**Essential Fish Habitat Assessment**

**SC 41 Bridge Replacement over the Wando River**

**Berkeley and Charleston Counties, South Carolina**

Construction PIN: 32099

Project Number: 8.158B

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Prepared for:



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1. **Introduction**

In conformance with the Magnuson-Stevens Fishery Conservation and Management Act of 1976 (as amended 1996) this assessment was conducted to describe potential adverse effects on essential fish habitat (EFH). EFH is defined as those waters and substrate necessary to fish for spawning, breeding, feeding, or growth to maturity (16 USC 1802, 50 CFR 600.10). The National Oceanic and Atmospheric Administration (NOAA) – National Marine Fisheries Service works closely with the South Atlantic Fishery Management Council (SAFMC) to minimize adverse impacts to EFH in the southeast. Adverse effects are those that reduce the quality and/or quantity of EFH, including direct, indirect, site specific, or habitat wide impacts, including individual, cumulative or synergistic consequences of actions.

This assessment describes the proposed project including potential effects to EFH, measures to minimize harm to EFH, and conclusions regarding impacts. This assessment is being submitted by the South Carolina Department of Transportation on behalf of and with permission of the Federal Highway Administration.

1. **Proposed Action**

The South Carolina Department of Transportation (SCDOT) proposes to replace the existing S.C. Route 41 bridge over the Wando River in Berkeley and Charleston Counties, South Carolina. The bridge was built in 1941 and is structurally deficient and functionally obsolete. The limits of the project extend along Clements Ferry Road from Harpers Ferry Way to Reflectance Road, a distance of approximately 1.5 miles (Figure 1). The existing bridge is a 1,690-foot by 22- foot structural steel and reinforced concrete bridge with a metal truss swing span. The fixed portion of the bridge has a vertical clearance of about 9 feet at high tide and 15 feet at low tide.

The project location is located about 17 miles upstream of the entrance to Charleston Harbor. The Wando River is about 22 feet deep at the swing bridge at low tide and 28 feet at high tide. The project corridor consists of mixed pine and hardwood maritime forest, estuarine emergent marsh wetlands, palustrine forested wetlands, and commercial and residential development. The estuarine emergent marsh wetlands are dominated by *Spartina alterniflora* and *Juncus roemerianus*.

The proposed project consists of replacing the entire bridge with a new fixed-span bridge. A preliminary design has been developed, and further refinements are anticipated through the design-build process. The proposed design consists of a fixed-span bridge with a vertical clearance of 55 feet above mean high water, and a horizontal clearance of at least 90 feet between fenders. The new bridge will be approximately 2,300 feet long and approximately 68 feet wide; although SC 41 is currently a two-lane road, the new bridge will be constructed to accommodate the likely future widening of SC 41 to four lanes as well as possible bike lanes and sidewalks.

The new bridge will be constructed about 110 feet to the east (upstream) and parallel to the existing bridge. The project will begin approximately 2,300 feet south of the existing bridge and continue through a relocated SC 41/Clements Ferry Road (S-33) intersection along Clements Ferry Road to near Reflectance Drive. The new bridge will include about 20 bents at 81 square feet each. All of the bents will be placed below mean low water.

The EFH study corridor extends about 1500 feet from the centerline of the existing right-of-way (ROW) along both sides of the existing along approximately 1.5 miles of SC 41 and encompasses approximately 550 acres (Figures 1 and 2).

The existing bridge will likely be removed upon completion of the new bridge. Work for the proposed improvements is anticipated to begin in 2013/2014 and should be complete in 2017.

1. **Essential Fish Habitat Setting**

Essential Fish Habitat is defined in the Magnuson-Stevens Act as “all waters and substrate necessary to fish for spawning, breeding, feeding or growth to maturity”. The South Atlantic Fishery Management Council (SAFMC) is tasked with conserving and managing fish stocks for a portion of the Atlantic coast. Habitat types that are designated as EFH by the SAFMC and are present within the project study area are discussed below. All of these habitats are elements of the tidal creek system of the Wando River and the Charleston Harbor Coastal Inlet.

**Estuarine water column**

Estuarine water column is the open water habitat between the water surface and bottom sediments within an estuarine environment. Estuaries are semi-enclosed coastal bodies of water where saline ocean water mixes with fresh water from upland rivers and streams. The estuarine water column provides habitat for planktonic phytoplankton and zooplankton, and free-swimming larval, juvenile, and adult fish and crustaceans.

Estuarine water column habitat within the project study area consists of waters of the Wando River below the SC 41 bridge. The estuarine water column is by far the dominant essential fish habitat in the SC 41 bridge replacement project area, comprising about half of the entire study corridor and about 90 percent of the affected aquatic habitats(Figure 2).

**Intertidal flat**

Intertidal flats are fine-grained sedimentary depositional habitats where the duration of tidal inundation prevents establishment of estuarine emergent wetlands. Intertidal flats are generally high in primary productivity, resulting from a rich benthic microalgae community and inflow of detritus. They provide habitat for a variety of estuarine-dependent species, including benthic invertebrates, small fishes, and predators.

Intertidal flats are a common component of the estuarine environment in the project study area, and generally occurring as thin bands along the lower edges of estuarine emergent wetlands (Figure 2).

**Estuarine emergent wetlands**

Estuarine emergent wetlands are tidal wetlands dominated by salt-tolerant non-woody plant communities with

low species diversity but high primary productivity. Most estuarine emergent wetlands in South Carolina are dominated by one or two species (usually *Spartina alterniflora* and/or *Juncus roemerianus*). Estuarine emergent wetlands provide essential fish habitat for juvenile and adult forms of many fish and shellfish species.

Estuarine emergent wetlands are the second largest component of the estuarine environment in the project area. They occur in large swaths through much of the intertidal area along the Wando River and its tributaries (Figure 2).

**Oyster reefs and shell banks**

Oyster reefs and shell banks consist of natural hard benthic structures found primarily in intertidal habitats, and are formed by the attachment of many individual shellfish and their shells to each other. Oyster reefs and shell banks in the project area consist primarily of Eastern oyster (Crassostrea virginica). Mussels, barnacles, and other encrusting invertebrates are also commonly found in these habitats. Oyster reefs and shell banks provide feeding and nursery areas for shrimp and other federally managed species, as well as nutrient recycling, sediment stabilization, and refuge habitat.

The Wando River and adjoining tidal creeks within the project study area have been classified by SCDHEC as Shellfish Harvesting Waters (SFH). Class SFH are tidal salt waters protected for shellfish harvesting and uses listed in Class SA and Class SB. Class SA and SB waters are suitable for primary and secondary contact recreation, crabbing, fishing, and for the survival and propagation of a balanced indigenous aquatic community of marine fauna and flora. Information on the location of oyster reefs was obtained from SCDNR (South Carolina Intertidal Oyster Reef Mapping). Oyster reefs and shell banks are present in numerous locations along the north shoreline of the Wando River and on tidal flats south and east of SC 41, although none are located under or immediately adjacent to the existing or proposed bridges (Figure 2). It is likely that oysters and other benthic epifauna are present on the pilings of the existing bridge, but these structures were not assessed as part of this evaluation.

### Habitat Areas of Particular Concern

Habitat Areas of Particular Concern (HAPC) are areas designated by the NMFS and the Fishery Management Councils as subsets of EFH which are rare, particularly susceptible to human-induced degradation, especially ecologically important, or located in an environmentally stressed area. HAPC include high value intertidal and estuarine habitats and habitats used for migration, spawning, and rearing of fish or shellfish.

In South Carolina the nursery habitat of shrimp is estuarine emergent wetlands and the deeper holes and creek channels adjoining the marsh system. Therefore, the HAPC for early growth and development of shrimp encompasses the tidal creeks and their associated estuarine water column, estuarine emergent wetlands, intertidal flats, and oyster reef and shell banks. Areas which meet the criteria for EFH-Habitat Areas of Particular Concern (EFH-HAPCs) for penaeid shrimp in South Carolina include all coastal inlets and all Outstanding Resource Waters in the coastal counties. The Wando River within the project limits is identified by NMFS as a HAPC – Coastal Inlet.

1. **Managed Fishery Species**

### The South Atlantic Fishery Management Council currently manages eight fisheries.  These fisheries include: coastal migratory pelagics, coral and live bottom habitat, dolphin and wahoo, golden crab, shrimp, the snapper grouper complex, spiny lobster, and Sargassum. Of these managed fisheries, only the shrimp fishery plays a significant role in the SC 41 bridge replacement project study area. Species managed by the SAFMC as coastal migratory pelagics (Spanish mackerel, king mackerel, and cobia) and snapper / grouper (73 species of snapper, grouper, and other reef dwelling fish) are present in the offshore and coastal waters of South Carolina and may occur in the project area as very occasional migrants and are unlikely to be affected by the proposed work.

### These fishery species are discussed below.

### Shrimp

Two commercially important marine shrimp species managed by the SAFMC are brown shrimp (*Farfantepenaeus aztecus*) and white shrimp (*Litopenaeus setiferus*) shrimp. Both species are important components of estuarine ecosystems. Larval, post-larval, and juvenile shrimp are found in estuarine waters in the spring and summer, and adult forms tend to move to deeper nearshore waters in the fall and winter. These species are common in the Wando River and in the project study area.

EFH for brown and white shrimp includes inshore estuarine nursery areas, offshore marine habitats used

for spawning and growth to maturity, and all interconnecting water bodies as described in the

Council Habitat Plan. Within the project study area EFH consists of estuarine emergent wetlands, the estuarine water column; and intertidal flats. EFH-HAPC for penaeid shrimp in the project area consists of Coastal Inlets, including the Wando River.

**Snapper -Grouper Complex**

The snapper grouper management plan manages 73 species of snapper, grouper and other relatively large fish species that inhabit deepwater reefs and other hard structures as adults. Many species in the snapper-grouper complex may occur in estuarine habitats, especially in the southern portion of their ranges in Florida. Five species are considered estuarine-dependent, and of these species only the gag grouper (*Mycteroperca microlepis*), is relatively common in South Carolina waters where it usually occurs in deeper offshore areas. None of these species are expected to occur in study area or the Wando River as a whole except as very occasional and short-term visitors. No HAPC for snapper / grouper occurs in or near the project study area.

### Coastal Migratory Pelagic Species

Coastal migratory pelagic species, including Spanish mackerel (*Scomberomorus maculatus*) and Cobia (*Rachycentron canadum*) reside in nearshore and offshore waters as adults and in estuarine waters as larvae and juveniles. Adults typically spawn in offshore waters and larval fish move to nearshore oceanic or lower salinity estuarine waters. None of these species are expected to occur in study area or the Wando River as a whole except as very occasional and short-term visitors. No HAPC for coastal migratory pelagic species occurs in or near the project study area

**Other Species of Concern**

Some important recreational and commercial fishery species that occur in the project area are managed by other regional, State, or Federal agencies including the Atlantic States Marine Fisheries Commission and NOAA’s Highly Migratory Species Division, and other Regional Fishery Management Councils. These species include red drum (*Sciaenops ocellatus*), bluefish *(Pomatomus saltatrix)*, summer flounder (*Paralichtys dentatus*), blue crab (Callinectes sapidus), Eastern oyster (Crassostrea virginica), and hard clam (Mercenaria mercenaria). Coastal inlets and the associated estuarine habitats discussed above are used by all life stages of these species.

The Atlantic sturgeon (*Acipenser oxyrinchus*) and the shortnose sturgeon (*Acipenser brevisrostrum*) are endangered species that occur in coastal rivers and estuaries, including the Cooper River and associated waterways such as the Wando River. The Cooper River supports a small population of both species but successful reproduction in the Wando River has not been confirmed and is very unlikely since this river terminates a short distance upstream of the Wando River bridge. Adult sturgeon migrate up coastal rivers and spawn in freshwater river reaches up to the fall line. Following spawning, the adult sturgeon gradually move downstream to estuarine and/or coastal marine waters. Juvenile sturgeon also move downstream into brackish waters where they mature and then move on to nearshore coastal waters. Adults of both species may occasionally occur in the vicinity of the project study area.

1. **Analysis of Effects on Essential Fish Habitat**

The potential for actions to impact managed species will vary based on life history stage, habitat use, distribution, and abundance. The managed shrimp species discussed above utilize the estuarine water column, estuarine emergent wetlands, intertidal flats, and oyster reefs and shell banks at various stages in their life histories. Table 1 summarizes possible temporary and permanent impacts.

Table 1. Potential Impacts to EFH

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Habitat Type** | **Temporary Impacts** | | **Permanent Impacts** | |
| **Indirect** | **Direct** | **Indirect** | **Direct** |
| Estuarine water column | Siltation from adjacent uplands | Noise and vibration | Shading | Fill from bents |
| Intertidal flats  and  Oyster reefs and shell banks | Siltation from adjacent uplands | None | Shading | None |
| Estuarine emergent wetlands | Siltation from adjacent uplands | None | Shading | Fill for road bed |

**Temporary Impacts**

No temporary fill in any aquatic habitat is anticipated under this project. There may be temporary impacts from siltation resulting from stormwater runoff from grading work within the construction limits. Removal of the existing pilings and construction of the new pilings may also cause localized, temporary siltation within the water column. These potential temporary impacts are not quantifiable but should be minimal provided construction work is conducted in accordance with Best Management Practices (BMPs), the Project Commitments contained in the Finding of No Significant Impact (FONSI), and the terms and conditions of the various State and Federal permits that will be required for this project.

Siltation into EFH and other aquatic habitats may reduce visibility for aquatic organisms and affect feeding, movement, and predator avoidance. Increased turbidity can also alter dissolved oxygen levels and primary productivity in the affected estuarine waters. Deposition of suspended sediments can affect benthic communities by smothering and burying organisms, and very heavy siltation may result in direct filling and loss of habitats adjacent to disturbed areas.

Temporary impacts from siltation during construction can be avoided and minimized by appropriate use of silt fences, sediment traps, and other BMPs. Use of appropriate sediment and erosion control measures should result in only minimal effects to subtidal and intertidal habitats in the Wando River. Such impacts are expected to be relatively minor, temporary, and limited to the immediate area of construction. Tidal and river flow in the Wando River will tend to dilute and disperse any materials that eroded into the water. After construction, all graded and disturbed areas will be permanently stabilized, eliminating any future siltation.

Localized, temporary disturbance to fish and other organisms in the estuarine water column may occur from noise and vibration during pile removal and placement. The nature and duration of such disturbance will depend on the demolition and construction methods used, which have yet to be determined. Impacts within the construction area might occur due to increased noise, but adult and juvenile fish and shrimp should be able to avoid injury by temporarily relocating to another area. Incidental take of eggs and early larval stages may occur, but is not expected to contribute to a significant reduction in any species populations. SCDOT has decided to implement a seasonal construction moratorium for all in-water work related to this bridge replacement project for the period of January 1 to April 15.

Table 2. Quantities of Temporary Impacts

|  |  |  |
| --- | --- | --- |
| **Habitat Type** | **Temporary Impacts** | |
| **Indirect** | **Direct** |
| Estuarine water column | Not quantifiable | Not quantifiable |
| Intertidal flats, Oyster reefs and shell banks | Not quantifiable | None |
| Estuarine emergent wetlands | Not quantifiable | Not quantifiable |
| Total | Not quantifiable | Not quantifiable |

**Permanent Impacts**

The proposed bridge and associated roadway improvements will require filling 1.888 acres of wetlands (0.547 acre of estuarine emergent marsh, 1.02 acres of palustrine emergent marsh, and 0.321 acre of palustrine forested wetlands), and placement of bents in the bed of the Wando River, affecting approximately 0.046 acre of river bed. Fill in these areas will result in permanent loss of habitat proportional to the acreage filled. Loss of such habitat will reduce overall primary productivity and suitable spawning and nursery habitat for aquatic organisms that utilize these areas. These impacts are summarized in Table 3. There may be some opportunities for wetland restoration associated with removal of portions of the existing roadway but a detailed assessment has not been conducted.

The bridge deck will shade approximately 5 acres of estuarine water column and 0.097 acre of estuarine emergent marsh. The existing bridge shades approximately one acre of estuarine water column. However, the much higher vertical clearance of the proposed bridge (55 feet versus 15 feet) will significantly reduce any potential adverse effects of shading, which will be limited to extremely minor reductions in primary productivity of the estuarine water column and estuarine emergent marsh.

Removal of the existing bridge pilings will directly disturb any oysters and other epifauna attached to them, but the new pilings will serve as comparable habitat for these species. There will be no direct impacts to any oyster beds identified by SCDNR. Although there is no evidence of impaired hydraulic flow under the existing bridge, pilings for the new bridge will be more widely spaced and will impose no restriction on hydraulic flow in the Wando River.

In addition to the above considerations, the proposed project will not encourage future development that would cause the incremental loss of the cited fishery resources in this report.

Table 3. Quantities of Permanent Impacts

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Habitat Type** | **Permanent Impacts** | | | | |
| **Existing Indirect**  (to be removed) | **Proposed**  **Indirect** | **Existing Direct**  (to be removed) | **Direct** | **Net Direct** |
| Estuarine water column | 1 acre  (shading) | 5 acres (shading) | 0.035 acre  (pilings) | 0.046 acre  (pilings) | 0.011 acre  (pilings) |
| Intertidal flats, Oyster reefs and shell banks | None | None | None | None | None |
| Estuarine emergent wetlands | None | 0.097 acre  (shading) | None | 0.547 acre  (fill) | 0.547 acre  (fill) |
| Total | 1 acre  (shading) | 5.097 acre  (shading) | 0.035 acre  (pilings) | 0.593 acre  (pilings and fill) | 0.558 acre  (pilings and fill) |

1. Avoidance and Minimization Measures

Impacts to EFH were avoided and minimized as much as practicable. Various alternative corridors were developed and considered for the roadway and bridge as it traverses the Wando River. All of the corridors were transitioned to match the existing horizontal and vertical roadway alignments as quickly as possible to minimize the length of the project while still maintaining the desired design criteria. Identifying the location (upstream, on alignment, or downstream) and limits of the alternative corridors relative to the existing SC-41 alignment was critical in assessing potential impacts to the surroundings and evaluating corridors against each other. The location of each alternative corridor was also selected so that the existing swing span could remain in service during the construction of each potential alternative corridor considered. Ultimately three different roadway alignments were evaluated, and impacts to estuarine emergent wetlands and palustrine forested wetlands were reduced by about one acre by selection of the proposed alignment.

Although the proposed bridge has a slightly higher in-channel impact from the various bents and pilings (0.035 acre vs. 0.046 acre), the average spacing between bents and pilings will be much greater (about 135 feet vs. 40 feet) for the proposed bridge. This will allow for more natural flow of water in the river channel. The proposed bridge will also be much higher (55 feet vs. 14 feet), reducing any adverse affects of shading.

The proposed bridge will have a contained stormwater management collection system, eliminating direct release of surface runoff from the bridge deck to the estuarine waters below. Stormwater will be collected and diverted through a treatment system to reduce suspended dissolved contaminants that might impact EFH and managed species present in the Wando River.

Given the potential for temporary siltation and erosion, the contractor will be required to minimize these actions through implementation of construction Best Management Practices (BMP), reflecting policies contained in 23 CFR 650B and SCDOT’s Supplemental Specifications on Seeding and Erosion Control Measures of August 15, 2001. These BMPs will likely include silt fencing adjacent to disturbed areas, mulching or seeding to stabilize exposed soils, and hay bales and similar devices to control erosion.

It is anticipated that any tidal marsh or emergent wetland areas that experience temporary impacts during construction will revegetate quickly and naturally after project completion. However, if vegetated areas impacted by the project are determined to have not naturally regenerated, plantings with emergent or marsh grass species may be considered.

BMPs will require on-site contractors to take measures to ensure that no contaminants will be released into the water. SCDOT has emergency spill recommendations to the contractor in the event of an accident. If a leak is evident or a spill occurs, the contractor should be notified and should verify that it is mitigated as soon as practical by authorized personnel. Any unused or contaminated materials should be disposed of in accordance with Federal, State, and local laws.

SCDOT will implement a seasonal construction moratorium for all in-water work related to this bridge replacement project for the period of January 1 to April 15. In-water work is defined as any activity that could result in the physical destruction or alteration (e.g. excavation, fill, pile driving, drilled shaft construction) of important spawning habitats. During the moratorium the contractor would be allowed to work from a barge in order to construct columns, caps, and bridge superstructure. The contractor would be allowed to move barges between shafts during the moratorium; however, barges must be secured by cables as placement of spuds to secure barges will not be allowed during the moratorium. Equipment and materials used during the construction of the bridge will not obstruct or impede passage through more than 50 percent of the channel.

Compensatory mitigation for unavoidable impacts to wetlands and other waters of the US will be provided in accordance with the requirements of the Corps of Engineers and SC Department of Health and Environmental Control.

1. Conclusions

It is the determination of SCDOT that the proposed project will have minimal adverse direct and cumulative impacts on essential fish habitat or aquatic species managed by the SAFMC. Impacts to essential fish habitat have been avoided and minimized as much as practicable, and any unavoidable impacts will be compensated through a compensatory mitigation plan that will be reviewed by the various Federal and State natural resource agencies.

It is the determination of the Department that the proposed project will adversely impact the EFH in the project area, but it is not anticipated that the impacts will be significant. Since there will be impacts to the EFH and possibly aquatic species managed by the SAFMC, compensatory mitigation will be purchased from Huspah Mitigation Bank with coordination through the Army Corp of Engineers (ACOE).

1. References

Atlantic States Marine Fisheries Commission (ASMFC). 2002. Amendment 2 to the Interstate Fishery Management Plan for Red Drum. Fishery Management Report No. 38 of the Atlantic States Marine Fisheries Commission.

Berry, W., N. Rubenstein and B. Melzian. 2003. “The Biological Effects of Suspended and Bedded Sediment (SABS) in Aquatic Systems: A Review.” Internal Review: U.S. Environmental Protection Agency Office of Research and Development. Narragansett, Rhode Island.

Bortone, S.A., and J.L. Williams. 1986. Species profiles: life histories and environmental requirements of coastal fishes and invertebrates (South Florida)--gray, lane, mutton, and yellowtail snappers. U.S. Fish Wildl. Serv. Biol. Rep. 82(11.52). U.S. Army Corps of Engineers, TR EL-82-4.

Boschung, H.T., J.D. Williams, D.W. Gotshall, D.K. Caldwell, M.C. Caldwell, C. Nehring, and J. Verner. 1983. The Audubon Society Field Guide to North American Fishes, Whales, and Dolphins. Alfred A. Knopf, New York, NY.

Cowardin, L.M., Carter, V., Golet, F.C., & LaRoe, E.T. 1979. Classification of wetlands and deepwater habitats of the United States. U.S. Department of the Interior, Fish and Wildlife Service, Washington, D.C.

Fahay, M.P., P.L. Berrien, D.L. Johnson, and W.W. Morse. 1999. Essential Fish Habitat Source Document: Bluefish, Pomatomus saltatrix, Life History and Habitat Characteristics. NOAA Technical Memorandum NMFS-NE-144. National Oceanic and Atmospheric Administration, Woods Hole, Massachusetts.

Godcharles, M.F., and M.D. Murphy. 1986. Species profiles: life histories and environmental requirements of coastal fishes and invertebrates (south Florida) -- king mackerel and Spanish mackerel. U.S. Fish Wildl. Serv. Biol. Rep. 82(11.58). U.S. Army Corps of Engineers, TR EL-82-4.

Grimes, B.H., M.T. Huish, J.H. Derby, and D. plot-an. 1989. Species profiles: life histories and environmental requirements of coastal fishes and invertebrates (Mid-Atlantic)--summer and winter flounder. U.S. Fish Wildl. Serv. Biol. Rep. 82(11.112). U.S. Army Corps of Engineers, TR EL-82-4.

Larson, S.C., M.J. Van Den Avyle, and E.L. Bozeman, Jr. 1989. Species profiles: life histories and environmental requirements of coastal fishes and invertebrates (South Atlantic)--brown shrimp. U.S. Fish Wildl. Serv. Biol. Rep. 82(11.90). U.S. Army Corps of Engineers TR EL-82-4. 14 pp.

McKenzie, M.D. ed. 1981. Profile of the Penaeid Shrimp Fishery in the South Atlantic. South Atlantic Fishery Management Council, Charleston SC.

Mercer, L.P., L.R. Phalen, and J.R. Maiolo. 1990. Fishery Management Plan for Spanish Mackerel. Fisheries Management Report No. 18. Atlantic States Marine Fisheries Commission, Washington, D.C.

Mid-Atlantic Fishery Management Council (MAFMC). 1998. Summary Of Essential Fish Habitat Description And Identification For Mid-Atlantic Fishery Management Council Managed Species. National Marine Fisheries Service, National Oceanic and Atmospheric Administration.

Muncy, R.J. 1984. Species profiles: life histories and environmental requirements of coastal fishes and invertebrates (South Atlantic)--white shrimp. U.S. Fish Wildl. Serv. FWS/OBS-82/11.27. U.S. Army Corps of Engineers, TR EL-82-4. 19 pp.

National Marine Fisheries Service (NMFS). 1999. Essential Fish Habitat: A Marine Fish Habitat Conservation Mandate for Federal Agencies (South Atlantic Region). National Oceanic and Atmospheric Administration, St. Petersburg, FL.

NOAA Fisheries (NOAA). 2006. Marine and Anadromous Fish. Accessed August 8, 2006. Available: http://www.nmfs.noaa.gov/pr/species/fish/. Office of Protected Resources.

NOAA Fisheries (NOAA). 2008. South Atlantic ELMR Relative Abundance Tables. Estuarine Living Marine Resources Project. Available: http://www.ccma.nos.noaa.gov/products/ biogeography/efh/sa-efh/sa\_tabs.pdf

North Carolina Division of Marine Fisheries (NCDMF). 2001. Red drum fishery management plan. North Carolina Department of Environment and Natural Resources, Morehead City, North Carolina.

Office of Sustainable Fisheries (OSF), Highly Migratory Species Management Division. 1999. Final Fishery Management Plan For Atlantic Tuna, Swordfish, and Sharks. National Marine Fisheries, Silver Spring, Maryland.

Office of Sustainable Fisheries (OSF). 2005. Draft Consolidated Atlantic Highly Migratory Species Fishery Management Plan. National Marine Fisheries, National Oceanic and Atmospheric Administration.

Oliver, J.D., M.J. Van Den Avyle, and E.L. Bozeman, Jr. 1989. Species profiles: life histories and environmental requirements of coastal fishes and invertebrates (South Atlantic)--bluefish. U.S. Fish Wildl. Serv. Biol. Rep. 82(11.96). U.S. Army Corps of Engineers TR EL-82-4.

Packer, D.B., S.J. Griesbach, P.L. Berrien, C.A. Zetlin, D.L. Johnson, and W.W. Morse. 1999. Essential Fish Habitat Source Document: Summer Flounder, *Paralichthys dentatus*, Life History and Habitat Characteristics. National Marine Fisheries Serv., James J. Howard Marine Sciences Lab., 74 Magruder Rd., ighlands, NJ 07732.

Pottern, G. B., M. T. Huish, and J. H. Kerby. 1989. Species profiles: life histories and environmental requirements of coastal fishes and invertebrates (mid-Atlantic) -- bluefish. U.S. Fish Wildl. Serv. Biol. Rep. 82111.94). U.S. Army Corps of Engineers, TR EL-82-4.

Reagan, R.E. 1985. Species profiles: life histories and environmental requirements of coastal fishes and invertebrates (Gulf of Mexico) -- red drum. U.S. Fish Wildl. Serv. Biol. Rep. 82(11.36). U.S. Army Corps of Engineers, TR EL-82-4. 16 PP.

Rogers, S. G., and M. J. Van Den Avyle. 1983. Species profiles: life histories and environmental requirements of coastal fishes and invertebrates (South Atlantic) -- summer flounder. U.S. Fish Wildl. Serv. FWS/OBS-82/11.15. U.S. Army Corps of Engineers, TR EL-82-4.

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

Scarlett, P.G. 1982. Fishery Management Plan for the Summer Flounder (*Paralichthys dentatus*) Fishery. Fishery Management Report No. 3 for the Atlantic States Marine Fisheries Commission.

Schwartz, F.J. 1984. Sharks, sawfish, skates and rays of the Carolinas. Special Publication, Institute of Marine Sciences, Morehead City, North Carolina.

South Atlantic Fishery Management Council (SAFMC). 1981. M.D. McKenzie, ed. Profile of the Penaeid shrimp fishery in the south Atlantic. National Marine Fisheries Service, National Oceanic and Atmospheric Administration, Charleston, SC.

South Atlantic Fishery Management Council (SAFMC). 1983. Fishery Management Plan, Regulatory Impact Review, and Final Environmental Impact Statement for the Snapper-Grouper Fishery of the South Atlantic Region. In cooperation with the National Marine Fisheries Service. South Atlantic Fishery Management Council, Charleston, SC.

South Atlantic Fishery Management Council (SAFMC). 1998. Final Habitat Plan For The South Atlantic Region: Essential Fish Habitat Requirements For Fishery Management Plans Of The South Atlantic Fishery Management Council. National Marine Fisheries Service, National Oceanic and Atmospheric Administration.

South Atlantic Fishery Management Council (SAFMC). 2009a. Fishery Ecosystem Plan of the South Atlantic Region Volume II: South Atlantic Habitats and Species. South Atlantic Fishery Management Council (SAFMC). North Charleston,SC.