising sea. As a worst case scenario, a federal commitment to protect structures on the barrier island could lead to an all-encompassing dike and the subsequent disappearance of the beach.

b. Page 137, paragraph 3 through page 139, paragraph 3. This text is all directed at telling the Corps how it should do its planning. See general comment b.

FWS Response: The paragraphs in question refer to conservation measures related to the National Environmental Policy Act (NEPA) and the selection of the preferred alternative. In the project under consideration, the preferred alternative, either a structural or non-structural approach, will greatly influence the level of environmental impacts. The FWCA mandates that fish and wildlife resources should receive equal consideration with other aspects of water resources planning. The Service would discuss the merits of the non-structural alternatives under the authority of the FWCA even if the NEPA did not exist. In this regard, the Service believes that the FWCA and the NEPA are mutually reinforcing in that both statutes can be used to minimize adverse impacts to fish and wildlife resources.

c. Page 139, paragraph 5, 1st sentence. This statement is not true. Dr. Martin Posey of the University of North Carolina at Wilmington has been studying the offshore borrow site at Kure Beach and now has a draft report available.

FWS Response: The Service appreciates this information. The Service looks forward to reading Dr. Posey's report.

d. Page 142, paragraph 2. What is the basis for the March 31 date?

FWS Response: Part of the paragraph in question states "Therefore, the Service proposes that initial construction be accomplished by using at least two dredging vessels that

commence work on or after October 1. These vessels would work as weather allows through the winter and attempt to finish initial construction by March 31. If some work remained after March 31, these vessels would continue work into the spring until work was completed."

The basis for a March 31 cessation for offshore sand mining and beach placement comes from the data presented in Table 15 on page 141. As the report states on page 140, this table ". . . indicates that there is no single month, or even a single season, when all adverse impacts to important fish and wildlife resources could be avoided. As might be expected, overall biological activity for these resources is less during the colder months. From a strictly biological point of view, the least harmful six-month period would be the months of October through March." The proposed work period would avoid most, but not all, of the sea turtle nesting season. The period would avoid most, but not all, of the piping plover nesting season. The period would avoid the general period when *Emerita* spp. are on the beach, and most of the period when *Donax* species are on the beach. The period would avoid the May-October period which is considered a general period for beach invertebrate recruitment.

e. Page 142, paragraph 4. We do not consider recommendations that we do not build the project or use alternative ocean or estuary borrow sites where EFH has not been designated, (when <u>all</u> ocean and estuary waters in the state are designated as EFH) to be helpful in the planning process. They should be eliminated and meaningful recommendations provided.

FWS Response: The Service finds nothing in this paragraph suggesting that all ocean and estuary borrow areas in the state have been or will be designated as Essential Fish Habitat (EFH). The last two sentences of this paragraph state that the author of Appendix B indicated that an option for avoiding impacts to fisheries would be ". . . to seek alternative sources of material for constructing the proposed project other than offshore deposits which lie within significant wintering grounds for major stocks of highly important ecological, commercial and recreational fishery resources. This could include upland sites, as well as alternative ocean or estuary sites, if they can be located, where resource values may be less and where Essential Habitat (EH) or Essential Fish Habitat (EFH) has not been designated." These sentences clearly indicate that in July 1999 when this was written, the Service believed that some ocean and estuary borrow could be used without adversely impacting EFH. Criticisms of the Corps should take into account the conditions at the time a document was drafted, and to label a recommendation as meaningless based on conditions that have changed does not contribute to a constructive dialog.

The Service realizes that most, if not all oceans and estuarine water may be designated as EFH. Under such circumstances the Service would not recommend that all work in an area of EFH be avoided. The Service would recommend that the Corps recognize the sensitive nature of EFH, recognize the economic benefits derived from ensuring healthy

stocks of commercial fisheries, and develop specific plans to minimize all adverse impacts associated with work in EFH.

f. Page 143, paragraph 1. We believe it is inappropriate for the Service to tell the Corps that it should develop a policy for dredging in areas of EFH. For your information, the Corps and the NMFS are working together on many EFH issues and the Service should allow our agencies to work together without interjecting its views.

FWS Response: See FWS Response to General Comment b and Page 119, paragraph 2 (Section 10, r).

g. Page 143, paragraph 2, 1st sentence. This sentence implies that there are concerns that the Corps would not adequately fund monitoring sea turtle activities. We are unaware that this has ever been a problem. Please clarify.

FWS Response: The sentence in question states "[i]f sediment placement extends into the sea turtle nesting season, May 1 through November 15, the Corps must ensure that a program of nest monitoring and relocation is initiated with adequate funding." The Service finds no suggestion in this sentence that the Corps may not adequately fund the sea turtle monitoring and nest relocation effort. The Service is also unaware of any problems with funding such activities in the past. We hope these statements have clarified the Service's position.

h. Page 143, paragraph 3. We believe that the local sea turtle programs are already working well. We see no value in the Federal government coming in and telling the local sponsor to take certain actions if those actions are unnecessary. If the Service believes additional measures are necessary, please clarify.

FWS Response: As a result of the Corps' determination that the preferred alternative may affect the loggerhead and green sea turtles, the Service issued a Biological Opinion on November 22, 2000. In that opinion the Service gave the reasonable and prudent measures with their implementing terms and condition designed to minimize the impact of incidental take that might otherwise result from the proposed action. It is the legal responsibility of the Corps to comply with the Biological Opinion. Section 7 of the Endangered Species Act (ESA) applies to activities of a federal agency. Under this section, the federal government is not telling the local sponsor what must be done, but rather telling a federal agency what must be done. If the local sea turtle program fulfills these requirements, the Corps will be in compliance with the Endangered Species Act (ESA). However, the ultimate responsibility for complying with the Biological Opinion remains with the Corps.

The Service's Biological Opinion also contains six Conservation Recommendations which the Corps may implement, at its discretion, to further the purposes of the ESA.

These measures would further avoid or minimize adverse impacts of the project, help the species recovery plans, or develop new information.

The paragraph in question suggested that the beach surveys could be more effective if survey personnel were allowed to use motorized vehicles on the beaches during surveys. The ability to move rapidly along the beach may allow the monitors to reach a nest site before waves or tides wash out signs of the female's crawl. At the time the Draft FWCA was written, it was our understanding that certain communities had ordinances against the use of motorized vehicles on beaches. This suggestion for improving beach monitoring came from the State Sea Turtle Coordinator. The Service believes this suggestion has merit and recommends that the Corps investigate whether such action is appropriate for the study area. If local monitors believe that the use of motorized vehicles would make their work more efficient, there would be "value" in implementing this change. We hope that the discussion above clarifies this paragraph.

i. Page 143, paragraph 4. These issues are not within the jurisdiction of the Service. The Corps will address them with the NMFS, the agency that oversees these resources. Inclusion of recommendations for a resource administered by another agency should not be included in a FWCA report. Please delete.

FWS Response: See response to Corps' General Comment b and Page 119, paragraph 2, 3rd sentence (Section 10, r).

j. Page 143, paragraph 5, 2nd sentence. Donoghue (1999) indicates that it is unlikely that these animals are being killed. If the Service has data indicating otherwise, please include it.

FWS Response: See response above to Corps comments on 117, Paragraph 2 (Section 10, i). As noted in that response, the Service is not certain that Donoghue's work actually assessed the extent which beach invertebrates were killed by sand placement on the beach. Her sampling techniques apparently extended about four inches below the surface of the beach and we find no evidence that systematic searches were made through what may have been several feet of deposited sediment. The Service does not deny that the statement (Donoghue 1999, p. 183) appears in the dissertation, but we can find nothing in her actual work to support such a statement.

k. Page 144, last paragraph, over to page 142, top of page. Please see comment b on Section 10. We do not believe the Service has made a convincing argument that sedimentation should be monitored in near shore hardbottom areas. Also, please explain how the monitoring distance of 25-30 miles was determined. We believe this distance is excessive as dredging would occur in coarse sand and there is no known reason to expect impacts out to that distance.

FWS Response: Upcoming geotechnical investigations during the PED phase of the project will determine if hardbottom areas are present in or adjacent to the planned borrow areas. At such time, the Service will work with the Corps and other resource agencies to develop necessary monitoring plans. The 25-30 mile distance is incorrect.

Evidence summarized in DOI (1999) indicate that a buffer on the order of a few miles is most appropriate and would incorporate control sites. Longer distances on the order of tens of miles would be appropriate for monitoring of fishery resources such as striped bass, which may migrate long distances but depend on the project area during wintering periods.

l. Page 145, paragraph 2. Productivity in the water column should not be affected by an increase in water depth; therefore, we can only conclude that the Service is concerned about productivity of benthic microalgae. Does the Service actually want the Corps to triple or quadruple the size of its borrow areas to keep from adversely impacting the productivity of benthic microalgae? Has the Service considered the additional impacts to benthic organisms? Even with removing material from a borrow site, the resulting depths would still be within the range of depths naturally occurring in the project area. This "conservation measure" seems directly opposed to the goal of impact minimization. Please clarify the Service's intent.

FWS Response: This paragraph is based on the idea that the penetration of solar energy decreases as water depth increases. A decrease in solar energy results in a decrease in photosynthetic activity, the driving force for primary productivity. The surface layer of the ocean that receives enough light to support photosynthesis is the euphotic zone. The availability of inorganic nutrients also influences primary production. Thurman (1994, p. 370) writes that primary photosynthetic production in the ocean varies from about 0.1 gram of carbon per square meter per day ($gC/m^2/day$) in the open ocean to more than 10 ($gC/m^2/day$) in highly productive areas. This variation is due to the uneven distribution of nutrients throughout the photosynthetic zone and seasonal changes in the availability of solar energy. While the Service is not suggesting that any nearshore sand mining operation would produce changes of this magnitude, we do suggest that increased turbidity at both the borrow sites and immediately seaward of the disposal area could experience short-term reductions in primary productivity. Offshore dredging has the potential to reduce the solar energy reaching the bottom and produce a reduction in photosynthetic activity. The Service cannot predict the actual magnitude of such impacts in the project area, but mentions these points as a worthwhile area for post-project monitoring.

Regarding the Corps' statement that ". . . the resulting depths would still be within the range of depths naturally occurring in the project area," the Corps states (USACOE 2000b, p. 3-6) that existing depths at the northern and southern borrow areas are -32 to -62 feet National Geodetic Vertical Datum (NGVD) and -32 to -52 feet NGVD, respectively. NGVD is approximately mean sea level. The average depth of dredging in the northern and southern sites would be 9 and 12 feet, respectively (USACOE 2000b, p. 6-5). After dredging, the maximum depths in the northern and southern areas could be -71 feet and -64 feet NGVD, respectively. Neither of these depths would be typical of the existing area. The dredging would effectively give these areas the same solar penetration as bottom areas farther offshore. A reduction in the primary production of benthic microalgae is a potential consequence. This was the basis for the recommendation in the

Draft FWCA Report that sediment be removed over a wider area with less reduction in depth.

Minimizing the environmental impacts of offshore sand mining for whatever reason involves the balancing of conflicting goals. As the Corps states, removing the required sand in a thin layer would impact a greater area of benthic organisms, but minimize the creation of large, deep holes. This Final FWCA does not have the recommendation for removing sand in a thin layer over a larger area. In light of the many uncertainties involved, this Final FWCA recommends (No. 7) that the Corps establish a program to monitor dredging impacts on primary productivity and benthic invertebrate community composition. The program should assess the diversity, abundance, biomass, and production of benthic and infaunal macroinvertebrates of the offshore borrow areas. The program should include pre-project baseline data and post-project data at one-, three-, five-, and ten-years after dredging.

m. Page 148, 3rd paragraph, first 2 sentences. These lines contradict the future with a project condition presented on page 79.

FWS Response: The paragraph in questions deals with conservation measures related to increased development within the project areas. The sentences mentioned state "There are no conservation measures which can be associated with the current project to address these future impacts. While current LUPs [Land Use Plans] stress the need for controlled development and the orderly provision of both adequate water and wastewater treatment, there are no guarantees that policies will not change in the future." The sentence on Page 79 appears to be one that states "It is likely that all available uplands which are not protected by designation as a conservation area within local LUP will be developed."

The Service sees no contradictions in these statements. The first sentence from page 148 means that there are no design features or construction techniques for the artificial berm-dune system that would minimize the environmental impacts of the development that may be fostered by the sense of security, i.e., reduced risk, provided by the structure. The second sentence from page 148 states that current protective measures contained in the local Land Use Plan may be changed. The third sentence of the 3rd paragraph from page 148 states that "[t]he Town of Kitty Hawk has stated (1994, p. 37) that:

> "The Town supports the guidelines of the Coastal Area Management Act and the associated policies of the Coastal Resources Commission but reserves the right to review and oppose sections of the CAMA or its implementation that may be deemed contrary to the Town's land use policies and development preferences."

This policy of the town (Town of Kitty Hawk 1994, p. 37) suggests that there are local land use policies and development preferences which be at odds with those of the statewide Coastal Resources Commission (CRC). Time will tell whether the local

development preferences will be more accommodating or restrictive than those of the CRC.

n. Page 148, paragraph 4. Please support this paragraph with an actual analysis.

FWS Response: The paragraph in question states "[i]n addition to the habitat losses associated with future development, there is a concern for a spiraling cycle of increased development and ever greater efforts to protect increasingly valuable property. If the current project conveys the idea that a firm commitment has been made to halt beach recession, increased development will occur near the beach. As the artificial beach-dune system washes away, the value of structures at risk from storm damage will be much greater than today. Therefore, a future benefit-cost analysis will justify greater expenditures to create the next beach-dune system which will in turn generate additional development in the ever enlarging shadow of the constructed dune."

Please see the response to Corps' comment on Page 41, paragraph 3 (Section 3, c). Furthermore, Nordstrom (1994) discusses the interrelationship between development and artificial protective structures on Long Beach Island, New Jersey after the severe Ash Wednesday northeaster in March 1962. The storm caused considerable property damage since the beach was narrow and dunes were low prior to the storm. The island was overwashed and sand was carried into the bay behind the island. The five breaches in the island were artificially closed. A large number of shore protection projects were implemented after the storm. The loss of sand from the beach and dunes on the oceanside was rectified by the creation of a new dune line using sediment dredged from borrow areas in the bay. The new dune line was linear and shore-parallel, and bore little resemblance to the hummocky dune that existed before the storm. The author states that "[c]onstruction of new buildings and facilities occurred at a rapid pace after the storm; many of the new structures were more elaborate than those constructed prior to 1962 (US Congress 1976), and the new seaward-most construction line was at the same location it was prior to the storm." The author concludes that "[a]s a result of past precedent, and taking into account the development pressure and current level of investment in many barrier islands, it is likely that future structures damaged by storms will be replaced (USACOE 1989a) or there will be an increase in the level of development and protection. This assessment supports the idea that over time there can be an increase in both the value of development and the costs of protective measures to protect such development.

o. Page 148 last paragraph, first sentence. Where is the evidence for a slow evolution towards an "all encompassing dike?" Nothing like this has been begun at Wrightsville Beach or Carolina Beach, both of which have been in place over 30 years.

FWS Response: The sentence in question states "With a constantly rising sea level, the cost of the beach-dune system (which will slowly evolve toward an all encompassing dike) will simply become too expensive in spite of the value of the structures it protects." The long-term process mentioned is in the early stages. Sand placements on Wrightsville

and Carolina Beaches began around 1955 (Pilkey et al. 1998, p. 97). Starting in the mid-1990s shoreline recession and inlet migration at the northern end of the island prompted owners of the Shell Island Resort to place a barrier of large sandbags on both the ocean and inlet shoreline. There has been extensive bulkhead construction on the sound sides of these islands. At this stage in the response to sea level rise, much of the highly developed island of Wrightsville Beach has some form of protective structure. The question then becomes what will be the response if these protective structures fail. In the mid-1990s a rock revetment was built to protect the Fort Fisher State Historic Site, south of Carolina Beach. A rock revetment was constructed at the northern end of Carolina Beach in the wake of Hurricane Fran in 1996 after the storm removed the nourished beach (Pilkey 1998, p. 189, Figure 7.17). These revetments are still in place and bear a certain resemblance to a rock wall that could be expanded to other areas in the future. If one looks at the range of structural protective measures that have been taken in just the last 50 years and extrapolates to the measures that may be needed in the face of sea level that may be rising at an increasing rate, an all encompassing dike is not beyond the realm of possibility within the next 100 years. The Service will revise the text to indicate that such a dike is a possibility rather than a certainty.

Section 13 [Recommendations]

a. Due to the extensive and serious nature of our comments on the draft FWCA report, we believe that many of the recommendations in this section will require adjustment or deletion; therefore, it would be repetitive to comment on recommendation at this time. Once the report revisions have been made, please revise the recommendations section as appropriate. Corps responses to the recommendations found in the Final EIS should be considered in your revisions.

FWS Response: The Service believes that our responses in this Appendix to our Final FWCA Report provide more detailed supporting evidence for the environmental impacts described in our Draft FWCA Report. We also believe that we have provided the clarification requested by the Corps. However, new information and additional coordination has occurred in the almost year and a half since the Draft FWCA was released. Therefore, the Service has revised our recommendations which are provided in the cover letter that constitutes the first part of this Final FWCA Report for this project.

Section 14 [Summary of Findings and Service Position]

a. Page 156-158. This section should be revised to address current information made available to the USFWS in the Final EIS.

FWS Response: This Final FWCA Report is based on the most recent planning documents of the Corps. Under standard procedures this Final FWCA would be used by the Corps in drafting the Final EIS. However, the Final EIS was released with a cover date of September 2000, approximately two week after the DOI provided comments on the Draft EIS. The Service had insufficient time to prepare a Final FWCA Report. Based on the Final Feasibility Report, the Final EIS, and the Final Report of the Chief of

Engineers, the first part of this reports contains a revised statement on the position of the Service.

Appendix B

a. Please finalize this attachment

FWS Response: The authors will finalize the document as soon as feasible. One of the authors (WRL) has recently (January 2001) collected additional data in the project area.

Appendix C

Please update this report based on complete onshore and offshore sand data and evaluation provided in the FEIS.

FWS Response: Appendix C was submitted to the Service under a contract that has since closed. Therefore the Appendix cannot be updated.

References for Corps Comments

Burger, J., M. A. Howe, D. C. Hahn, and J. Chase. 1977. Effects of tide cycles on habitat selection and habitat partitioning by migrating shorebirds. The Auk (4: 743-758.

Connors, P. G., J. P. Myers, C. S. W. Connors, and F. A. Pitelka. 1981. Interhabitat movements by sanderlings in relation to foraging profitability and the tidal cycle. The Auk 98:49-64.

Department of the Interior, Minerals Management Service. 1999. Environmental Report. Use of Federal Offshore Sand Resources for Beach and Coastal Restoration in New Jersey, Maryland, Delaware and Virginia. OCS Study MMS 99-0036.

Donoghue, C. R. 1999. The influence of swash processes on *Donax variabilis* and *Emerita talpoida*. PhD. Dissertation, Univ. of Virginia.

Smith, A. P. 1988. A characterization of beach use by birds in southeastern North Carolina. Unpublished M.S. Thesis. University of North Carolina at Wilmington.

Literature Cited in FWS Responses

Bowen, P. R. and G. A. Marsh. 1988. *Benthic faunal colonization of an offshore borrow pit in southeastern Florida*. Miscellaneous Paper D-88-5. U. S. Army Corps of Engineers, Waterways Experiment Station. Vicksburg, Mississippi.

Bush, D. M., O. H. Pilkey, Jr., and W. J. Neal. 1996. Living by the Rules of the Sea. Duke University Press. Durham, North Carolina. 179 pp.

Canadian Wildlife Service 1994. The 1991 international piping plover census in Canada. S. P. Fleming (ed.). Ontario Canada.

Caviedes, C. 1991. Five hundred years of hurricanes in the Caribbean – Their relationship with global climatic variations. *GeoJournal*, 23:301-310.

Coastal Ecology Branch. 1997. Characterization of benthic resources at a beach renourishment borrow area site in the vicinity of Coney Island, New York. U.S. Army Corps of Engineer. Waterways Experiment Station, Vicksburg, MS.

Dean, C. 1999. Against the Tide: The Battle for America's Beaches. Columbia University Press. New York. 279 pp.

Department of the Interior, Minerals Management Service. 1999. Environmental Report. Use of Federal Offshore Sand Resources for Beach and Coastal Restoration in New Jersey, Maryland, Delaware and Virginia. OCS Study MMS 99-0036.

Dexter, D. M. 1969. Structure of an intertidal sandy-beach community in North Carolina. Ches. Science. 10:93-98.

Dickerson D.D. and D.A. Nelson. 1989. Recent results on hatchling orientation responses to light wavelengths and intensities. Pages 41-43 *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 NMFSSEFC-232.

Donoghue, C. R. 1999. The influence of swash processes on *Donax variabilis* and *Emerita talpoida*. PhD. Dissertation, Univ. of Virginia.

Everts, C.H., J.P. Battley, Jr., and P.N. Gibson. 1983. *Shoreline Movements: Report 1, Cape Henry, Virginia, to Cape Hatteras, North Carolina, 1849-1980.* U.S. Army Corps of Engineers, Technical Report CERC-83-1, 113 p.

Federal Emergency Management Agency (FEMA). 1997. *Building Performance Assessment: Hurricane Fran in North Carolina*. Washington, D.C., 81 p.

Frankenberg, D. 1995. The Nature of the Outer Banks: Environmental Processes, Field Sites, and Development Issues, Corolla to Ocracoke. The University of North Carolina Press. Chapel Hill. 157pp.

Fussell, J.O., III. and Lyons, M. 1990. Birds of the Outer Banks. Leaflet. Eastern National Parks and Monuments Association and The Coastal Wildlife Refuge Society.

Godfrey, P. J. 1970. Oceanic overwash and its ecological implications on the Outer Banks of North Carolina. Office of natural Sciences Studies. National Park Service. Department of the Interior. Washington, DC. 44 pp.

_____ and M.M. Godfrey. 1976. *Barrier Island Ecology of Cape Lookout National Seashore and Vicinity, North Carolina*. National Park Service Scientific Monographic Series, No. 9, 160 p.

Hackney, C. T., M. R. Posey, S. W. Ross, and A. R. Norris. (eds.). 1996. A Review and Synthesis of Data on Surf Zone Fishes and Invertebrates in the South Atlantic Bight and the Potential Impact from Beach Renourishment. Report to the Wilmington District, U. S. Army Corps of Engineer. Wilmington, North Carolina. 109 pp.

Heinz Center (The). 2000. Evaluation of Erosion Hazards. Report prepared for the Federal Emergency Management Agency (Contract EMW-97-CO-0375) by The H. John Heinz III Center for Science, Economics and the Environment. Washington, DC. 205 pp.

Hicks, S.D. 1981 (Apr). Long period sea level variations for the United States through 1978. *Shore and Beach*, pp. 26-29.

Huntsman, G. 1994. Living resources: fisheries. pp. 5-9. in Hart, K. (ed.) Managing the Coastal Ocean for the 21th Century: North Carolina's Role. Proceedings from a conference held May 20-21, 1993, University of North Carolina at Wilmington. N.C. Sea Grant Publication UNC-SG-94-02. 54 pp.

Hurme, A. K. and E. J. Pullen. 1988. Biological Effects of Marine Sand Mining and Fill Placement for Beach Replenishment: Lessons for Other Uses. *Marine Mining* 7:123-136.

Johnson, R. O. and W. G. Nelson. 1985. Biological effects of dredging in an offshore borrow area. *Florida Scientist.* 48:166-188.

Levinton, J. S. 1982. Marine Ecology. Prentice Hall. Englewood Cliffs, New Jersey. 526 pp.

Limpus, C. J. 1991. Marine turtles of Raines Island, Australia. Unpublished paper presented at the Eleventh Annual Workshop on Sea Turtle Biology and Conservation. 26 February - 2 March, 1991. Jekyll Island, Georgia.

Lindeman, K. C. 1997. Development of grunts and snappers of southeastern Florida: cross-shelf distribution and effects of beach management alternatives. Ph.D. dissertation. Univ. Miami. Coral Gables, FL. 419 pp.

_____ and D.B. Snyder. 1999. Nearshore Hardbottom Fishes of Southeast Florida and Effects of Habitat Burial Caused by Dredging. Fishery Bulletin. 97:508-525.

Mann, T.M. 1977. Impact of developed coastline on nesting and hatchling sea turtles in southeastern Florida. Unpubl. M.S. thesis. Florida Atlantic University, Boca Raton, FL. 100pp.

Mead, J. G. 1999. Bottlenose dolphin - Tursiops truncatus. pp. 264-265 in D. E. Wilson and S. Ruff. The Smithsonian book of North American Mammals. Smithsonian Institution Press. Washington, DC. 750 pp.

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.

_____ and S.J. Shettleworth. 1968. Wavelength preferences and brightness cues in water finding behavior of sea turtles. Behavior 32:211-257.

National Research Council. 1995. Beach Nourishment and Protection. National Academy Press. Washington, D.C. 334 pp.

Nordstrom, K. F. 1994. Developed coasts. Chapter 13, pp. 477-509. in R. W. G. Carter and C. D. Wooddroffe. (eds.) Coastal Evolution - Late Quaternary Shoreline Morphodynamics. Cambridge University Press. Cambridge, United Kingdom.

O'Connor, J. M., D. A. Neumann, and J. A. Sherk, Jr. 1976. Lethal effects of suspended sediments on estuarine fish. TP 76-20. U. S. Army Corps on Engineers, Coastal Engineering Research Center. Fort Belvoir, Virginia.

Parnell, J. F., D. M. DuMond, D. A. McCrimmon. 1986. Colonial waterbird habitats and nesting populations in North Carolina estuaries: 1983 survey. Technical Report D-86-3. Dredging Operations Technical Support Programs. U. S. Army Corps of Engineers. Wilmington District. Wilmington, North Carolina. 16 pp. + 21 Table + 26 Figures.

_____, W. W. Walker, and Samuel Cooper 1992. Nesting colonial waterbird trends at Cape Hatteras National Seashore. pp. 119-131. in C. A. Cole and K. Turner (eds.). Barrier Island Ecology of the Mid-Atlantic Coast: A Symposium. Technical Report No. NPS/SERCAHA/NRTR-93/04. National Park Service. Atlanta, GA. 208pp.

_____, W. W. Golder, and T. M. Henson. 1995. 1993 atlas of colonial waterbirds of North Carolina estuaries. North Carolina Sea Grant College Program Publication UNC-SG-95-02. North Carolina State University. Raleigh, NC. 117pp.

Pearse, A. S., H. T. Humm, and G. W. Wharton. 1942. Ecology of sand beaches at Beaufort, NC. Ecological Monograph. 12:135-190.

Peterson, C. H. and N. M. Peterson. 1979. The ecology of intertidal flats of North Carolina: a community profile. U. S. Fish and Wildlife Service, Office of biological Services. FWS/OBS-79/39. 73pp.

_____, D. H. M. Hickerson, and G. G. Johnson. 2000. Short-term consequences of nourishment and bulldozing on the dominant large invertebrates of a sandy beach. Journal of Coastal Research. 16:368-378.

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. 272pp.

_____, W.J. Neal, S.R. Riggs, C.A. Webb, D.M. Bush, D.F. Pilkey, J. Bullock, and B.A. Cowan. 1998. The North Carolina Shore and Its Barrier Islands: Restless Ribbons of Sand. Durham, NC: Duke University Press, 318 p.

Pullen, E. J. and S. M. Naqvi. 1983. Biological impacts on beach replenishment and borrowing. Shore and Beach (April 1983):27-31.

Reilly, F.J. Jr., and V.J. Bellis. 1978. A study of the ecological impact of beach nourishment with dredged materials on the intertidal zone. East Carolina University Institute for Coastal and Marine Resources, Technical Report No. 4., Greenville, North Carolina. 107 pp.

Riggs, S. R. 1994. Nonliving resources. pp. 13-19. in Hart, K. (ed.) Managing the Coastal Ocean for the 21th Century: North Carolina's Role. A proceedings from a conference held May 20-21, 1993, University of North Carolina at Wilmington. N.C. Sea Grant Publication UNC-SG-94-02. 54 pp.

_____, S.R., W.J. Cleary, and S.W. Snyder. 1995. Influence of inherited geologic framework on barrier shoreface morphology and dynamics. Marine Geology, 126:213-234.

Ruppert, E. E. and R. S. Fox. 1988. Seashore Animals of the Southeast. University of South Carolina Press. Columbia, South Carolina. 429pp.

Saloman, C. H. 1974. Physical, chemical, and biological characteristics of the nearshore zone of Sand Key, Florida, prior to beach restoration. Vols. 1 & 2. National Marine Fisheries Service, Gulf Coast Fisheries Center, Panama City, FL.

_____, S. P. Naughton, and J. L. Taylor. 1982. Benthic community response to dredging borrow pits, Panama City Beach, Florida. Miscellaneous Report No. 82-3. Prepared for the U. S. Army Corps of Engineers, Coastal Engineering Research Center, Fort Belvoir, Va.

Schafale, M.P. and A.S. Weakley. 1990. Classification of the Natural Communities of North Carolina Third Approximation. NC Natural Heritage Program, Raleigh, NC 325pp.

Scott, L. C. and F. S. Kelley. 1998. An evaluation and comparison of benthic community assemblages and surf clam populations within the offshore borrow area site for the Great Egg Harbor Inlet

and Peck Beach, Ocean City, New Jersey Project. Prepared by Vesar, Inc. Columbia MD for U.S. Army Corps of Engineers, Philadephia, PA.

Smith, E. 1999. Atlantic and East Coast hurricanes 1900-1998: A frequency and intensity study for the Twenty-First Century. Bulletin of the American Meteorological Society, 80(12):2717-2720.

Thurman, H. V. 1994. Introduction to Oceanography. Macmillian Publishing Company. New, NY. 550 pp.

Titus, J.G. and V. Narayanan. 1995. The Probability of Sea Level Rise. Washington, D.C.: U.S. Environmental Protection Agency, EPA 230-R95-008, 186 pp.

Town of Kitty Hawk. 1994. 1994 Town of Kitty Hawk, North Carolina Land Use Plan Update- Kitty Hawk, North Carolina. 106 pp. + Appendices.

Trembanis, A.C., H.R. Valverde and O.H. Pilkey. 1998. Comparison of beach nourishment along the U.S. Atlantic, Great Lakes, Gulf of Mexico and New England Shorelines. Journal of Coastal Research, Special Issue No. 26, pp. 246-251.

U.S. Army Corps of Engineers. 1989. Benefits reevaluation study: Brigantine Island , New Jersey. U. S. Army Corps of Engineers. Philadelphia District.

_____. 1990. Draft Feasibility Report and Environmental Assessment, Morehead City Harbor Improvement, Morehead City, North Carolina. U. S. Army Corps of Engineers, Wilmington District, Wilmington, North Carolina. 86 pp. + Appendices.

_____. 1999a (January). Draft Supplement III, Environmental Impact Statement, Manteo (Shallowbag) Bay, Dare County, North Carolina. U.S. Army Corps of Engineers. Wilmington District. Wilmington, North Carolina.

_____. 1999b. The New York District's Biological Monitoring Program for the Atlantic Coast of New Jersey, Asbury Park to Manasquan Section Beach Erosion Control Project. Phases II-III, During Construction and 1st Year Post-Construction Studies. Vicksburg, MS: Waterways Experiment Station, various paginations.

_____. 2000a (June). Draft Feasibility Report and Environmental Impact Statement on Hurricane Protection and Beach Erosion Control. Dare County Beaches (Bodie Island Portion), Dare County, North Carolina. Volume I. (Draft Feasibility Report, 102 pp. + plates + appendices; Draft EIS, 10 Chapters +Attachments+Appendices), Wilmington Corps District, Wilmington, North Carolina.

_____. 2000b (September). Final Feasibility Report and Environmental Impact Statement on Hurricane Protection and Beach Erosion Control. Dare County Beaches (Bodie Island

Portion), Dare County, North Carolina. Volume I. (Draft Feasibility Report, 99 pp. + plates + appendices and Final EIS, 11 chapters +attachments), Wilmington Corps District, Wilmington, North Carolina.

U. S. Congress. 1976. New Jersey coastal inlets and beaches Hereford inlet to Delaware Bay entrance to Cape Many canal. House Document 94-641. U. S. government Printing Office. Washington, DC.

U. S. Department of Energy. 1988. Workshop on Sea Level Rise and Coastal Processes. Office of Energy Research. Office of Basic Energy Sciences. Carbon Dioxide Research Division. DOE/NBB-0088. Palm Coast Florida. March 9-11, 1988.

U. S. Fish and Wildlife Service. 1996 (May). Piping plover (*Charadrius melodus*), Atlantic Coast Population, Revised Recovery Plan. Hadley, Massachusetts. 258 pp.

_____. 1999 (July). Northern Dare County Storm Damage Reduction Project, Dare County, North Carolina. Draft Fish and Wildlife Coordination Act Report. Raleigh Field Office, Raleigh, NC. 173 pp. + Appendices.

Van Dolah, R.F., P. H. Wendt, R. M. Martore, M. V. Levisen, W. A. Roumillat. 1992. A physical and biological monitoring study of the Hilton Head beach nourishment project. Marine Resources Research Institute, South Carolina Marine Resources Division, Charleston, S.C. 159 pp.

_____, R. M. Martore, and M.V. Levisen. 1993. A physical and biological monitoring study of the Hilton Head beach nourishment project. Supplemental report prepared by the South Carolina Marine Resources Research Institute for the Town of Hilton Head, South Carolina.

Van Dolah, R. F., Martore, R. M., Lynch, A. E., Wendt, P. H., Levisen, M. V., Whitaker, D. J., and W. D. Anderson. 1994. Final Report. Environmental evaluation of the Folly Beach nourishment project. South Carolina Department of Natural Resources, Marine Resources Division, Charleston SC. Prepared for the United States Army Corps of Engineers, Charleston District, Charleston, SC.

Wilbur, P. and M. Stern. 1992. A re-examination of infaunal studies that accompany beach nourishment projects. New Directions in Beach Management: Proceedings of the 5th Annual National Conference on Beach Preservation Technology. Florida Shore and Beach Preservation Association. Tallahassee, Florida, pp. 242-257.

Witherington, B.E. 1992. Behavioral response of nesting sea turtles to artificial lighting. Herpetologia. 48:31-39.

_____ and K.A. Bjorndal. 1991. Influences of artificial lighting on the seaward orientation of hatchling loggerhead turtles (*Caretta caretta*). Biol. Cons. 55:139-149.

_____. and R. Erik Martin. 1996. Understanding, Assessing, and Resolving Light-Pollution Problems on Sea Turtle Nesting Beaches. Florida Marine Research Institute (FMRI). FMRI Technical Report TR-2. Florida Department of Environmental Protection. 73 pp.