Chapter 4

websites

Cogentrix Power Generating P

Southport Cogeneration Plant

Plant at a glance:

- 120 megawatt cogeneration facility
- Fueled by bituminous coal
- Electricity sold to Progress Energy (Carolina Power & Light Co.)
- Steam sold to Archer Daniels Midland
- Employs 21 people
- Began commercial operation in September 1987

The Facility:

The Southport Cogeneration Plant, located in Southport, North Carolina, utilizes a stoker coal fueled design to provide 120 megawatts of reliable electricity to Progress Energy, formerly Carolina Power & Light Co. A cogeneration facility, Southport also provides process steam to the adjacent Archer Daniels Midland (ADM) pharmaceutical manufacturing facility. The plant went into commercial operation service in September 1987.

Cogentrix currently has a 100% ownership interest in the Southport Cogeneration Plant.

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(NMFS 2002)

Endangered Species Act - Section 7 Consultation
Biological Opinion

Agency:	National Marine Fisheries Service
Activity:	Shrimp Trawling in the Southeastern United States, under the Sea Turtle Conservation Regulations and as Managed by the Fishery Management Plans for Shrimp in the South Atlantic and Gulf of Mexico
Consultation Conducted By:	National Marine Fisheries Service, Southeast Region
Date Issued:	DEC 2 2002
Approved By:	Rolland A. Schmitten Acting Regional Administrator

This document represents the National Marine Fisheries Service's (NOAA Fisheries) biological opinion (Opinion) based on our review of shrimp trawling, as conducted under Federal regulations implemented to manage the shrimp fisheries in the Gulf and South Atlantic and to conserve listed turtles, and shrimp trawling's effects on loggerhead turtles (*Caretta caretta*), Kemp's ridley turtles (*Lepidochelys kempii*), leatherback turtles (*Dermochelys coriacea*), hawksbill turtles (*Eretmochelys imbricata*), and green turtles (*Chelonia mydas*). This Opinion has been prepared in accordance with section 7(a)(2) of the Endangered Species Act (ESA) of 1973, as amended (16 U.S.C. 1536 *et seq.*).

Introduction

Section 7(a)(2) of the ESA requires that each federal agency shall ensure that any action authorized, funded, or carried out by such agency is not likely to jeopardize the continued existence of any endangered or threatened species or result in the destruction or adverse modification of critical habitat of such species. When the action of a federal agency may affect a protected species, that agency is required to consult with either NOAA Fisheries or the U.S. Fish and Wildlife Service (FWS), depending upon the protected species that may be affected. For the actions described in this document, the action agency is NOAA Fisheries under both its authorities to manage shrimping and sea turtle conservation through the Magnuson-Stevens Fishery Conservation and Management Act (MSA) and the ESA. The consulting agency is the Protected Resources Division of the Southeast Regional Office of NOAA Fisheries.

This Opinion is based on information found in ESA recovery plans, the most current stock assessment reports, observer and logbook data on fishery effort and protected species interactions within the U.S. South Atlantic and Gulf of Mexico shrimp fisheries, studies on turtle catch per unit effort (CPUE), consultations with fishery and sea turtle researchers and NOAA Fisheries personnel, published and unpublished scientific and fisheries reports, and biological opinions for this and other relevant fisheries. This Opinion was developed at the NOAA Fisheries, Southeast Regional Office, St. Petersburg, Florida.

Consultation History

The consultation history for this action is closely tied to the lengthy regulatory history for sea turtle conservation and particularly the regulations governing the use of Turtle Excluder Devices (TEDs). A summary of that regulatory history can be found in Appendix III.

On September 30, 1987, NOAA Fisheries completed a biological opinion on the implementation of the 1987 TED regulations. The 1987 opinion addressed the potential adverse effects to listed species due to the implementation of the rule, and concluded that the regulations would have a positive impact on sea turtles by substantially reducing mortalities. At that time, NOAA Fisheries' policy on ESA section 7 consultation was to address the potential impacts to listed species of management actions and not to address potential adverse effects of the fishery itself. The policy is ultimately changed on October 18, 1990, when the Assistant Administrator for Fisheries advise all NOAA Fisheries Regional Directors that future ESA consultations on fishery management actions would address both the fishery and the proposed management action.

In April 1992, the South Atlantic Fishery Management Council (SAFMC) requested consultation on the Shrimp Fishery Management Plan for the South Atlantic, and the Gulf of Mexico Fishery Management Council (GMFMC) requested consultation on Amendment 6 to the Gulf of Mexico Shrimp Fishery Management Plan. On August 19, 1992, NOAA Fisheries completed section 7 consultation and issued a biological opinion that considered the two Council's FMPs, the shrimp fishery itself in the Gulf and South Atlantic, and the implementation of the 1992 revised sea turtle conservation regulations. The opinion concludes that shrimp trawling, as managed by the Councils and in compliance with the proposed sea turtle conservation regulations, was not likely to jeopardize the continued existence of listed species under NOAA Fisheries jurisdiction. With respect to leatherback turtles, however, the opinion stated, "Leatherback mortalities remain a problem that must be addressed to avoid jeopardizing the recovery of this species."

On November 14, 1994, NOAA Fisheries completed a section 7 consultation and issued a biological opinion on the impacts of shrimp trawling in the southeastern United States (NMFS 1994). Consultation on the shrimp fishery had been reinitiated by NOAA Fisheries as the result of extraordinarily high strandings of sea turtles, particularly the critically endangered Kemp's ridley turtle, in Texas and Louisiana corresponding to periods of heavy nearshore shrimping effort. The opinion concluded that "[c]ontinued long-term operation of the shrimp fishery in the southeastern U.S., resulting in mortalities of Kemp's ridley turtles at levels observed in the Gulf of Mexico in 1994, is likely to jeopardize the continued existence of the Kemp's ridley population."

The jeopardy opinion included a reasonable and prudent alternative (RPA) that would allow the shrimp fishery to continue and avoid the likelihood of jeopardizing Kemp's ridley sea turtles. NOAA Fisheries ultimately implemented all the elements of the RPA.

On June 11, 1996, NOAA Fisheries completed a section 7 consultation and issued a biological opinion on the impacts of shrimp trawling in the southeastern United States (NMFS 1996). NOAA Fisheries reinitiated consultation on the shrimp fishery to evaluate the effects of the an April 24, 1996 proposed rule and of a plan to implement a shrimp vessel registration system and to consider the effects of strandings-based incidental take levels that had been exceeded. The opinion concluded that continued operation of the shrimp fishery was not likely to jeopardize listed sea turtles, with implementation of the proposed TED rule changes and of a shrimp vessel registration system, which the opinion required to be proposed formally by the end of 1996. The opinion also eliminated the strandings-based incidental take levels that had been in place since March 1995. The Opinion required a more flexible requirement for NOAA Fisheries to consult with state stranding coordinators to identify significant local stranding events and to implement 30-day restrictions on shrimping in response, as appropriate.

On November 13, 1996, NOAA Fisheries completed a section 7 consultation and issued a biological opinion on the impacts of shrimp trawling in the southeastern United States (NMFS 1996a). NOAA Fisheries reinitiated consultation on the shrimp fishery to evaluate the effects of the final rule implementing the April 24, 1996, proposed rule and of elevated loggerhead strandings that occurred during 1996. The opinion concluded that continued operation of the shrimp fishery is not likely to jeopardize listed sea turtles, with the publication of the final rule, which implemented the RPA component of the 1994 opinion requiring NOAA Fisheries to address mortalities resulting from incorrect installation of TEDs and the certification of TEDs which do not effectively exclude sea turtles. The opinion extended the deadline for finalizing the shrimp vessel registration requirement through February 1997.

On March 24, 1998, NOAA Fisheries completed a section 7 consultation and issued a biological opinion on the impacts of shrimp trawling in the southeastern United States (NMFS 1998). NOAA Fisheries reinitiated consultation to evaluate the effects of approving the use of a new soft TED, to discuss the decision not to implement a mandatory shrimp vessel registration system (part of the 1994 biological opinion's RPA), and to evaluate recent data on sea turtle populations and strandings. The opinion concluded that continued operation of the shrimp fishery is not likely to jeopardize listed sea turtles, with continued improved enforcement of the sea turtle conservation regulations and expanded education and outreach programs.

Reinitiation of consultation on the effects of the shrimp fishery and the sea turtle conservation regulations on listed sea turtles is appropriate at this time for a number of reasons. The most important is NOAA Fisheries' proposed implementation of a final rule (see *Proposed Action* section below) that will further enhance the effectiveness of the sea turtle conservation regulations by requiring increases in the sizes of TED escape openings to allow large loggerhead and leatherback sea turtles to escape from trawls, by correcting the structural weakness of certain TED designs, and by modifying the current TED exemptions for bait shrimping and try nets to better protect sea turtles. A report (Epperly and Teas 1999, later published as Epperly and Teas 2002) on the sizes of stranded sea turtles compared to the regulatory-minimum TED opening sizes caused NOAA Fisheries to become concerned about the adequacy of the current TED requirements. In addition, the sizes of the TED escape openings had never been intended to be large enough to exclude leatherback sea turtles and NOAA Fisheries had instead depended on the leatherback contingency plan for leatherback conservation. After implementing the leatherback contingency plan many times in the late 1990s and early 2000s, and also having to implement three emergency rules where the contingency plan did not apply, NOAA Fisheries determined that the leatherback contingency plan was too complicated and ineffective. In response primarily to these issues, NOAA Fisheries published an advanced notice of proposed rulemaking in April 2000 and a proposed rule in October 2001 to amend the TED regulations to address, primarily, the inefficiency of TEDs at releasing large loggerhead and leatherback sea turtles. Lastly, new evidence has become available and additional analyses have been conducted that allow us to update our estimates of sea turtle-shrimp trawling interaction and the effects of that interaction on the listed species (see *Effects of the Action* section for details).

The previous major biological opinions on shrimp trawling (i.e., NMFS 1992, 1994, 1996, and 1998) have each built upon the previous ones and included significant incorporation by reference. Since the history of shrimp trawling and the sea turtle conservation regulations have grown so long and complicated, as the above chronology demonstrates, we believe that it is now time for this Opinion to be a stand-alone document. NOAA Fisheries has also consulted many times on the possible effects of individual management actions implemented under the MSA for the fishery management plans (FMPs) for shrimp in the South Atlantic and Gulf of Mexico. These have not led to formal consultations and preparation of biological opinions, however, as the effects of those actions did not change the basis for the conclusions of the current biological opinions. As a result, the previous biological opinions are not as up-to-date on current fishery management measures. This Opinion will attempt to improve upon the previous opinions, with a more explicit description of the action, including a discussion of the fishery, as managed by NOAA Fisheries and the Councils.

I. Description of the Proposed Action

NOAA Fisheries proposes to revise its sea turtle conservation regulations for shrimp trawling in the South Atlantic and Gulf of Mexico. NOAA Fisheries proposes to take this action under the authority of the Endangered Species Act of 1973, as amended. The purpose of the proposed action is to further enhance the effectiveness of the sea turtle conservation regulations by, among other things, increasing the size of TED escape openings to allow larger loggerhead and leatherback sea turtles to escape from trawl gear used in the shrimp fishery. This opinion also considers the direct and indirect effects of the shrimp fisheries, as managed under the FMPs, in the South Atlantic and Gulf of Mexico. We also identify the action area and define the scope of our analysis.

A. Sea Turtle Conservation Regulations

The *Consultation History* section above and Appendix III provide a complete chronology, with references, of the evolution of the sea turtle conservation regulations. The current sea turtle conservation regulations are codified at 50 CFR sections 222.102, 223.205, 223.206, 223.207, and 224.104. The final rule being considered by NOAA Fisheries would amend the TED regulations, as follows:

> Effective 30 days after publication in the *Federal Register* in the Atlantic Area, and 6 months after publication in the Gulf Area,
> (a) Require all hard TEDs to have a grid with a minimum outside measurement of 32 inches (81-cm) by 32 inches (81-cm);
> (b) require the use of either the double cover flap TED or a TED-opening with a minimum of 71 inch (180 cm) straight-line stretched mesh in all offshore waters (from the COLREGS demarcation line seaward) and in inshore waters of Georgia and South Carolina;
> (c) require a TED-opening in all inshore waters of the Atlantic and Gulf Areas (from the COLREGS Demarcation line landward) except for the inshore waters of Georgia and South Carolina of at least 44 inch (112 cm) straight-line stretched mesh measurement with a 20 inch (51 cm) vertical taut height, with each measurement taken separately;
> (d) disallow the use of the hooped hard TED in offshore waters in the Atlantic and Gulf Areas and the inshore and offshore waters off of Georgia and South Carolina; and allow a hooped hard TED in inshore waters, other than Georgia and South Carolina, to have a minimum size of 35

inches (89 cm) by 27 inches (67 cm) on the top opening, with a minimum inside horizontal measurement of at least 35 inches (89 cm) and an inside vertical measurement of at least 30 inches (76 cm) on the front hoop, with a clearance between the bars and the top of the front hoop no less than 20 inches (51 cm);
(e) allow the use of the weedless TED with a brace bar;
(f) require all accelerator funnels to have a stretched mesh opening of no less than 44 inches (112 cm) in the 44 inch (112 cm) TED and no less than 71 inches (180 cm) in the 71 inch (180 cm) TED and the double cover flap TED;
(g) require bait shrimpers to use TEDs in states where a state-issued bait shrimp license holder can also fish for food shrimp from the same vessel; and
(h) require the use of tow times for small try nets without TEDs.

Following this amendment of the sea turtle conservation regulations, TEDs would be required in essentially all shrimp trawls in the Southeast. In offshore waters, TEDs would have escape openings sufficient to exclude all sea turtles encountered, including leatherback turtles. In inshore waters, TEDs would have escape openings sufficient to exclude all sea turtles encountered, up through the size of very large adult loggerhead turtles. The leatherback contingency plan would no longer apply.

Limited exemptions to TED use would, with some modifications, continue to apply. A shrimp trawler that complies with tow-time limits is exempt from TED requirements if it:
(a) retrieves its nets entirely by hand;
(b) is a bait shrimper retaining all live shrimp on board in a live well and has no more than 32 pounds of dead shrimp aboard, if it has a valid original state bait-shrimp license, and if the state license allows the licensed vessel to participate in the bait shrimp fishery only;
(c) has only a pusher-head trawl, skimmer trawl, or wing net rigged for fishing; or
(d) has a single try net with a headrope length of 12 ft or less and a footrope length of 15 ft or less, the try net need not have a TED installed.

Maximum tow time limits are 55 minutes in the summer (April-October) and 75 minutes in the winter (November- March). The use of tow times can protect incidentally captured sea turtles from drowning, but NOAA Fisheries has generally only allowed tow time use under the above limited circumstances, since fishermen's compliance with tow times has tended to be low. These four exemptions are for gears or fishing practices that, out of physical, practical, or economic necessity, require fishermen to limit their tow times naturally. NOAA Fisheries would also continue to have the authority to implement 30-day temporary notice actions that could authorize the use of tow times in lieu of TEDs if:
(a) the Assistant Administrator of NOAA Fisheries determines that environmental conditions (e.g., the presence of algae, seaweed, or debris) make TED use impracticable; or
(b) the Assistant Administrator of NOAA Fisheries determines that TEDs do not work to protect sea turtles.

NOAA Fisheries has from time to time issued temporary TED exemptions in response to post-hurricane debris problems or heavy, localized algae blooms as authorized at 50 CFR § 223.206(d)(3)(ii). In issuing these exemptions, NOAA Fisheries has consulted with the fishery management officials in the affected states (all previous TED exemptions have applied only to state waters) and received the commitment from the state to enforce vigorously the tow time limits. We expect that NOAA Fisheries will continue to issue such occasional exemptions in the future, as circumstances warrant, and with the cooperation of the affected states, although we cannot predict the frequency with which they may occur. Since 1997

NOAA Fisheries has issued these exemptions in North Carolina, Texas, Mississippi, Alabama, and Louisiana without a detected increase in strandings.

For certain types of gears or fishing practices, the chance of capturing a turtle has been deemed low or non-existent, and these gears and fishing practices have been exempted from the TED requirements, even without tow time limits:

(a) Beam or roller trawls if the frame is outfitted with rigid vertical bars, spaced no more than 4" apart; and
(b) Shrimp trawlers fishing for or possessing royal red shrimp, if royal red shrimp make up at least 90% of the catch.

The sea turtle conservation regulations provide one additional means for issuing exemptions to the TED requirements. The Southeast Regional Administrator of NOAA Fisheries may issue authorization letters to allow fishery research that would otherwise be subject to the TED requirements and to fishermen or researchers to develop modified or new TEDs, subject to any conditions and restrictions he deems appropriate (50 CFR§ 223.207(e)(2)). For authorizations to conduct fishery research without TEDs, these restrictions invariably include a requirement to limit tow times, often to less than the 55/75 minutes allowed for shrimpers. Reporting of any sea turtle mortality is required as a condition of these authorizations, and none has ever been reported. These research or gear testing TED exemptions represent a very small portion of shrimp trawl fishing effort, compared to the larger, shrimp harvest fishery that is the main subject of the sea turtle conservation regulations.

TED exemptions issued to test experimental TEDs must meet a number of criteria prior to approval. Those criteria include the following:

(a) The experimental TED design must be significantly different in design from currently approved or previously tested TEDs;
(b) the NOAA Fisheries Harvesting Systems Branch and the SERO PR Division must believe that the experimental TED has the potential to improve TED performance and its ability to exclude turtles is not likely to be lower than currently approved TEDs;
(c) the applicant must not have a history of violations of the sea turtle conservation regulations and;
(d) if the applicant has previously been issued an exemption (or exemptions) under these regulations he/she must have filed a report to NOAA Fisheries on the outcome of the exempted TED testing.

The Southeast Regional Administrator may also issue exemptions to many fishermen at the same time to facilitate the wide range testing of certain experimental TED designs. These exemptions are issued for TED designs that the Harvesting Systems Branch feel show promise for increased performance and have already been tested on a smaller scale. The applicants for these exemptions must also meet the above criteria.

In addition to the authority to issue exemptions to the TED regulations, NOAA Fisheries retains the authority under the ESA and the implementing regulations at 50 CFR 223.206(d)(4) to implement 30-day emergency restrictions to respond to sea turtle takings that would violate the restrictions, terms, or conditions of an incidental take statement, biological opinion, or incidental take permit or that may be likely to jeopardize the continued existence of any listed species. NOAA Fisheries has used this authority many times (as shown in the chronology above). While the intent of the new TED amendment is to reduce sea turtle mortality significantly and to reduce the need for further restrictions, it is possible that NOAA Fisheries would have to depend occasionally on this emergency authority to respond to unforeseen circumstances, or changes in the operation of the fishery, to prevent unauthorized takes of listed species.

An important factor in the sea turtle conservation regulations' success has been the level of compliance in the shrimp fishery. Effective enforcement has been necessary to achieve compliance. For example, in the 1980s, with the varying regimes of voluntary compliance and suspended enforcement, TED compliance was almost non-existent, but ultimately responded to increased enforcement in through the early 1990s. By 1994, compliance was greatly improved, in the sense that virtually all shrimpers had TEDS installed, but the 1994 biological opinion determined that shrimpers' incorrect installation and improper use of TEDs was the major apparent cause of Kemp's ridley mortality at a level that led to a jeopardy finding. The RPA in that biological opinion included 3 major components, one of them being to improve TED regulation compliance. NOAA Fisheries has subsequently implemented numerous improvements to the overall enforcement regime, including expanded TED technical training programs to fishermen; TED technical training programs for NOAA Enforcement, U.S. Coast Guard (USCG), and state law enforcement officers; the creation of specially-trained and quickly-deployable teams of NOAA Fisheries special agents and enforcement officers to deal specifically with TED compliance, through both proactive policing and crisis response; the use of the NOAA Fisheries TED teams to patrol waters inshore and nearshore waters, where USCG resources have traditionally not been used; the inclusion of gear technicians in NOAA Fisheries TED boarding teams, to maximize positive information exchange with fishermen and to identify and correct technical difficulties in the field; and, perhaps most importantly, the development of Joint Enforcement Agreements with most of the southeast states, under which state enforcement officers can take on the responsibilities for enforcement of Federal regulations, including the TED requirements. These programs have greatly improved the effectiveness of TEDs enforcement since 1994 and have successfully increased compliance in the fishery.

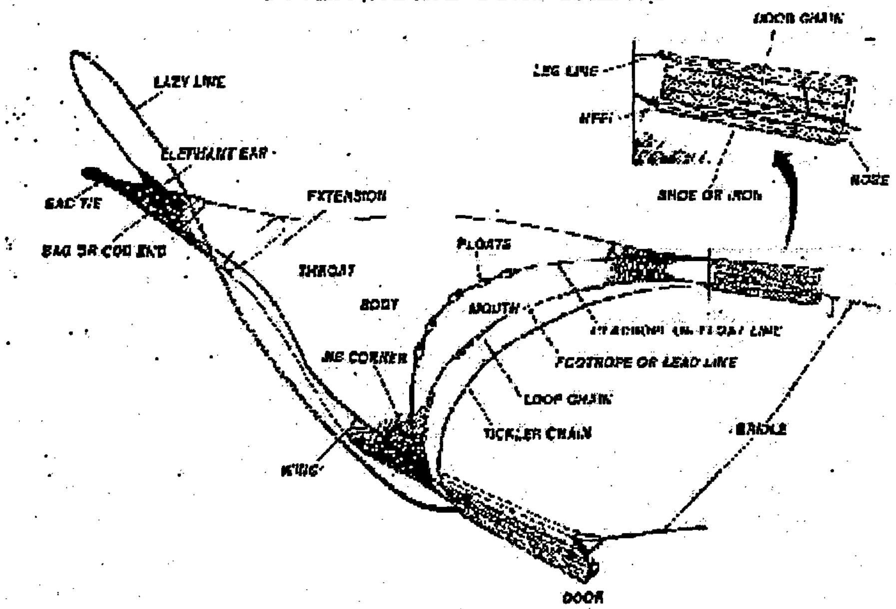
This Opinion considers the sea turtle conservation measures, as amended by the final rule, and the continuation of the existing enforcement programs by NOAA Fisheries, the USCG, and the States (under JEAs) within the proposed action.

B. The Shrimp Fishery

Shrimp Fishery Gear

Various types of gear are used to capture shrimp including but not limited to cast nets, haul seines, stationary butterfly nets, wing nets, skimmer nets, traps, and beam trawls. The otter trawl with various modifications, is the dominant gear used in offshore waters and is the gear being addressed in the regulation which is the primary subject of this consultation. A basic otter trawl consists of a heavy mesh bag with wings on each side designed to funnel the shrimp into the "cod end" or "tail bag." A pair of otter boards or trawl doors positioned at the end of each wing hold the mouth of the net open by exerting a downward and outward force at towing speed. The following schematic shows a typical otter trawl configuration.

OTTER TRAWL COMPONENTS



Shrimp trawl nets are usually constructed of nylon or polyethylene mesh webbing, with individual mesh sizes ranging from as small as 1-1/4" to 2". The sections of webbing are assembled according to the size and design (usually flat, balloon, or semi-balloon) of trawl desired, which affects the width and height of the trawl's opening and its bottom-tending characteristics. The tongue or "mongoose" design incorporates a triangular tongue of additional webbing attached to the middle of the headrope pulled by a center towing cable, in addition to the two cables pulling the doors. This configuration allows the net to spread wider and higher than conventional nets and as a result has gained much popularity for white shrimp fishing.

Try nets are small otter trawls about 12 to 16 feet in width that are used to test areas for shrimp concentrations. These nets are towed during regular trawling operations and lifted periodically to allow the fishermen to assess the amount of shrimp and other fish and shellfish being caught. These amounts in turn determine the length of time the large trawls will remain set or whether more favorable locations will be selected.

Until the late 1950s, most shrimp vessels pulled single otter trawls, ranging from 80 to 100 feet in width, directly astern of the boat. Double-rig trawling was introduced into the shrimp fleet during the late 1950s. The single large trawl was replaced by two smaller trawls, each 40 to 50 feet in width, towed simultaneously from stoutly constructed outriggers located on the port and starboard sides of the vessels. The advantages of double-rig trawling include: (1) increased catch per unit of effort, (2) fewer handling problems with the smaller nets, (3) lower initial gear costs, (4) a reduction in costs associated with damage or loss of the nets, and (5) greater crew safety.

In 1972, the quad rig was introduced in the shrimp fishery, and by 1976 it became widely used in the EEZ of the western Gulf. The quad rig consists of a twin trawl pulled from each outrigger. One twin trawl typically consists of two 40- or 50-foot trawls connected to a center sled and spread by two outside trawl doors. Thus, the quad rig with two twin trawls has a total spread of 160-200 feet versus the total spread of 110 feet in the old double rig of two 55-foot trawls. The quad rig has less drag and is more fuel efficient.

The quad rig is the primary gear used in federal waters by larger vessels. Smaller boats and inshore trawlers often still use single- or double-rigged nets. In recent years, the skimmer trawl has become a major gear in the inshore shrimp fishery in the northern Gulf and also has some use in inshore North Carolina.

U.S. Gulf of Mexico Shrimp Fishery

The Final Environmental Impact Statement (EIS) for the original Gulf shrimp FMP and the FMP as revised in 1981 contain a description of the Gulf shrimp fishery. This material is incorporated by reference and is not repeated here in detail. Amendment 9 to the FMP was passed by the Gulf of Mexico Fishery Management Council (GMFMC) in 1997, including a Supplemental EIS that updated this information. The following information is provided as an overview and is taken from the FMP or summarized from Amendment 11 to the Fishery Management Plan for the Shrimp Fishery of the Gulf of Mexico prepared by the GMFMC in April, 2001.

The U.S. Gulf of Mexico shrimp fishery as described in the FMP consists of brown, white, pink, and royal red shrimp. Seabobs and rock shrimp occur as incidental catch in the fishery.

Shrimp of the genus *Penaeus* have an ever changing size distribution. Early shrimp development takes place in inshore nursery areas. Later after reaching a larger size, they migrate seaward. Prior to the onset of maturation, shrimp begin moving from the inshore habitat to higher salinity offshore waters.

Brown shrimp is the most important species in the U.S. Gulf fishery. In the U.S. Gulf of Mexico, catches are high along the Texas, Louisiana, and Mississippi coasts. Brown shrimp are caught out to at least 50 fathoms, though most come from less than 30 fathoms. The season begins in May with principal catches made from June through October (with peaks in June and July) and gradually declines to an April low. White shrimp range along the Gulf coast from the mouth of the Ochlockonee River, Florida, to Campeche, Mexico. They are second in value and are found in nearshore waters to about 20 fathoms. White shrimp are comparatively shallow-water shrimp, with most of the catch coming from less than 15 fathoms. There is a small spring and summer fishery for overwintering individuals, but the majority are taken from August through December. Pink shrimp are found off all Gulf states but are most abundant off Florida's west coast and particularly in the Tortugas grounds off the Florida Keys. Most landings are made from October through May. In the western Gulf states, pink shrimp are landed mixed with browns. Most pink catches are made within 30 fathoms, with a peak catch at 11 to 15 fathoms. The commercial fishery for royal red shrimp has expanded in recent years with the development of local markets. This deep-water species is most abundant on the continental shelf from about 140 to 275 fathoms east of the Mississippi River. Pink and Brown shrimp are primarily caught at night when they are most active. White shrimp are primarily caught during the day.

The three principal species (penaeids) are short-lived and provide annual crops; however, royal red shrimp live longer, and several year classes may occur on the grounds at one time. The condition of each shrimp stock is monitored annually, and none has been classified as being overfished.

Brown, white, and pink shrimp are subjected to fishing from inland waters and estuaries, through the state-regulated territorial seas, and into federal waters of the EEZ. Royal red shrimp occur only in very deep waters in the EEZ. Management measures implemented under the MSA apply only to federal waters of the EEZ. Cooperative management occurs when state and federal regulations are consistent. Examples are the seasonal closure off Texas, the Tortugas Shrimp Sanctuary, and the shrimp/stone crab seasonally closed zones off Florida.

NOAA Fisheries has classified commercial shrimp vessels comprising the nearshore and offshore fleet into size categories from under 25 feet to over 85 feet. Based on the data available, more than half fall into a size range from 56 to 75 feet.

A final rule implementing Amendment 11 to the FMP will become effective September 6, 2002, and all shrimp vessels fishing in the Gulf of Mexico EEZ will be required to obtain a Federal shrimp vessel permit prior to December 5, 2002. Many vessels maintain licenses in several states because of their migratory fishing strategy. The number of vessels in the fishery at any one time varies due to economic factors such as the price and availability of shrimp and cost of fuel. NOAA Fisheries maintains two types of vessel files, both of which are largely dependent on port agent records. One is for vessels that are recorded as landing shrimp, the shrimp landings file (SLF); the other is the vessel operating units file (VOUF) that lists vessels observed at ports. The exact number of commercial vessels participating in the Gulf shrimp fishery is not known but documented vessels are believed to be around 3,600 in number (not including state vessels and boats) (J. Nance, NOAA Fisheries Galveston Laboratory pers. comm., 2002).

NOAA Fisheries estimates fishing effort independently from the number of vessels fishing. NOAA Fisheries uses the number of hours actually spent fishing from interview data with vessel captains to develop reports as 24-hour days fished. These estimates have been controversial and not well understood because the effort reported does not necessarily reflect the number of active vessels in the fleet.

A recreational shrimp trawl fishery occurs seasonally and almost entirely in the inside waters of the states. There are about 8,000 small boats participating using trawls up to 16 feet in width. About half the boats are licensed in Louisiana.

U.S. South Atlantic Area Shrimp Fishery

The Final Environmental Impact Statement for the original South Atlantic Shrimp FMP and the FMP contain a description of the shrimp fishery. This material is incorporated by reference and is not repeated here in detail. The following information is summarized from the Stock Assessment and Fishery Evaluation Report for the Shrimp Fishery of the South Atlantic Region (September 1999) prepared by the South Atlantic Fishery Management Council and is provided here as an overview.

The shrimp fishery is the largest and most valuable commercial fishery in the South Atlantic area with approximately 1,400 large vessels and 1,000 small boats in 1994. Penaeid shrimp including white

(*Penaeus setiferus*), brown (*Penaeus aztecus*), and pink (*Penaeus duorarum*) constitute the majority of the harvest occurring from coastal, near-shore, and estuarine waters off the states of North Carolina through southeast Florida. Rock shrimp (*Sicyonia brevirostris*) is concentrated primarily in Florida from Fernandina Beach to south of Cape Canaveral to Melbourne. Landings have fluctuated over time.

Shrimp of the genus *Penaeus* are essentially an annual crop and have an ever changing size distribution. Early shrimp development takes place in inshore nursery areas. Later, they migrate seaward and are almost always greater than about 100 mm (3.9 in) when they emigrate. Prior to the onset of maturation, shrimp begin moving from the inshore habitat to higher salinity offshore waters. White shrimp begin moving seaward through the summer and fall with a gradient of increasing size from fresh water to water of higher salinity, and they begin entering the commercial catch in high salinity water at about 90 mm (3.5 in). In North Carolina, white shrimp begin entering the commercial fishery in July and continue to be caught through December. In Florida, white shrimp leave inshore waters at about 120 mm (4.7 in). Brown shrimp first enter the commercial fishery in North Carolina in June at about 100 mm. Movement of brown shrimp appears to take place primarily at night. Pink shrimp leave Florida estuaries two to six months after having arrived as postlarvae. Shrimp that overwinter in estuaries migrate to sea in May and June, at which time spawning takes place. Recruitment to the area offshore of Cape Canaveral begins in April and May and again during October and November.

The contribution of each species to total shrimp landing in the south Atlantic varies in a relatively consistent pattern among the four southeastern states. Shrimp landings vary seasonally, governed primarily by the life cycles of the particular species. The peak shrimping season generally runs from July through October.

In North Carolina, brown shrimp is the principal species while white shrimp is a minor component of the overall catch, with pink shrimp sometimes being an important component of the catch, and rock shrimp constituting a minor component of any year's catch. In North Carolina, commercial quantities of pink shrimp appear in early spring with peak catches usually in mid-May. By mid-July, the season for brown shrimp reaches its peak and continues until late fall, when shrimp leave coastal waters. Relatively small catches of white shrimp occur in the Southport-Cape Fear area in North Carolina in fall.

In South Carolina and Georgia, there are virtually no pink shrimp in the landings, which are dominated by white shrimp. The relative contribution of brown shrimp to the catch varies yearly, but rarely exceeds the catch of white shrimp. Rock shrimp landings in recent years have been either nonexistent or minimal for South Carolina and constitute a low percentage of total shrimp catch for Georgia vessels. In South Carolina, overwintering white shrimp usually appear in early spring, with the season generally opening in May. These roe shrimp will be fished until June or early July when brown shrimp begin to occur in offshore waters. Brown shrimp will be fished until early autumn at which time white shrimp predominate in the catch until the fishery closes in December. In Georgia, the seasonality of the fishery is similar to South Carolina.

On the east coast of Florida, the fishery is dominated by white shrimp, which may be available as late as March in central Florida. In northeast Florida, some pink shrimp enter the catch, primarily as a bycatch of the rock shrimp fishery, but as in Georgia and South Carolina, white shrimp predominate in terms of value. In recent years, landings of rock shrimp have become an increasing component of shrimp landings in Florida.

Commercial shrimp fishermen who shrimp in state waters are required to purchase a commercial license in all states in the south Atlantic region. In North Carolina, in 1990 there were 1,956 full-time commercial and 1,832 part-time commercial shrimping licenses issued; however, active trawlers were believed to be fewer than this. In South Carolina in 1990 there were 579 resident and 378 non-resident commercial shrimp trawling licenses issued for a total 957. In Georgia 501 commercial shrimp trawling licenses were issued in 1990. In Florida there were 299 commercial shrimp trawlers in 1990. Unfortunately, studies providing updated effort data for the South Atlantic shrimp fishery are lacking.

In order to stay productive year round, many commercial fishermen participate in other types of fisheries when not shrimping. Most of these fisheries are seasonal, with fishermen emphasizing one specific fishery during a particular time of year. Various combinations of these seasonal fisheries are used by the shrimpers to fill out their annual round, or yearly cycle of fishing activities. Unfortunately, at this time there is little information available pertaining to the exact structure of these annual cycles for the South Atlantic shrimp fishery. Without such information it is difficult to fully understand the significance of shrimping to the fishermen involved.

Fisherman migration is an additional adaptation to the seasonal nature of the shrimp fishery. Rather than switch over to other fisheries available to them locally, some shrimpers choose to temporarily migrate to other states or regions with greater abundance of shrimp.

Recreational and commercial bait shrimp fisheries also exist in the South Atlantic area, in state waters.

C. Fishery Management Measures

History of Management Plans and Amendments of the Gulf Shrimp Fishery

The fishery for shrimp in the Gulf Exclusive Economic Zone (EEZ) is managed under the Fishery Management Plan for the Shrimp Fishery of the Gulf of Mexico (FMP). The FMP was prepared by the Gulf of Mexico Fishery Management Council, approved by NOAA Fisheries, and implemented under the authority of the MSA by regulations at 50 CFR part 622.

The FMP/EIS for the shrimp fishery in the Gulf of Mexico was prepared by the GMFMC and implemented as federal regulations on May 15, 1981. The goal of the plan was to enhance yield in volume and value by deferring harvest of small shrimp to provide for growth. Management measures included: (1) establishing a cooperative Tortugas Shrimp Sanctuary with the state of Florida to close a shrimp trawling area where small pink shrimp comprise the majority of the population most of the time; (2) a cooperative 45-day seasonal closure with the state of Texas to protect small brown shrimp emigrating from bay nursery areas; and (3) seasonal zoning of an area of Florida Bay for either shrimp or stone crab fishing to avoid gear conflict.

Amendment 1, approved later that year, provided the Regional Administrator (RA) of NOAA Fisheries with the authority (after conferring with the GMFMC) to adjust by regulatory amendment the size of the Tortugas Sanctuary or the extent of the Texas closure, or to eliminate either closure for one year.

Amendment 2 (1983) updated catch and economic data in the FMP.

Amendment 3 (1984) resolved a shrimp-stone crab gear conflict on the west-central coast of Florida.

Amendment 4, partially approved in 1988 and finalized in 1989, identified problems that developed in the fishery and revised the objectives of the FMP accordingly. The annual review process for the Tortugas Sanctuary was simplified, and the GMFMC's and RA's review for the Texas closure was extended to February 1st. Disapproved was a provision that white shrimp taken in the exclusive economic zone (EEZ) be landed in accordance with a state's size/possession regulations to provide consistency and facilitate enforcement with the state of Louisiana. This latter action was to have been implemented at such time when Louisiana provided for an incidental catch of undersized white shrimp in the fishery for seabobs. This proposed action was disapproved by NOAA Fisheries with the recommendation that it be resubmitted under the expedited 60-day Secretarial review schedule after Louisiana provided for a bycatch of undersized white shrimp in the directed fishery for seabobs. This resubmission was made in February of 1990 and applied to white shrimp taken in the EEZ and landed in Louisiana. It was approved and implemented in May of 1990.

In July 1989, NOAA Fisheries published revised guidelines for FMPs that interpretively addressed the Magnuson Act National Standards (50 CFR Part 602). These guidelines required each FMP to include a scientifically measurable definition of overfishing and an action plan to arrest overfishing should it occur.

In 1990, Texas revised the period of its seasonal closure in Gulf waters from June 1 to July 15 to May 15 to July 15. The FMP did not have enough flexibility to adjust the cooperative closure of federal waters to accommodate this change, thus an amendment was required.

Amendment 5, approved in 1991, defined overfishing for Gulf brown, pink, and royal red shrimp and provided for measures to restore overfished stocks if overfishing should occur. Action on the definition of overfishing for white shrimp was deferred, and seabobs and rock shrimp were deleted from the management unit. The duration of the seasonal closure to shrimping off Texas was adjusted to conform with the changes in state regulations.

Amendment 6 (1993) eliminated the annual reports and reviews of the Tortugas Shrimp Sanctuary in favor of monitoring and an annual stock assessment. Three seasonally opened areas within the sanctuary continued to open seasonally, without need for annual action. A proposed definition of overfishing of white shrimp was rejected by NOAA Fisheries as not being based on the best available data.

Amendment 7, finalized in 1994, defined overfishing for white shrimp and provided for future updating of overfishing indices for brown, white, and pink shrimp as new data become available. A total allowable level of foreign fishing for royal red shrimp was eliminated; however, a redefinition of overfishing for this species was disapproved.

Amendment 8, submitted in 1995 and implemented in early 1996, addressed management of royal red shrimp. It established a procedure that would allow total allowable catch for royal red shrimp to be set up to 30% above maximum sustainable yield (MSY) for no more than two consecutive years so that a better estimate of MSY could be determined. This proposal was subsequently rejected by NOAA Fisheries because the Sustainable Fisheries Act MSA defined exceeding MSY as overfishing.

Amendment 9, with Supplemental EIS, approved in May 1998, required the use of NOAA Fisheries certified bycatch reduction devices (BRDs) in shrimp trawls used in the EEZ from Cape San Blas, Florida (85°30' W. Longitude) to the Texas/Mexico border and provided for the certification of the Fisheye BRD in the 30 mesh position. The purpose of this action was to reduce the bycatch mortality of juvenile red snapper by 44% from the average mortality for the years 1984-89. This amendment exempted shrimp trawls fishing for royal red shrimp outside of 100 fathoms, as well as groundfish and butterfish trawls. It also excluded small try nets and no more than two rigid frame roller trawls that do not exceed 16 feet. Amendment 9 also provided mechanisms to change the bycatch reduction criterion and to certify additional BRDs.

The Generic Sustainable Fisheries Act Amendment to the Gulf of Mexico Fishery Management Plans was partially approved by NOAA Fisheries on November 17, 1999. NOAA Fisheries approved the descriptions of the fisheries and fishing communities, construction changes to stone crab traps to reduce bycatch, and certain stock status criteria definitions. NOAA Fisheries disapproved the portions dealing with bycatch reporting, bycatch reduction for fisheries other than stone crabs, and certain stock status criteria definitions.

The Generic Amendment to Address Essential Fish Habitat (EFH) Requirements of the Fishery Management Plans of the Gulf of Mexico was approved by NOAA Fisheries on February 8, 1999. NOAA Fisheries approved identification of EFH for 26 species discussed in the amendment and the coral complex, but did not approve using those descriptions as proxies for all remaining species under management. NOAA Fisheries approved the discussion of impacts on EFH from the use of three types of fishing gears, but concluded that additional assessments for the remaining gear types should be considered in subsequent amendments as more information became available.

Amendment 11, effective September 6, 2002, implements a Federal permit system for all shrimp trawl vessels that intend to fish in the Gulf of Mexico exclusive economic zone. All shrimp trawl vessels must obtain a permit prior to December 5, 2002.

Amendment 10, currently under Secretarial review, would implement BRDs east of Cape San Blas, Florida, and establish bycatch reporting requirements for the shrimp fishery throughout the Gulf of Mexico.

This Opinion considers these implemented and proposed management measures by the GMFMC within the proposed action.

History of Management Plans and Amendments of U.S. South Atlantic Area Shrimp Fishery

The fishery for shrimp in the U.S. southeast Atlantic EEZ is managed under the FMP for the Shrimp Fishery of the South Atlantic Region. The FMP was prepared by the South Atlantic Fishery Management Council (South Atlantic Council or SAFMC), approved by NOAA Fisheries, and implemented under the authority of the MSA by regulations at 50 CFR part 622.

A fishery management plan with an EIS for the shrimp fishery of the South Atlantic region was prepared by the SAFMC and approved in December 1993. The principle actions included white shrimp in the management unit (brown, pink, royal red, and rock shrimp were recognized but not included in the management unit), established stock status criteria (optimum yield [OY] and overfishing) for white shrimp, and established options to close the EEZ adjacent to closed state waters to white shrimp fishing following severe cold weather (exempted from closures were fisheries for royal red and rock shrimp).

Amendment 1, (1996), added rock shrimp to the management unit, prohibited rock shrimp trawling in the Oculina Bank Habitat Area of Particular Concern, and required Federal vessel permits for the rock shrimp fishery.

Amendment 2 (1997), with a Supplemental Final EIS, added brown and pink shrimp to the management unit along with describing overfishing thresholds and OY targets, required the use of certified BRDs in shrimp trawls fished in the EEZ, and established a BRD certification process.

Amendment 3 (1998), with a Supplemental EIS, addressed EFH requirements for the species in the management unit.

Amendment 4 (1998), with an Environmental Assessment, addressed Sustainable Fishery Act requirements of the MSA, including establishment of stock status thresholds and targets (MSY, OY) as well as rebuilding requirements and bycatch reporting requirements.

Amendment 5 with a Supplemental EIS (2002), would establish a limited access program for the rock shrimp fishery, require operator's permits for the rock shrimp fishery, establish fishing gear restrictions, and require the use of vessel monitoring systems (VMS) on all rock shrimp vessels.

This Opinion considers these implemented and proposed management measures by the SAFMC within the proposed action.

Management by the States

A major amount of shrimping occurs in state waters in the Gulf and South Atlantic areas, and therefore is not under the management of the Councils. State shrimp management regulates the shrimp fisheries in significant ways that can, in turn, affect the level and type of shrimp effort that listed species may encounter. The states, for example, require permits or licenses for trawlers operating in state waters or landing shrimp in the state. All states but North Carolina restrict the number and/or the size of nets that may be used in inshore state waters. In Georgia and South Carolina, inshore waters are for the most part closed to commercial trawlers. Many states also restrict the number and/or the size of nets that may be used in offshore state waters as a way to limit overall effort (Georgia, South Carolina, Louisiana, Texas [out to 3 nautical miles], and Florida [out to 3 nautical miles in the Gulf, 1 nautical mile in the Atlantic]). Most states manage their shrimp stocks with minimum mesh size requirements for trawls and with closed seasons to protect spawning shrimp or to allow juvenile shrimp to mature to more valuable sizes. Some states (Texas, Florida, Georgia, and South Carolina) require shrimp trawlers to use TEDs, with regulations that either mirror or are more restrictive than the Federal requirements, and some states (Texas, Florida, Georgia, North Carolina and South Carolina) also require the use of BRDs in state waters. Georgia, South Carolina, and Florida (partially) restrict shrimp trawling to daytime hours only in state waters.

D. Action Area and Scope of the Analysis

The shrimp fishery in Federal waters is managed under FMPs in both the South Atlantic and the Gulf of Mexico. Thus, the shrimp fishery in Federal waters is clearly part of the Federal action, as it is authorized through NOAA Fisheries' MSA authority. The shrimp fisheries in the various states' waters are not under the fishery management jurisdiction of NOAA Fisheries. NOAA Fisheries' authority under the ESA, however, is not restricted to Federal waters, and the state shrimp fisheries are directly regulated by NOAA Fisheries, to the extent that most shrimp trawlers are required to use TEDs for purposes of sea turtle conservation. The state shrimp fisheries existed prior to and would exist without the Federal TED regulations. Since the purpose of the TED regulations is the conservation of sea turtles (in both state and Federal waters) and the TED regulations include an authorization to state water shrimp fishermen to incidentally capture sea turtles, we must evaluate the regulations' sufficiency through the means of a biological opinion and the jeopardy standard. We therefore believe that the proper scope of the section 7 consultation is the effect of shrimp trawling, as conducted under the TED regulations and the FMPs, on all listed species within Federal waters and on listed sea turtles within state waters. Therefore, the action area, with respect to listed marine mammals, sturgeons, and seagrass, is the Federal waters in the Gulf of Mexico and the South Atlantic area. The action area, with respect to listed sea turtles, is all marine and tidal waters, both state and Federal, in the Gulf and South Atlantic area (i.e., from the Texas-Mexico border to the North Carolina-Virginia border).

II. *Status of Listed Species and Critical Habitat*

NOAA Fisheries has determined that the action being considered in this biological opinion may affect the following species and critical habitat provided protection under the Endangered Species Act of 1973 (16 U.S.C. 1531 *et seq.*; ESA).

<u>Endangered</u>

Blue whale	*Balaenoptera musculus*
Humpback whale	*Megaptera novaeangliae*
Fin whale	*Balaenoptera physalus*
Northern right whale	*Eubalaena glacialis*
Sei whale	*Balaenoptera borealis*
Sperm whale	*Physeter macrocephalus*
Leatherback sea turtle	*Dermochelys coriacea*
Hawksbill sea turtle	*Eretmochelys imbricata*
Kemp's ridley sea turtle	*Lepidochelys kempii*
Green sea turtle	*Chelonia mydas**
Olive ridley sea turtle	*Lepidochelys oliveacea***
Shortnose sturgeon	*Acipenser brevirostrum*

*Green turtles in U.S. waters are listed as threatened except for the Florida breeding population which is listed as endangered. Due to the inability to distinguish between these populations away from the nesting beach, green turtles are considered endangered wherever they occur in U.S. waters.

**Olive ridley turtles are listed as threatened except for the Mexican breeding population which is listed as endangered. Due to the inability to distinguish between these populations away from the nesting beach, olive ridley turtles are considered endangered wherever they occur in U.S. waters.

Threatened

Loggerhead sea turtle	*Caretta caretta*
Johnson's seagrass	*Halophila johnsonii*
Gulf sturgeon	*Acipenser oxyrinchus desotoi*

Critical Habitat

Northern right whale	*Eubalaena glacialis*
Johnson's seagrass	*Halophila johnsonii*
Gulf sturgeon	*Acipenser oxyrinchus desotoi*

Species of large whales protected by the ESA can be found in or near the Atlantic portion of the action area. Blue, fin, sei, and sperm whales are predominantly found seaward of the continental shelf where shrimping does not take place. Northern right whales and humpback whales are coastal animals and have been sighted in the nearshore environment in the Atlantic along the southeastern United States from November through March. Northern right and humpback whales have been spotted in the Gulf of Mexico on rare occasions; however, these are thought to be inexperienced juveniles. There are no known endemic populations of these whales in the Gulf of Mexico. Sperm whales can be found along the continental shelf in the Gulf of Mexico. There is little or no shrimp fishing in this area in the Gulf. There have been no reported interactions between large whales and shrimp vessels in the Atlantic or Gulf of Mexico. Also shrimp trawlers move slowly (1 to 2 knots while trawling) which would give a whale or the fishing vessel time to avoid a collision. Based on the above information, the chances of the proposed action affecting species of large whales protected by the ESA is discountable and will not be discussed further in this Opinion.

Designated northern right whale critical habitat (50 FR 28793) can be found in the action area from the mouth of the Altamaha River, Georgia, to Jacksonville, Florida, out 15 nautical miles (nm) and from Jacksonville, Florida, to Sebastian Inlet, Florida, out 5 nm. The continued prosecution of the shrimp fishery in Federal waters will not alter the physical and biological features (water depth, water temperature, and the distribution of right whale cow/calf pairs in relation to the distance from the shoreline to the 40-m isobath [Kraus *et al.* 1993]) that were the basis for determining this habitat to be critical. Therefore, northern right whale critical habitat is not expected to be adversely modified by the proposed action and will not be discussed further in this Opinion.

Olive ridley turtles in the United States are mainly found in the Pacific Ocean and rarely found in the southeast United States. However, in the past two years three confirmed strandings of olive ridleys have been recorded in South Florida where there is currently little or no shrimp fishing effort. Although present, NOAA Fisheries believes that olive ridleys are extremely rare in the southeastern United States. Based on this information NOAA Fisheries believes that the chances of an olive ridley turtle being adversely affected by the proposed action are discountable. Therefore, olive ridley turtles are not likely to be adversely affected by the proposed action and will not be discussed further in this Opinion.

Shortnose sturgeon can be found in a number of river systems near the action area along the Atlantic coast. Shortnose sturgeon stay mainly in their natal river or the river's estuary and their populations in these areas are relatively small. Based on this information, the chances of a shortnose sturgeon entering Federal waters and being affected by the continued prosecution of the shrimp fishery in Federal waters is discountable. Therefore, shortnose sturgeon are not likely to be adversely affected by the proposed action and will not be discussed further in this Opinion.

Gulf sturgeon can be found in a number of rivers and estuaries in the Gulf of Mexico from west central Florida (Charlotte Harbor area) to Lake Pontchartrain. They stay mainly in state waters with very rare occurrences in Federal waters. Gulf sturgeon critical habitat is being proposed (a final rule designating critical habitat is expected to be published in the *Federal Register* in early 2003) and would be located in river and estuarine systems in Florida, Alabama, Mississippi, and Louisiana, which are all in state waters. Therefore the chances of a Gulf sturgeon or its proposed critical habitat being affected by the continued prosecution of the shrimp fishery in Federal waters is discountable. Therefore, Gulf sturgeon and their critical habitat are not likely to be adversely affected by the proposed action and will not be discussed further in this Opinion.

Johnson's seagrass and its critical habitat do not occur in Federal waters; therefore, the continued prosecution of the shrimp fishery in Federal waters will not affect Johnson's seagrass nor Johnson's seagrass critical habitat and will not be discussed further in this Opinion.

A. Species/critical habitat description

Loggerhead Sea Turtle

The loggerhead sea turtle was listed as a threatened species in 1978. This species inhabits the continental shelves and estuarine environments along the margins of the Atlantic, Pacific, and Indian Oceans. Within the continental U.S. loggerheads nest from Louisiana to Virginia. The major nesting areas include coastal islands of Georgia, South Carolina, and North Carolina, and the Atlantic and Gulf coasts of Florida, with the bulk of the nesting occurring on the Atlantic coast of Florida. Developmental habitat for small juveniles includes the pelagic waters of the North Atlantic and the Mediterranean Sea.

There is no critical habitat designated for the loggerhead sea turtle.

Green Sea Turtle

Federal listing of the green sea turtle occurred on July 28, 1978, with all populations listed as threatened, except for the Florida and Pacific coast of Mexico breeding populations which are endangered. The complete nesting range of the green turtle within NOAA Fisheries'Southeast Region includes sandy beaches of mainland shores, barrier islands, coral islands, and volcanic islands between Texas and North Carolina and at the U.S. Virgin Islands (U.S.V.I.) and Puerto Rico (NMFS and USFWS 1991a). Principal U.S. nesting areas for green turtles are in eastern Florida, predominantly Brevard through

Broward counties (Ehrhart and Witherington 1992). Regular green turtle nesting also occurs on St Croix, U.S.V.I., and on Vieques, Culebra, Mona, and the main island of Puerto Rico (Mackay and Rebholz 1996, C. Diez, Puerto Rico Department of Natural Resources, pers. comm.).

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

Kemp's Ridley Sea Turtle

The Kemp's ridley was listed as endangered on December 2, 1970. Internationally, the Kemp's ridley is considered the most endangered sea turtle (Zwinenberg 1977, Groombridge 1982). Kemp's ridleys nest in daytime aggregations known as arribadas, primarily at Rancho Nuevo, a stretch of beach in Mexico, in the state of Tamaulipas. The species occurs mainly in coastal areas of the Gulf of Mexico and the northwestern Atlantic Ocean. Occasional individuals reach European waters (Brongersma 1972). The post-pelagic stages are commonly found dwelling over crab-rich sandy or muddy bottoms. Juveniles frequent bays, coastal lagoons, and river mouths. Adults of this species are usually confined to the Gulf of Mexico, although adult-sized individuals sometimes are found on the Eastern Seaboard of the United States.

There is no designated critical habitat for the Kemp's ridley sea turtle.

Leatherback Sea Turtle

The leatherback was listed as endangered on June 2, 1970. Leatherbacks are widely distributed throughout the oceans of the world, and are found in waters of the Atlantic, Pacific, and Indian Oceans; the Caribbean Sea; and the Gulf of Mexico (Ernst and Barbour 1972). Adult leatherbacks forage in temperate and subpolar regions from 71°N to 47°S latitude in all oceans and undergo extensive migrations between 90°N and 20°S, to and from the tropical nesting beaches. In the Atlantic Ocean, leatherbacks have been recorded as far north as Newfoundland, Canada, and Norway, and as far south as Uruguay, Argentina, and South Africa (see NMFS SEFSC 2001). Female leatherbacks nest from the southeastern United States to southern Brazil in the western Atlantic and from Mauritania to Angola in the eastern Atlantic. The most significant nesting beaches in the Atlantic, and perhaps in the world, are in French Guiana and Suriname (see NMFS SEFSC 2001).

Critical habitat for the leatherback includes the waters adjacent to Sandy Point, St. Croix, U.S.V.I.

Hawksbill Sea Turtle

The hawksbill turtle was listed as endangered under the ESA (1973), and is considered Critically Endangered by the International Union for the Conservation of Nature (IUCN) based on global population declines of over 80% during the last three generations (105 years) (Meylan and Donnelly 1999). Only five regional nesting populations remain with more than 1,000 females nesting annually (Seychelles, Mexico, Indonesia, and two in Australia) (Meylan and Donnelly 1999). Most populations are declining, depleted, or remnants of larger aggregations. Although hawksbills are subject to the suite of threats that affect other marine turtles, the decline of the species is primarily attributed to centuries of exploitation for tortoiseshell, the beautifully patterned scales that cover the turtle's shell (Parsons 1972).

Critical habitat for the hawksbill includes the waters around Mona and Monito Islands, Puerto Rico.

B. Life history

Loggerhead Sea Turtle

Mating takes place in late March-early June, and eggs are laid throughout the summer, with a mean clutch size of 100-126 eggs in the southeastern U.S. Individual females nest multiple times during a nesting season, with a mean of 4.1 nests/nesting individual (Murphy and Hopkins 1984). Nesting migrations for an individual female loggerhead are usually on an interval of 2-3 years, but can vary from 1-7 years (Dodd 1988). Loggerhead sea turtles originating from the western Atlantic nesting aggregations are believed to lead a pelagic existence in the North Atlantic Gyre for as long as 7-12 years or more, but there is some variation in habitat use by individuals at all life stages. Turtles in this life history stage are called "pelagic immatures." Stranding records indicate that when pelagic immature loggerheads reach 40-60 cm straight-line carapace length they begin to recruit to coastal inshore and nearshore waters of the continental shelf throughout the U.S. Atlantic and Gulf of Mexico.

Benthic immature loggerheads, the life stage following the pelagic immature stage, have been found from Cape Cod, Massachusetts, to southern Texas, and occasionally strand on beaches in northeastern Mexico. Large benthic immature loggerheads (70-91 cm) represent a larger proportion of the strandings and in-water captures (Schroeder et al. 1998) along the south and western coasts of Florida as compared with the rest of the coast, which could indicate that the larger animals are either more abundant in these areas or just more abundant within the area relative to the smaller turtles. Benthic immature loggerheads foraging in northeastern United States waters are known to migrate southward in the fall as water temperatures cool (Epperly et al. 1995, Keinath 1993, Morreale and Standora 1999, Shoop and Kenney 1992), and migrate northward in spring. Past literature gave an estimated age at maturity of 21-35 years (Frazer and Ehrhart 1985; Frazer et al. 1994) and the benthic immature stage as lasting at least 10-25 years. However, NMFS SEFSC (2001) reviewed the literature and constructed growth curves from new data, estimating ages of maturity ranging from 20-38 years and benthic immature stage lengths from 14-32 years.

Juveniles are omnivorous and forage on crabs, mollusks, jellyfish and vegetation at or near the surface (Dodd 1988). Sub-adult and adult loggerheads are primarily coastal and typically prey on benthic invertebrates such as mollusks and decapod crustaceans in hard bottom habitats.

Green Sea Turtle

Green sea turtle mating occurs in the waters off the nesting beaches. Each female deposits 1-7 clutches (usually 2-3) during the breeding season at 12-14 day intervals. Mean clutch size is highly variable among populations, but averages 110-115. Females usually have 2-4 or more years between breeding seasons, while males may mate every year (Balazs 1983). After hatching, green sea turtles go through a post-hatchling pelagic stage where they are associated with drift lines of algae and other debris especially where advection from wind and currents concentrates pelagic organisms (Hirth 1997, NMFS and USFWS 1991a). Principal benthic foraging areas in the region include Aransas Bay, Matagorda Bay, Laguna Madre, and the Gulf inlets of Texas (Doughty 1984, Hildebrand 1982, Shaver 1994), the Gulf of Mexico off Florida from Yankeetown to Tarpon Springs (Caldwell and Carr 1957, Carr 1984), Florida Bay and the Florida Keys (Schroeder and Foley 1995), the Indian River Lagoon System, Florida (Ehrhart 1983), and the Atlantic Ocean off Florida from Brevard through Broward counties (Wershoven and Wershoven 1992, Guseman and Ehrhart 1992). Adults of both sexes are presumed to migrate between nesting and foraging habitats along corridors adjacent to coastlines and reefs. Age at sexual maturity is estimated to be between 20 to 50 years (Balazs 1982, Frazer and Ehrhart 1985).

Green sea turtles are primarily herbivorous, feeding on algae and sea grasses, but also occasionally consume jellyfish and sponges. The post-hatchling, pelagic-stage individuals are assumed to be omnivorous, but little data are available.

Kemp's Ridley Sea Turtle

Remigration of females to the nesting beach varies from annually to every 4 years, with a mean of 2 years (TEWG 1998). Nesting occurs from April into July and is essentially limited to the beaches of the western Gulf of Mexico, near Rancho Nuevo in southern Tamaulipas, Mexico. The mean clutch size for Kemp's ridleys is 100 eggs/nest, with an average of 2.5 nests/female/season.

Juvenile/subadult Kemp's ridleys have been found along the Eastern Seaboard of the United States and in the Gulf of Mexico. Atlantic juveniles/subadults travel northward with vernal warming to feed in the productive, coastal waters of Georgia through New England, returning southward with the onset of winter to escape the cold (Lutcavage and Musick 1985, Henwood and Ogren 1987, Ogren 1989). In the Gulf, juvenile/subadult ridleys occupy shallow, coastal regions. Ogren (1989) suggested that in the northern Gulf they move offshore to deeper, warmer water during winter. Studies suggest that subadult Kemp's ridleys stay in shallow, warm, nearshore waters in the northern Gulf of Mexico until cooling waters force them offshore or south along the Florida coast (Renaud 1995). Little is known of the movements of the post-hatching, planktonic stage within the Gulf. Studies have shown the post-hatchling pelagic stage varies from 1-4 or more years, and the benthic immature stage lasts 7-9 years (Schmid and Witzell 1997). The TEWG (1998) estimates age at maturity to range from 7-15 years.

Stomach contents of Kemp's ridleys along the lower Texas coast consisted of a predominance of nearshore crabs and mollusks, as well as fish, shrimp and other foods considered to be shrimp fishery discards (Shaver 1991). Pelagic stage, neonatal Kemp's ridleys presumably feed on the available sargassum and associated infauna or other epipelagic species found in the Gulf of Mexico.

Leatherback Sea Turtle

Female leatherbacks nest from the southeastern United States to southern Brazil in the western Atlantic and from Mauritania to Angola in the eastern Atlantic, with nesting occurring as early as late February or March. When they leave the nesting beaches, leatherbacks move offshore but eventually utilize both coastal and pelagic waters. Very little is known about the pelagic habits of the hatchlings and juveniles, and they have not been documented to be associated with the sargassum areas as are other species.

Leatherbacks are deep divers, with recorded dives to depths in excess of 1000 m (Eckert et al. 1989), but they may come into shallow waters if there is an abundance of jellyfish nearshore.

Although leatherbacks are a long-lived species (> 30 years), they are somewhat faster to mature than loggerheads, with an estimated age at sexual maturity reported of about 13-14 years for females, and an estimated minimum age at sexual maturity of 3-6 years, with 9 years reported as a likely minimum (Zug and Parham 1996) and 19 years as a likely maximum (NMFS SEFSC 2001). They nest frequently (up to 7 nests per year) during a nesting season and nest about every 2-3 years. During each nesting, they produce 100 eggs or more in each clutch and, thus, can produce 700 eggs or more per nesting season (Schultz 1975).

Leatherback sea turtles feed primarily on cnidarians (medusae, siphonophores) and tunicates (salps, pyrosomas). They are also the most pelagic of the turtles, but have been known to enter coastal waters on a seasonal basis to feed in areas where jellyfish are concentrated.

Hawksbill Sea Turtle

The life history of hawksbills consists of a pelagic stage that lasts from the time they leave the nesting beach as hatchlings until they are approximately 22 - 25 cm in straight carapace length (Meylan 1988, Meylan in prep.), followed by residency in developmental habitats (foraging areas where immatures reside and grow) in coastal waters. Adult foraging habitat, which may or may not overlap with developmental habitat, is typically coral reefs, although other hard-bottom communities and occasionally mangrove-fringed bays may be occupied. Hawksbills show fidelity to their foraging areas over periods of time as great as several years (van Dam and Diez 1998).

Hawksbills may undertake developmental migrations (migrations as immatures) and reproductive migrations that involve travel over hundreds or thousands of kilometers (Meylan 1999b). Reproductive females undertake periodic (usually non-annual) migrations to their natal beach to nest. Movements of reproductive males are less well known, but are presumed to involve migrations to the nesting beach or to courtship stations along the migratory corridor. Females nest an average of 3-5 times per season with some geographic variation in this parameter (see references on pp. 204-205 of Meylan and Donnelly 1999, Richardson et al. 1999). Clutch size is higher on average (up to 250 eggs) than that of green turtles (Hirth 1980). Reproductive females may exhibit a high degree of fidelity to their nest sites. This, plus the tendency of hawksbills to nest at regular intervals within a season, make them vulnerable to capture on the nesting beach.

C. Population Dynamics, Status, and Distribution

Loggerhead Sea Turtle

Loggerhead sea turtles occur throughout the temperate and tropical regions of the Atlantic, Pacific, and Indian Oceans and are the most abundant species of sea turtle occurring in U.S. waters. Loggerhead sea turtles concentrate their nesting in the north and south temperate zones and subtropics, but generally avoid nesting in tropical areas of Central America, northern South America, and the Old World (Magnuson et al. 1990).

In the western Atlantic, most loggerhead sea turtles nest from North Carolina to Florida and along the Gulf coast of Florida. There are 5 western Atlantic subpopulations, divided geographically as follows: (1) a northern nesting subpopulation, occurring from North Carolina to northeast Florida at about 29° N (approximately 7,500 nests in 1998); (2) a south Florida nesting subpopulation, occurring from 29° N on the east coast to Sarasota on the west coast (approximately 83,400 nests in 1998); (3) a Florida Panhandle nesting subpopulation, occurring at Eglin Air Force Base and the beaches near Panama City, Florida (approximately 1,200 nests in 1998); (4) a Yucatán nesting subpopulation, occurring on the eastern Yucatán Peninsula, Mexico (Márquez 1990) (approximately 1,000 nests in 1998) (TEWG 2000); and (5) a Dry Tortugas nesting subpopulation, occurring in the islands of the Dry Tortugas, near Key West, Florida (approximately 200 nests per year) (NMFS SEFSC 2001). Natal homing of females to the nesting beach provides the barrier between these subpopulations, preventing recolonization with turtles from other nesting beaches.

Based on the data available, it is difficult to estimate the size of the loggerhead sea turtle population in the United States or its territorial waters. There is, however, general agreement that the number of nesting females provides a useful index of the species' population size and stability at this life stage. Nesting data collected on index nesting beaches in the United States from 1989-1998 represent the best data set available to index the population size of loggerhead sea turtles. However, an important caveat for population trends analysis based on nesting beach data is that this may reflect trends in adult nesting females but not reflect overall population growth rates. Given this caveat, between 1989 and 1998, the total number of nests laid along the U.S. Atlantic and Gulf coasts ranged from 53,014 to 92,182 annually, with a mean of 73,751. On average, 90.7% of these nests were from the south Florida subpopulation, 8.5% were from the northern subpopulation, and 0.8% were from the Florida Panhandle nest sites. There is limited nesting throughout the Gulf of Mexico west of Florida, but it is not known to which subpopulation the turtles making these nests belong.

The number of nests in the northern subpopulation from 1989 to 1998 was 4,370 to 7,887, with a 10-year mean of 6,247 nests. With each female producing an average of 4.1 nests in a nesting season, the average number of nesting females per year in the northern subpopulation was 1,524. The total nesting and non-nesting adult female population is estimated as 3,810 adult females in the northern subpopulation (TEWG 1998, 2000). The northern population, based on number of nests, has been classified as stable or declining (TEWG 2000). Another consideration adding to the vulnerability of the northern subpopulation is that NMFS scientists estimate that the northern subpopulation produces 65% males, while the south Florida subpopulation is estimated to produce 80% females (NMFS SEFSC 2001).

The southeastern U.S. nesting aggregation is of great importance on a global scale and is second in size only to the nesting aggregation on islands in the Arabian Sea off Oman (Ross 1979, Ehrhart 1989, NMFS and USFWS 1991b). The global importance of the southeast U.S. nesting aggregation is especially important because the status of the Oman colony has not been evaluated recently, but it is located in an area of the world where it is highly vulnerable to disruptive events such as political upheavals, wars, catastrophic oil spills, and lack of strong protections (Meylan et al. 1995).

Ongoing threats to the western Atlantic populations include incidental takes from dredging, commercial trawling, longline fisheries, and gill net fisheries; loss or degradation of nesting habitat from coastal development and beach armoring; disorientation of hatchlings by beachfront lighting; nest predation by native and non-native predators; degradation of foraging habitat; marine pollution and debris; watercraft strikes; and disease.

Green Sea Turtle

The vast majority of green turtle nesting within the southeast United States occurs in Florida. In Florida from 1989-1999, green turtle abundance from nest counts ranges from 109-1,389 nesting females per year (Meylan et al. 1995 and Florida Marine Research Institute Statewide Nesting 2001 Database, unpublished data; estimates assume 4 nests per female per year, Johnson and Ehrhart 1994). High biennial variation and a predominant 2-year re-migration interval (Witherington and Ehrhart 1989, Johnson and Ehrhart 1994) warrant combining even and odd years into 2-year cohorts. This gives an estimate of total nesting females that ranges from 705-1,509 during the period 1990-1999. It is important to note that because methodological limitations make the clutch frequency number (4 nests/female/year) an underestimate (by as great as 50%), a more conservative estimate is 470-1,509 nesting females in Florida between 1990 and 1999. In Florida during the period 1989-1999, numbers of green turtle nests by year show no trend. However, odd-even year cohorts of nests do show a significant increase during the period 1990-1999 (Florida Marine Research Institute, 2001 Index Nesting Beach Survey Database, unpublished data).

It is unclear how greatly green turtle nesting in the whole of Florida has been reduced from historical levels (Dodd 1981), although one account indicates that nesting in Florida's Dry Tortugas may now be only a small fraction of what it once was (Audubon 1926). Total nest counts and trends at index beach sites during the past decade suggest that green turtles that nest within the southeast United States are recovering and have only recently reached a level of approximately 1,000 nesting females. There are no reliable estimates of the number of green turtles inhabiting foraging areas within the southeast United States, and it is likely that green turtles foraging in the region come from multiple genetic stocks. These trends are also uncertain because of a lack of data. However, there is one sampling area in the region with a large time series of constant turtle-capture effort that may represent trends for a limited area within the region. This sampling area is at an intake canal for a power plant on the Atlantic coast of Florida where 2,578 green turtles have been captured during the period 1977-1999 (FPL 2000). At the power plant, the annual number of immature green turtle captures (minimum straight-line carapace length < 85 cm) has increased significantly during the 23-year period. Another long-term in-water monitoring study in the Indian River Lagoon of Florida has tracked the populations of juvenile green turtles in a foraging environment and noted significant increases in catch-per-unit effort (more than doubling) between the years 1983-85 and 1988-90. An extreme, short-term increase in CPUE of ~300% was seen between 1995 and 1996 (Ehrhart *et al.* 1996).

Status of immature green turtles foraging in the southeast United States might also be assessed from trends at nesting beaches where many of the turtles originated, principally, Florida, Yucatán, and Tortuguero. Trends at Florida beaches are presented above. Trends in nesting at Yucatán beaches cannot be assessed because of irregularity in beach survey methods over time. Trends at Tortuguero (ca. 20,000-50,000 nests/year) show a significant increase in nesting during the period 1971-1996 (Bjorndal et al. 1999).

The principal cause of past declines and extirpations of green turtle assemblages has been the over-exploitation of green turtles for food and other products. Although intentional take of green turtles and their eggs is not extensive within the southeast United States, green turtles that nest and forage in the region may spend large portions of their life history outside the region and outside United States jurisdiction, where exploitation is still a threat. Adult green turtles and immatures are exploited heavily on foraging grounds off Nicaragua and to a lesser extent off Colombia, Mexico, Panama, Venezuela, and the Tortuguero nesting beach (Carr et al. 1978, Nietschmann 1982, Bass et al. 1998b, Lagueux 1998).

There are significant and ongoing threats to green turtles from human-related causes. Threats to nesting beaches in the region include beach armoring, erosion control, artificial lighting, and disturbance, which can be expected to increase with time. Pollution is known to have both direct (ingestion of foreign materials such as tar balls and plastics) and indirect (degradation of foraging grounds) impacts on green sea turtles. Foraging habitat loss also occurs as a result of direct destruction by dredging, siltation, boat damage, and other human activities. Green turtles are often captured and occasionally killed by interactions with fishing gear. Collisions with power boats and encounters with suction dredges have killed green turtles along the U.S. coast and may be common elsewhere where boating and dredging activities are frequent (Florida Marine Research Institute, Sea Turtle Stranding and Salvage Network Database). Threats from increasing incidences of disease, which may or may not have some relation to human influences, are also a concern. The occurrence of green turtle fibropapillomatosis disease was originally reported in the 1930s, when it was thought to be rare (Smith and Coates 1938). Presently, this disease is cosmopolitan and has been found to affect large numbers of animals in some areas, including Hawaii and Florida (Herbst 1994, Jacobson 1990; Jacobson et al. 1991).

Kemp's Ridley Sea Turtle

L. kempii has a very restricted distribution relative to the other sea turtle species. Data suggests that adult Kemp's ridley turtles are restricted somewhat to the Gulf of Mexico in shallow near shore waters, and benthic immature turtles of 20-60 cm straight line carapace length are found in nearshore coastal waters including estuaries of the Gulf of Mexico and the Atlantic, although adult-sized individuals sometimes are found on the Eastern Seaboard of the United States. The post-pelagic stages are commonly found dwelling over crab-rich sandy or muddy bottoms. Juveniles frequent bays, coastal lagoons, and river mouths.

Of the seven extant species of sea turtles in the world, the Kemp's ridley has declined to the lowest population level. Most of the population of adult females nest on the Rancho Nuevo beaches (Pritchard 1969). When nesting aggregations at Rancho Nuevo were discovered in 1947, adult female populations were estimated to be in excess of 40,000 individuals (Hildebrand 1963). By the early 1970s, the world population estimate of mature female Kemp's ridleys had been reduced to 2,500-5,000 individuals. The population declined further through the mid-1980s. Recent observations of increased nesting suggest that the decline in the ridley population has stopped and the population is now increasing.

The TEWG (1998) identified three population trends in benthic immature ridleys. Benthic immatures are not yet reproductively mature but have recruited to feed in the nearshore benthic environment, where they are exposed to nearshore mortality sources that often result in strandings. Increased production of hatchlings from the nesting beach beginning in 1966 resulted in an increase in benthic ridleys that leveled off in the late 1970s. A second period of increase followed by leveling occurred between 1978 and 1989 as hatchling production was further enhanced by the cooperative program between the U.S. Fish and Wildlife Service and Mexico's Instituto Nacional de Pesca to increase the nest protection and relocation program in 1978. A third period of steady increase, which has not leveled off to date, has occurred since

1990 and appears to be due to the greatly increased hatchling production and an apparent increase in survival rates of immature turtles beginning in 1990, due in part to the introduction of turtle excluder devices (TEDs) in the U.S. and Mexican shrimping fleets. Adult ridley numbers have now grown, as shown in nesting increases at the main nesting sites in Mexico. Nesting at Tamaulipas and Veracruz increased from a low of 702 nests in 1985, to 1,930 nests in 1995, to 6,277 nests in 2000 (USFWS 2000). The population model used by the TEWG (1998) projected that Kemp's ridleys could reach the intermediate recovery goal identified in the Recovery Plan, of 10,000 nesters by the year 2020 if the assumptions of age to sexual maturity and age specific survivorship rates used in their model are correct.

The largest contributor to the decline of the ridley in the past was commercial and local exploitation, especially poaching of nests at the Rancho Nuevo site, as well as the Gulf of Mexico trawl fisheries. The advent of TED regulations for trawlers and protections for the nesting beaches have allowed the species to begin to rebound. Many threats to the future of the species remain, including interactions with fishery gear, marine pollution, foraging habitat destruction, illegal poaching of nests and potential threats to the nesting beaches from such sources as global climate change, development, and tourism pressures.

Leatherback Sea Turtle

Leatherbacks are widely distributed throughout the oceans of the world, and are found in waters of the Atlantic, Pacific, Caribbean, and the Gulf of Mexico (Ernst and Barbour 1972). The leatherback is the largest living turtle and it ranges farther than any other sea turtle species, exhibiting broad thermal tolerances (NMFS and USFWS 1995). Genetic analyses of leatherbacks to date indicate that within the Atlantic basin significant genetic differences occur among St. Croix (U.S. Virgin Islands), and mainland Caribbean populations (Florida, Costa Rica, Suriname/French Guiana) and between Trinidad and the mainland Caribbean populations (Dutton et al. 1999) leading to the conclusion that there are at least three separate subpopulations of leatherbacks in the Atlantic.

Nest counts are the only reliable population information available for leatherback turtles. Recent declines have been seen in the number of leatherbacks nesting worldwide (NMFS and USFWS 1995). A population estimate of 34,500 females (26,200-42,900) was made by Spotila et al. (1996), who stated that the species as a whole was declining and local populations were in danger of extinction. Historically, it was due primarily to intense exploitation of the eggs (Ross 1979) but adult mortality has increased significantly from interactions with fishery gear (Spotila et al. 1996). The Pacific population is in a critical state of decline, now estimated to number less than 3,000 total adult and subadult animals (Spotila et al. 2000). The status of the Atlantic population is less clear. In 1996, it was reported to be stable, at best (Spotila et al. 1996), but numbers in the western Atlantic at that time were reported to be on the order of 18,800 nesting females. According to Spotila (pers. comm.), the western Atlantic population currently numbers about 15,000 nesting females, whereas current estimates for the Caribbean (4,000) and the eastern Atlantic, off Africa, (numbering ca. 4,700) have remained consistent with numbers reported by Spotila et al. in 1996.

The nesting aggregation in French Guiana has been declining at about 15% per year since 1987. From 1979-1986, the number of nests was increasing at about 15% annually. The number of nests in Florida and the U.S. Caribbean has been increasing at about 10.3% and 7.5%, respectively, per year since the early 1980s but the magnitude of nesting is much smaller than that along the French Guiana coast (see NMFS SEFSC 2001). In summary, the conflicting information regarding the status of Atlantic leatherbacks makes it difficult to conclude whether or not the population is currently in decline. Numbers at some nesting sites are up, while at others they are down.

Zug and Parham (1996) pointed out that the combination of the loss of long-lived adults in fishery-related mortality (especially entanglement in gear and drowning in trawls), and the lack of recruitment stemming from elimination of annual influxes of hatchlings because of intense egg harvesting, has caused the sharp decline in leatherback populations. Other important ongoing threats to the population include pollution, loss of nesting habitat, and boat strikes.

Hawksbill Sea Turtle

The hawksbill is a medium-sized sea turtle with adults in the Caribbean ranging in size from approximately 62.5 to 94.0 cm straight carapace length. The species occurs in all ocean basins although it is relatively rare in the Eastern Atlantic and Eastern Pacific, and absent from the Mediterranean Sea. Hawksbills are the most tropical of the marine turtles, ranging from approximately 30°N to 30° S. They are closely associated with coral reefs and other hard-bottom habitats, but they are also found in other habitats including inlets, bays and coastal lagoons. The diet is highly specialized and consists primarily of sponges (Meylan 1988) although other food items, notably corallimorphs and zooanthids, have been documented to be important in some areas of the Caribbean (van Dam and Diez 1997, Mayor et al. 1998, Leon and Diez 2000).

In the Western Atlantic, the largest hawksbill nesting population occurs in the Yucatán Península of Mexico, where several thousand nests are recorded annually in the states of Campeche, Yucatán, and Quintana Roo (Garduño-Andrade et al. 1999). Important but significantly smaller nesting aggregations are documented elsewhere in the region in Puerto Rico, the U.S. Virgin Islands, Antigua, Barbados, Costa Rica, Cuba, and Jamaica (Meylan 1999a). Estimates of the annual number of nests for each of these areas are of the order of hundreds to a few thousand. Nesting within the southeastern U.S. and U.S. Caribbean is restricted to Puerto Rico (>650 nests/yr), the U.S. Virgin Islands (~400 nests/yr), and, rarely, Florida (0-4 nests/yr)(Eckert 1995, Meylan 1999a, Florida Statewide Nesting Beach Survey database). At the two principal nesting beaches in the U.S. Caribbean where long-term monitoring has been carried out, populations appear to be increasing (Mona Island, Puerto Rico) or stable (Buck Island Reef National Monument, St. Croix, USVI) (Meylan 1999a).

III. Environmental Baseline

This section contains an analysis of the effects of past and ongoing human and natural factors leading to the current status of the species, its habitat, and ecosystem, within the action area. The environmental baseline is a snapshot of a species' health at a specified point in time and includes state, tribal, local, and private actions already affecting the species, or that will occur contemporaneously with the consultation in progress. Unrelated Federal actions affecting the same species or critical habitat that have completed formal or informal consultation are also part of the environmental baseline, as are Federal and other actions within the action area that may benefit listed species or critical habitat.

The environmental baseline for this Opinion includes the effects of several activities that affect the survival and recovery of threatened and endangered species in the action area. The activities that shape the environmental baseline in the action area of this consultation are primarily fisheries and recovery activities associated with reducing fisheries impacts. Other environmental impacts include effects of discharges, dredging, military activities, and industrial cooling water intake.

A. Status of the Species Within the Action Area

The five species of sea turtles that occur in the action area are all highly migratory. Individual animals will make migrations into nearshore waters as well as other areas of the North Atlantic Ocean, Gulf of Mexico, and the Caribbean Sea. The range-wide status information provided in Section II therefore provides a good representation of the status of the species within the action area, the Gulf of Mexico and South Atlantic shrimping grounds.

B. Factors Affecting the Species Environment Within the Action Area

As explained above, sea turtles travel widely throughout the Atlantic, Gulf of Mexico, and Caribbean Sea. Therefore, individuals found in the action area can potentially be affected by activities anywhere else within this wide range.

Federal Actions

In recent years, NOAA Fisheries has undertaken several ESA section 7 consultations to address the effects of federally-permitted fisheries and other Federal actions on threatened and endangered species. Each of those consultations sought to develop ways of reducing the probability of adverse effects of the action on sea turtles. Similarly, recovery actions NOAA Fisheries has undertaken under the ESA are addressing the problem of take of sea turtles in the fishing and shipping industries. The following summary of anticipated sources of incidental take of turtles includes only those Federal actions which have undergone formal section 7 consultation.

Potential adverse effects from Federal vessel operations in the action area and throughout the range of sea turtles include operations of the Navy (USN) and Coast Guard (USCG), the Environmental Protection Agency, the National Oceanic and Atmospheric Administration (NOAA), and the Army Corps of Engineers (COE). NOAA Fisheries has conducted formal consultations with the USCG and the USN on their vessel operations. Through the section 7 process, where applicable, NOAA Fisheries has and will continue to establish conservation measures for all these agency vessel operations to avoid or minimize adverse effects to listed species. At the present time, however, they represent potential for some level of interaction.

In addition to vessel operations, other military activities including training exercises and ordnance detonation also adversely affect sea turtles. Consultations on individual activities have been completed, but no formal consultation on overall USCG or USN activities in any region has been completed at this time.

The construction and maintenance of Federal navigation channels has also been identified as a source of turtle mortality. Hopper dredges move relatively rapidly (compared to sea turtle swimming speeds) and can entrain and kill sea turtles, presumably as the drag arm of the moving dredge overtakes the slower moving turtle. Regional biological opinions (RBOs) with corresponding ITSs have been issued to the COE for the southeast Atlantic waters and the Gulf of Mexico. Consultation is currently underway, on a new RBO for the COE's Gulf of Mexico hopper dredging operations.

The COE and Minerals Management Service (MMS) oil and gas exploration, well development, production, and abandonment/rig removal activities also adversely affect sea turtles. Both of these agencies have consulted with NOAA Fisheries on these types of activities.

Adverse effects on threatened and endangered species from several types of fishing gear occur in the action area. Efforts to reduce the adverse effects of commercial fisheries are addressed through the ESA section 7 process. Gillnet, longline, trawl gear, and pot fisheries have all been documented as interacting with sea turtles. For all fisheries for which there is a Federal FMP or for which any Federal action is taken to manage that fishery, impacts have been evaluated under section 7. Several formal consultations have been conducted on the following fisheries that NOAA Fisheries has determined are likely to adversely affect threatened and endangered species: American lobster, monkfish, dogfish, a previous consultation on the southeastern shrimp trawl fishery, northeast multispecies, Atlantic pelagic swordfish/tuna/shark, and summer flounder/scup/black sea bass fisheries.

On June 14, 2001, NOAA Fisheries issued a jeopardy opinion for the Highly Migratory Species (HMS) fisheries off the eastern United States. The HMS Opinion found that the continued prosecution of the pelagic longline fishery in the manner described in the HMS FMP was likely to jeopardize the continued existence of loggerhead and leatherback sea turtles. This determination was made by analyzing the effects of the fishery on sea turtles in conjunction with the environmental baseline and cumulative effects. NOAA Fisheries then implemented a reasonable and prudent alternative (RPA) in the HMS fishery which would allow the continuation of the pelagic longline fishery without jeopardizing the continued existence of loggerhead and leatherback sea turtles. The provisions of this RPA include the closure of the Grand Banks region off the northeast United States and gear restrictions that are expected to reduce the by-catch of loggerheads by as much as 76% and leatherbacks by as much as 65%. Further, NOAA Fisheries is implementing a major research project to develop measures aimed at further reducing longline by-catch. The implementation of this RPA reduces the negative effects that the HMS fishery has on the environmental baseline. The conclusions of the June 14, 2001, HMS Opinion and the subsequent implementation of the RPA are hereby incorporated into the environmental baseline section of this Opinion.

The environmental baseline for the June 14, 2001, HMS Opinion also considered the impacts from the North Carolina offshore spring monkfish gillnet fishery and the inshore fall southern flounder gillnet fishery, both of which were responsible for large numbers of sea turtle mortalities in 1999 and 2000, especially loggerhead sea turtles. However, during the 2001 season NOAA Fisheries implemented an observer program that observed 100% of the effort in the monkfish fishery, and then in 2002 a rule was enacted creating a seasonal monkfish gillnet closure along the Atlantic coast based upon sea surface temperature data and turtle migration patterns. In 2001, NOAA Fisheries also issued an ESA section 10 permit with mitigative measures for the southern flounder fishery in Pamlico Sound and is working on a permanent final rule and 3-year section 10 permit to be implemented beginning in the 2002 fall season. Additionally, in 2002 a rule was implemented for the Virginia pound net fishery regarding mesh size of pound net leaders to reduce turtle entanglements. Subsequently, the sea turtle mortalities in these fisheries were drastically reduced. The reduction of turtle mortalities in these fisheries reduces the negative effects these fisheries have on the environmental baseline.

Another action with Federal oversight which has impacts on sea turtles is the operation of electrical generating plants. Sea turtles entering coastal or inshore areas have been affected by entrainment in the cooling-water systems of electrical generating plants. Biological opinions have already been written for a number of electrical generating plants, and others are currently undergoing section 7 consultation. However, sea turtle mortality associated with these activities is relatively low and does not significantly affect the environmental baseline.

State or Private Actions

Commercial vessel traffic and recreational pursuits can have an adverse effect on sea turtles through propeller and boat strike damage. Private vessels participate in high speed marine events concentrated in the southeastern United States and are a particular threat to sea turtles, and occasionally to marine mammals as well. The magnitude of the impacts of these marine events is not currently known. NOAA Fisheries and the USCG are in early consultation on these events, but a thorough analysis has not been completed.

Various fishing methods used in state fisheries, including trawling, pot fisheries, fly nets, and gillnets are known to cause interactions with sea turtles. Georgia and South Carolina prohibit gillnets for all but the shad fishery. Florida has banned all but very small nets in state waters, as has Texas. Louisiana, Mississippi, and Alabama have also placed restrictions on gillnet fisheries within state waters such that very little commercial gillnetting takes place in southeast waters, with the exception of North Carolina. Most pot fisheries in the Southeast are prosecuted in areas frequented by sea turtles.

Strandings in the North Carolina area represent, at best, 7%-13% of the actual nearshore mortality (Epperly et al. 1996). Studies by Bass et al. (1998a), Norrgard (1995), and Rankin-Baransky (1997) indicate that the percentage of northern loggerheads in this area is highly over-represented in the strandings when compared to the approximately 9% representation from this subpopulation in the overall U.S. sea turtle nesting populations. Specifically, the genetic composition of sea turtles in this area is 25%-54% from the northern subpopulation, 46%-64% from the South Florida subpopulation, and 3%-16% from the Yucatán subpopulation. The cumulative removal of these turtles on an annual basis would severely impact the recovery of this species.

Other Potential Sources of Impacts in the Environmental Baseline

A number of activities that may indirectly affect listed species include discharges from wastewater systems, dredging, ocean dumping and disposal, and aquaculture. The impacts from these activities are difficult to measure. Where possible, however, conservation actions are being implemented to monitor or study impacts from these elusive sources.

NOAA Fisheries, the USN, and MMS have been working cooperatively to establish a policy for monitoring and managing acoustic impacts from anthropogenic sound sources in the marine environment.

Acoustic impacts can include temporary or permanent injury, habitat exclusion, habituation, and disruption of other normal behavior patterns.

Conservation and Recovery Actions Shaping the Environmental Baseline

NOAA Fisheries implemented a series of regulations aimed at reducing potential for incidental mortality of sea turtles in commercial fisheries. The most important of these was the implementation of TED regulations for the shrimp fishery (as detailed in the Consultation History section of this Opinion), and to a lesser extent the southern flounder trawl fishery.

NOAA Fisheries is also working to develop a TED which can be effectively used in a type of trawl known as a fly net, which is sometimes used in the mid-Atlantic and northeast fisheries to target sciaenids and bluefish. Limited observer data indicate that takes can be quite high in this fishery. A prototype design has been developed, but testing under commercial conditions is still necessary.

In addition, NOAA Fisheries has been active in public outreach efforts to educate fishermen regarding sea turtle handling and resuscitation techniques. As well as making this information widely available to all fishermen, NOAA Fisheries recently conducted a number of workshops with longline fishermen to discuss bycatch issues including protected species, and to educate them regarding sea turtle handling and release guidelines. NOAA Fisheries intends to continue these outreach efforts and hopes to reach all fishermen participating in the pelagic longline fishery over the next one to two years. There is also an extensive network of Sea Turtle Stranding and Salvage Network participants along the Atlantic and Gulf of Mexico which not only collects data on dead sea turtles, but also rescues and rehabilitates any live stranded turtles.

In summary, the above adverse and beneficial factors are affecting loggerhead, leatherback, Kemp's ridley, green, and hawksbill sea turtles within the action area. These past and ongoing adverse effects result in the serious injury or mortality of significant numbers of sea turtles each year and combine to slow their recovery throughout their range. Likewise, beneficial actions combine to save a significant, though unquantifiable numbers (estimated to be thousands) of sea turtles and hatchlings each year. Overall, when viewed in light of the adverse effects discussed above, NOAA Fisheries believes that these management measures will help maintain stability and may help to increase populations of sea turtles in the action area.

IV. Effects of the Action

In this section of the Opinion, we assess the probable direct and indirect effects of the shrimp fisheries and the sea turtle conservation regulations on listed species of sea turtles. The purpose of this assessment is to determine if it is reasonable to expect that the fisheries, as conducted under the proposed revisions to the sea turtle conservation regulations, can be expected to have direct or indirect effects on threatened and endangered species that appreciably reduce their likelihood of surviving and recovering in the wild. This section begins with a discussion of the factors to be considered in that evaluation. Specifically, we will assess the types of effects that are expected from the proposed action (How will the proposed action affect listed sea turtles?) and discuss some of the available data and assumptions used in making our overall assessment. Next, we will look at the extent of those effects (How many sea turtles will be affected?). Finally, we will assess the overall impact of those effects on sea turtle populations (What will the proposed action mean for sea turtle populations?).

A. Factors to be Considered

Scope of the Analysis

This biological opinion treats sea turtle populations in the Atlantic Ocean as distinct from the Pacific Ocean populations for the purposes of this consultation. This approach is supported by interagency policy on the recognition of distinct vertebrate populations (61 Federal Register 4722). To address specific criteria outlined in that policy, sea turtle populations in the Atlantic basin are geographically discrete from populations in the Pacific basin, with limited genetic exchange (see NMFS and USFWS 1998). This approach is also consistent with traditional jeopardy analyses: the loss of sea turtle populations in the Atlantic basin would result in a significant gap in the distribution of each turtle species, which makes these populations biologically significant. Finally, the loss of these sea turtle populations in the Atlantic basin would dramatically reduce the distribution and abundance of these species and would, by itself, appreciably reduce the entire species' likelihood of surviving and recovering in the wild.

The analyses in this Opinion are based on an implicit understanding that the sea turtles considered in this Opinion are threatened with global extinction by a wide array of human activities and natural phenomena; we have outlined many of those activities in the *Status of the Species* section of this Opinion. NOAA Fisheries also recognizes that some of these other human activities and natural phenomena also pose serious threats to the survival and recovery of sea turtles (and other flora and fauna). Further, NOAA Fisheries recognizes that sea turtles will not recover without addressing the full range of human activities and natural phenomena such as patterns of beach erosion, predation on turtle eggs, and turtle captures, injuries, and deaths in other domestic and international fisheries and other State, federal, and private activities that could cause these animals to become extinct in the foreseeable future (USFWS and NMFS 1995).

Nevertheless, this Opinion focuses solely on whether the direct and indirect effects of the proposed changes to the sea turtle conservation regulations and shrimp trawl fisheries in the South Atlantic and Gulf of Mexico can be expected to appreciably reduce the listed sea turtles' likelihood of surviving and recovering in the wild by reducing their reproduction, numbers, or distribution. NOAA Fisheries will consider the effects of other actions on threatened and endangered turtles as a separate issue. Jeopardy analyses in biological opinions distinguish between the effects of a specific action on a species' likelihood of surviving and recovering in the wild and a species' background likelihood of surviving and recovering given the full set of human actions and natural phenomena that threaten a species.

Conservative Decisions

The analysis in this section is based upon the best available commercial and scientific data on sea turtle biology and the effects of the proposed action. This section, particularly the *Extent of the Effects of the Action* and the associated appendix to this Opinion, contains a great deal of numerical analysis. Frequently, the best available information might include two or more reasonable data estimates for a particular data point, or a range of values, or different analytical approaches may be applied to the same data sets. In those cases, in keeping with the direction from the U.S. Congress to provide the "benefit of the doubt" to threatened and endangered species [House of Representatives Conference Report No. 697, 96th Congress, Second Session, 12 (1979)], we will generally select the value that yields the most conservative outcome for turtles (i.e., would lead to conclusions of higher, rather than lower, risk to endangered or threatened species). Also, we will tend to give greater weight to studies that speak most directly to the effects of shrimp trawling on sea turtles, accepting, for example, fishery-dependent observation as more directly applicable to evaluating shrimp-turtle interactions than fishery-independent or laboratory work.

Indirect Effects

The most apparent possible route of indirect effects of shrimp trawling on sea turtles would be the disturbance of the benthic environment by trawl gear. Whether shrimp trawling has overall negative impacts on the benthic environment, however, is a question that is currently being studied at the NOAA Fisheries Galveston Laboratory, so the link to a negative effect on sea turtles would be tenuous. Benthic molluscan and crustacean prey items favored by Kemp's ridley and loggerhead turtles could conceivably be affected by trawl disturbance, but a possible effect of that disturbance would be to make them more susceptible to predation by sea turtles and possibly enhance foraging opportunities.

Another route of indirect effects of shrimp trawling may be the catch and removal of turtle prey items. The large amount of fish and crustacean bycatch that is discarded from shrimp trawlers probably provides an easy scavenging meal for Kemp's ridley and loggerhead turtles, however, and the net indirect effect of shrimp bycatch may be positive for those species. In many situations, shrimpers use their TEDs to exclude jellyfish from their catch. We believe it is unlikely that shrimping affects the availability of jellyfish for leatherback foraging. Shrimp trawls would be expected to have negative effects on seagrass or sponge bottoms that could support green or hawksbill turtle foraging. We believe it is likely, however, that, to the extent any impact to these forage resources has occurred, the risk of major future effects to these habitats is low. Many seagrass and sponge bottom habitats are either not productive shrimping areas or are untrawlable because of regulatory protection, depth, bottom obstructions, or inaccessibility.

A potentially more serious indirect impact to sea turtles could exist if shrimping activity affected the nesting behavior of female turtles, perhaps through disturbance from vessel lights, traffic, or trawl disturbance as they approach the beach for their nocturnal emergence. This effect would be of greatest concern in northeast Florida through southern North Carolina where shrimping is primarily nearshore and is active immediately adjacent to important loggerhead nesting beaches. The northern loggerhead subpopulation that nests in that region is, interestingly, not experiencing the nesting increase of the south Florida population (NMFS SEFSC 2001) which does not experience much shrimp effort adjacent to its nesting beaches. We are not aware of any data, however, indicating that shrimping disturbs loggerhead female nesting activity, nor that the relatively poorer nesting of the northern subpopulation is associated with female nesting disturbance.

In sum, although a number of potential routes of indirect effects exist, there is little to suggest that shrimp trawling indirectly affects sea turtles significantly, i.e., to a level where actual sea turtle 'take', in the ESA sense, occurs. If take has occurred indirectly, it has not been detected, and we would expect that it would, in fact, be difficult to detect. More importantly, there is considerable data on the extensive direct effects of shrimp trawling on sea turtles (see below), and the remainder of this *Effects of the Action* section will focus on those direct effects.

Direct Effects

Shrimp trawling directly affects sea turtles by capturing them in trawl nets. As turtles rest, forage, or swim on or near the bottom, shrimp trawls, pulled across the bottom at 1.5-3 knots can sweep over them. Shrimp otter trawls have an overhanging headrope to prevent shrimp from jumping over the mouth of the net when they are hit by the tickler chain or footrope. This overhang also probably prevents turtles from escaping shrimp trawls by heading for the surface. Video footage (NMFS Pascagoula Laboratory 2002) of wild loggerhead sea turtles encountering a TED in a trawl reveals that the turtles are usually oriented forward, apparently trying to outswim the advancing trawl. Because of the trawl's greater speed or the turtles' eventually tiring, however, the turtles gradually fall back toward the rear of the net where they encounter a TED or, if TEDs are not installed, into the cod end of the net where they are caught. Before the required use of TEDs, Henwood and Stuntz (1987) estimated that approximately 47,000 sea turtles were captured annually in the South Atlantic and Gulf of Mexico shrimp fisheries.

Sea turtles are air-breathing reptiles, and, although they are able to conduct lengthy voluntary dives, if they are captured in a shrimp trawl and unable to surface, they will eventually die. Henwood and Stuntz (1987) published a linear equation showing a strong positive relation between shrimp trawl tow time and incidence of sea turtle death, among the turtles observed captured aboard commercial shrimp trawlers. The National Research Council (NRC) (Magnuson et al. 1990) examined Henwood and Stuntz's data set and reported, "Death rates are near zero until tow times exceed 60 minutes; then they rise rapidly with increasing tow times to around 50% for tow times in excess of 200 minutes. Death rates never reach 100%, because some turtles might be caught within 40-60 minutes of lifting the net from the water." On the basis of this finding by the NRC, the sea turtle conservation regulations specify that, for those limited circumstances where shrimpers may comply with tow time limits instead of using TEDs, tow times be limited to 55 minutes from April through October and to 75 minutes from November through March (50 CFR 223.206(d)((3)). The regulatory tow time limits include a 15 minute allowance for setting and retrieving gear, since the NRC analysis of tow times looked at bottom time only. Of the turtles that do not succumb to forced submergence, some are "comatose" – unconscious, generally unresponsive, and with a drastically suppressed heart and respiration rate – indicative of at least a physiological injury. The sea turtle conservation regulations require fishermen to attempt to resuscitate comatose sea turtles (50 CFR 223.206(d)(1)(B)) before returning them to the water. If comatose turtles are returned to the water without resuscitation, they will likely die (Kemmerer 1989).

Henwood and Stuntz (1987) estimated the overall percentage of sea turtles that might be expected to die in commercial shrimp trawls, based on the average tow times determined in their study. For the Gulf of Mexico, their mortality estimate is 29%. For the Atlantic, their mortality estimate is 21%, reflecting the shorter average tow times in the Atlantic. The NRC (Magnuson et al. 1990) characterized these rates as underestimates, as Henwood and Stuntz assumed that all comatose turtles survived. The NRC suggested that the estimates could be low by as much as a factor of 3. Epperly et al. (2002) further analyzed the data set used by Henwood and Stuntz, following the NRC recommendations to consider all comatose turtles as dead and to analyze separately winter vs. summer mortality. They developed a logistic regression model for the tow time-mortality response (as opposed to the linear model used by Henwood and Stuntz), and applied it to updated data sets of average tow times in the commercial shrimp fleet (c.f., 1997-2002 observer data in Epperly et al. vs. 1973-1984 observer data in Henwood and Stuntz), and subdivided the observer data by 3 depth strata and 5 subregions (2 subregions in the Gulf of Mexico and 3 subregions in the Atlantic). The analysis of Epperly et al. (2002) confirms the findings of Henwood and Stuntz (1987) and Magnuson et al. (1990):

> Specifically, tows of short duration have little effect on mortality, intermediate tow times result in a rapid escalation to mortality, and eventually reach a plateau of high mortality. Mortality will be high on long tows, but will not equal 100%, as a turtle caught within the last hour of a long tow would likely survive.

Neither Henwood and Stuntz nor Epperly et al. attempted to estimate differing mortality rates based on the captured species, and the vast majority of animals in their data set were loggerheads. We believe it is probable that the 5 different sea turtle species have different physiological responses to lengthy forced submergence due to differing average body sizes and corresponding oxygen capacities. In the absence of species-specific estimates, however, these all-species mortality rates represent the best available scientific information which we will apply to each individual species in our analysis, later in this document.

In trawls equipped with sufficiently large and properly-functioning TEDs, sea turtles are able to escape quickly and avoid forced submergence. Video footage of the small, captive reared turtles used in TED testing and of wild loggerheads, documents similar behavior of the turtles to escape (NMFS Pascagoula Laboratory 2002). Generally, turtles are oriented forward when their backward progress toward the cod end is stopped by the TED grid. After briefly exploring the area around the TED (usually searching upwards), the turtles will find the escape opening and turn to exit the hole head-first.

Many factors of TED construction and installation affect the TED's efficiency (whether and how fast it excludes turtles). One useful metric of the overall efficiency is the time it requires turtles to escape. The control TED used during TED testing trials (a top-opening, bent-bar TED, with a Gulf-legal escape opening) had mean escape times for the captive-reared turtles ranging from 83 to 118 seconds in trials from 1997 to 2000. By comparison, the wild loggerheads encountering trawls equipped with the 71" opening TED or the double-cover TED (the TEDs required in offshore waters in the proposed action), had mean escape times of 31 seconds. Most turtles actually had a much quicker escape: the average is biased high by a couple of slower escapes; the median escape time was 19 seconds. Wild loggerheads encountering the 44" opening TED (the TED required for inshore use in the proposed action) had a slightly longer mean escape time of 46 seconds (30 seconds median escape time) (NMFS Pascagoula Laboratory 2002 and 2002a). Although the captive-reared and wild results are not directly comparable (the captive-reared escape times were measured from entering the trawl while the wild turtle escape times were measured from contact with the TED grid), we believe that these results suggest that sea turtles can escape from TEDs relatively quickly (very quickly with the larger-opening TEDs of the proposed action). Thus, escaping through large and properly-functioning TEDs represents a very brief period of forced submergence that probably has very little physiological effect on sea turtles.

For TEDs that have small openings or are otherwise not properly functioning, the length of time to escape will be adversely affected and even the ability to escape at all may be compromised. Additional underwater video collected by the NMFS Pascagoula Laboratory (2002a) revealed that about 1 in 3 loggerhead turtles encountered on one trip were unable to escape through TEDs with the currently legal escape opening size used in the Gulf of Mexico. In addition, the turtles that did escape took a relatively long time to do so – 156 seconds mean escape time, 101 seconds median escape time – suggesting a much greater effort required to escape and a greater risk of physiological injury than the turtles that encountered the larger TED openings, which escaped in about three-tenths to one-fifth the time. Interestingly, the captured turtles – observed on video to be unable to escape while the net was under tow – came out of the bottom-opening escape holes or out of the mouth of the net when the trawler stopped and hauled-back the nets. This observation suggests that turtles that are currently unable to escape from bottom-opening TEDs will not even be brought on deck and receive any needed resuscitation. The purpose of the proposed revision to the TED regulations, however, is to eliminate turtle capture associated with ineffective or small-opening TEDs and NOAA Fisheries believes that turtle escape will be rapid from TEDs required under the proposed action.

Previous biological opinions on the shrimp fishery have discussed the possible role of repeated captures of individual turtles in trawls. The 1994 biological opinion, in particular, found that repeated captures may have been a secondary contributor to the high strandings observed in the Gulf of Mexico that year, stating that "the simultaneous occurrence of intensive pulse fishing and abundant sea turtles may have led to the repeated submergence of individual turtles in short time periods, which could have contributed to the high levels of strandings." NOAA Fisheries subsequently sponsored research on forced submergence effects (e.g., Stabenau and Vietti 1999) and focused TED testing and regulatory improvement (e.g., 61 FR 66933, December 19, 1996) on improving the efficiency of TEDs, particularly for releasing small Kemp's ridley turtles, then the species of primary conservation concern.

Sea turtles that are forcibly submerged in trawls undergo respiratory and metabolic stress that can lead to severe disturbance of acid-base balance. Most voluntary dives by sea turtles appear to be aerobic, showing little if any increases in blood lactate and only minor changes in acid-base status (pH level of the blood). Sea turtles that are stressed as a result of being forcibly submerged rapidly consume oxygen stores. This triggers an activation of anaerobic glycolysis and subsequently disturbs the acid-base balance. It is likely that the rapidity and extent of the physiological changes that occur during forced submergence are functions of the intensity of struggling as well as the length of submergence (Lutcavage and Lutz 1997). These physiological mechanisms explain the link between tow-time length and mortality and injury (comatose condition). Sea turtles forcibly submerged for extended periods of time show marked, even severe, metabolic acidosis as a result of high blood lactate levels. With such increased lactate levels, lactate recovery times are long (even as much as 20 hours). This indicates that turtles are probably more susceptible to lethal metabolic acidosis if they experience multiple captures, because they would not have had time to process lactic acid loads (Lutcavage and Lutz 1997).

Despite this understanding of the mechanisms whereby repeated captures in a short period of time could contribute to sea turtle mortality, we have little to no data to assess the extent to which multiple captures are occurring and whether they are, in fact, having adverse effects on turtles. The most compelling information that such a link exists is the continued correlation of shrimp fishing effort with sea turtle strandings. In response, NOAA Fisheries has worked with the states (particularly Georgia and South Carolina) to reduce pulse fishing associated with shrimp season openings. Additionally, NOAA Fisheries published a temporary, emergency rule that closed nighttime shrimping from approximately Saint Augustine, Florida to Cape Fear, North Carolina, in an effort to control high shrimping effort that was associated with dramatically elevated sea turtle strandings (67 FR 37723, May 30, 2002). With highly efficient TEDs like the 71" TED and double-cover TED of the proposed action and TED escape times of around 30 seconds, it is difficult to assign significant physiological risk to repeated captures. A significant unknown is a turtle's energy expenditure that might be associated with trying to outrun a trawl, before even encountering the TED. In summary, the threat posed to sea turtles from repeated capture in shrimp trawls appears to be real, especially when inefficient TEDs are used, but no data exist to quantify the extent of the effect. We believe that the regulation revision in the proposed action will significantly reduce the threat from short-term repeated capture, as only the most highly efficient TEDs would be authorized in the shrimp fishery.

The NRC (Magnuson et al. 1990) reviewed numerous studies and data and determined that there was strong evidence that shrimp trawling is the primary agent for sea turtle mortality in the southeast United States. They estimated that 86% of the human caused mortalities on juvenile and adult sea turtles was caused by shrimp trawling. However, since 1990 the use of TEDs has relieved some of the pressure on sea turtle populations due to shrimp fishing. The use of TEDs has contributed to population increases documented for Kemp's ridley turtles. Kemp's ridleys are the smallest sea turtle species, and adults can easily pass through the current TED opening dimensions. Once the most critically endangered sea turtle, their nesting levels have increased from 700-800 per year in the mid-1980's to over 6,000 nests in 2000. Since 1990, corresponding with the more widespread use of TEDs in U.S. waters, the total annual mortality as determined by strandings has been reduced by 44%-50% (TEWG 2000). We believe that this demonstrates that the use of TEDs can have a significant beneficial impact on the survival and recovery of sea turtle species.

Despite the demonstrated success of TEDs for some species of sea turtles, recent information demonstrates that TEDs are not adequately protecting all species and size classes of turtles. A report by Epperly and Teas (2002) indicates that 33%-47% of stranded loggerheads and 1%-7% of stranded green turtles are too large to fit through the current TED openings. This is a much greater percentage than this size group represents in the population at large, at least in the Atlantic. For loggerheads particularly, the continued disproportionate loss of the largest, most mature size classes will seriously hamper recovery efforts. Comprehensive scientific data on the body depths of these turtles were not available when the original TED sizes were specified. The original TED sizes were also much too small to allow leatherback sea turtles – the largest species – to escape. Instead, NOAA Fisheries has attempted to address the incidental catch of leatherbacks through a regime of reactive closures that has proven complicated and ineffective. There is also concern about the status of these populations. The northern nesting population of loggerheads appears to be stable or declining (TEWG 2000), and nesting of leatherbacks is declining on several main nesting beaches in the western North Atlantic (NMFS SEFSC 2001).

B. Extent of the Effects of the Action

In this section, we address the question of how many sea turtles are affected by the proposed action. We will estimate the number of turtles currently affected by shrimping under the sea turtle conservation regulations and how that status quo will be changed by implementing the revised sea turtle conservation regulations (the proposed action).

Estimation Methods for Sea Turtle Interactions, Captures, and Mortality

Estimating the annual number of sea turtle interactions with shrimp trawls is, at its simplest, a question of multiplying the catch of sea turtles per unit fishing effort (CPUE), as measured by observers, by the annual fishing effort. Unfortunately, sampling gaps in the CPUE data sets and incompatibilities between reporting of turtle CPUE and shrimp fishery effort complicate the estimation process greatly. We therefore applied a number of analyses to different data sets, in an attempt to understand the scope of the question more fully and to identify the best available estimation method for each species. We also investigated a strandings-based estimation approach for two species – hawksbill and leatherbacks. Table 1 indicates which techniques were used to make an estimation of interactions between the shrimp fishery and the five species of sea turtles found in the southeast United States. The bold X's indicate the estimation methods we ultimately determined to be the best available for purposes of this Opinion's analysis. We will discuss each of the data sets and their associated analytical approaches in more detail below.

Table 1. Bycatch estimation methods applied to shrimp-sea turtle interaction data for this Opinion.

		Leatherback	Loggerhead	Kemp's Ridley	Green	Hawksbill
CPUE from Foundation 97-98	Gulf	x	x	x	x	
	Atlantic	x	x	x	x	
CPUE from SCDNR 2000	Atlantic		x	x	x	
CPUE from SCDNR 2001	Atlantic		x	x	x	
CPUE recalculated from Foundation 97-98 and adjusted for aerial surveys	Gulf	**X**	**X**	x	x	
	Atlantic	**X**	**X**	x	x	
CPUE recalculated from Foundation 97-98, without aerial survey adjustment	Gulf			**X**	**X**	
	Atlantic			**X**	**X**	
CPUE from Henwood & Stuntz (1978-1984)	Southeast	x				
Strandings Expansion	Southeast	x				**X**

Data Sets Available for Analysis

We considered numerous available data sets for turtle CPUE to apply to the estimates. A number of them were not carried forward to produce estimates: van Dolah and Maier's (1993) work on the distribution of loggerhead turtles in the entrance channel of Charleston Harbor, South Carolina; Dickerson et al.'s (1995) characterization of sea turtle catch rates inside 6 Atlantic navigation channels; turtle catch data contained in the shrimp trawl survey research work of the Texas Parks and Wildlife Department and the Louisiana Department of Wildlife and Fisheries; turtle catch data from the Southeast Area Monitoring and Assessment Program (SEAMAP) in the Atlantic; and the work of Renaud et al. (1997) on incidental capture of sea turtles in TED-equipped shrimp trawls. These were eventually eliminated for further use as possible CPUE figures because they were the least representative of actual shrimp trawl fishing. For example, the van Dolah and Maier and Dickerson et al. work was confined to navigation channels at a few sites in the Atlantic only. The SEAMAP, Texas, and Louisiana data are fishery research projects using established research stations, short tow times, and research trawl gear, not necessarily representative of commercial fishing effort. Renaud et al. (1997) CPUEs were not used because it was felt that they would be less conservative (provide for a less cautious analysis), as much of the observer work used was conducted with TEDs, reducing the CPUE. We ultimately used 3 data sets as the basis for sea turtle interaction estimations, at least for some species and areas:

- Henwood and Stuntz (1986, 1987) data set based on commercial shrimp trawler observations in the Gulf and Atlantic, 1973-1984
- Gulf and South Atlantic Fisheries Foundation ("Foundation") (Foundation 1998, Jamir 1999) data set based on commercial shrimp trawler observations, vessels not using TEDs, 1997-1998
- South Carolina Department of Natural Resources (SCDNR) sea turtle abundance data sets, based on research trawl sea turtle captures in the Atlantic only, 2000 and 2001, separately (Whitaker et al., unpublished data)

Of these data sets, the Foundation data is, on balance, the most representative of the current shrimp trawl fishery. It is significantly fresher than the Henwood and Stuntz data set. The SCDNR data sets are from the Atlantic only, and use data collected at pre-established research stations with non-shrimp trawl gear. The Foundation data set, on the other hand, represents fishery-dependent sampling (i.e., the shrimp captains selected the trawling sites, based on shrimp catches) and comes from the Gulf and the Atlantic. We kept the Henwood and Stuntz data set only for estimating leatherback interactions, as it had a larger leatherback sample size than the Foundation data set. We used the SCDNR data sets to produce turtle catch estimates in the Atlantic, for comparative purposes only, as they are fairly robust in terms of turtle sample size, even though they do not represent effort in the commercial shrimp fishery. The Foundation data set was used to estimate interactions for leatherbacks, loggerheads, Kemp's ridleys, and greens. None of these data sets included captures of hawksbills, and therefore could not be used for estimating hawksbill interactions.

The Foundation data set, while the best available to characterize shrimp trawl-turtle interactions, has several shortcomings. Most importantly, it samples a wide geographic portion of the fishery, including the areas of most intense effort, but does not include sampling from the entire range of the fishery. Notable sampling gaps in the Foundation data set are the eastern Gulf of Mexico, the northern subregion of the Atlantic (north of zone 33), and inshore waters in both the Gulf and Atlantic. The Foundation data set also includes a heavy bias in effort in the offshore Gulf of Mexico, which must be accounted for. Foundation (1998), Jamir (1999), and Epperly et al. (2002) contain more thorough discussions of the data set and possible sources of error.

Analytical Approaches Applied to the Estimation

Since Henwood and Stuntz (1987) and Magnuson et al. (1990), there have been only two efforts to estimate total sea turtle catch in the southeast shrimp fishery. Appendix I to this Opinion contains estimates for the Gulf and Atlantic, based on the CPUEs from Jamir (1999) and the SCDNR data sets. Epperly et al. (2002) produced estimates for the Gulf and Atlantic, based on a reanalysis of the Foundation data set. We here review and contrast the analytical approaches used in these two catch estimation efforts.

1. CPUE and Effort Standardized to 100' Headrope Hours

The CPUEs in Henwood and Stuntz (1986, 1987), Foundation (1998), and Jamir (1999) are all expressed in terms of turtles captured per hour of trawling, with a standardization of the observed shrimping effort to 100 feet of headrope. Thus, for example, 1 turtle captured in 1 hour of trawling aboard a shrimper pulling nets totalling 200 feet of headrope would produce an adjusted CPUE of 0.5 (1 turtle/ 1 hour x 100 feet/ 200 feet). (N.B., Jamir [1999] reported and corrected an error in the CPUE calculation in Foundation [1999]; only the CPUEs from Jamir [1999] are used in this Opinion.) The SCDNR data also lent itself readily to expression as catch per 100 foot headrope hour. This CPUE adjustment accounts for, and assumes a linear relationship in, increasing turtle catch with increasing amounts of net pulled by a trawler. Unfortunately, shrimp effort data is not collected by NMFS or the states in a similar format, and effort reporting is very different between the Gulf and Atlantic (see Epperly et al. [2002] for a more detailed review of shrimp effort reporting).

To use the CPUEs from the Foundation data set, as reported, or the SCDNR data sets, it is necessary to apply a series of multipliers to the effort data to convert it to standardized 100 foot headrope trawl hours. Appendix I to this Opinion contains details of these conversions, which yielded effort estimates of approximately 5 million hours in the Gulf (subdivided at 15 fathoms depth) and 860,000 hours in the Atlantic (no subdivision). These conversions will introduce bias into the estimation, depending on the accuracy of the conversion factors for hours fished per day and average size and number of nets per vessel. Once the effort is converted, simply multiplying the effort by the reported CPUEs produces a catch estimate.

This approach was applied to the SCDNR data sets in the Atlantic and the Foundation data set in the Gulf and Atlantic, as reported in Jamir (1999) but with CPUE in the Gulf pooled for the depth strata less than 15 fathoms. (Jamir originally reported CPUE in the Gulf in 0-5, 5-10, and 10-15 fathom increments, but sampling in each of the units separately was relatively light.) Because the original data sets were not available for these estimations and CPUE confidence intervals were not provided in the depth strata used for the analysis, the final catch estimates from this approach are single point estimates without confidence intervals.

2. *CPUE Recalculated to Match Effort Data*

Epperly et al. (2002) took the opposite approach to reconciling the units for effort and CPUE: instead of applying conversion factors to the effort data, they obtained and analyzed the original Foundation data sets and reexpressed the CPUE into units that would match the effort data (hours trawled in the Gulf and fishing days in the Atlantic). This approach avoids entirely the risk of introducing bias by converting effort data. At the same time, it does not try to account for varying fishing power across fishing vessels, instead assuming that the sampled effort in the Foundation data set is representative of overall effort.

3. *CPUE and Effort Subdivided by Season, Depth Strata, and Geographic Sub-region*

The estimates in Appendix I do not include any subdivisions by season or geographic sub-region, and depth in the Gulf is divided into two strata: less than and greater than 15 fathoms. Epperly et al. (2002) were able to recalculate CPUE from the Foundation data set into smaller subdivisions. Season was divided into winter (December-February) and summer (March-November). The Atlantic region was divided into south (south of 30° N.), north (north of 34° N.), and central subregions, with inshore and ocean depth strata. The Gulf of Mexico was divided into eastern and western sub-regions at the Mississippi River, with inshore and nearshore Gulf (0-10 fathoms) and offshore Gulf (10+ fathoms). The advantage of such subdivisions is an increase in the accuracy of the estimate, but with an increased risk of sampling bias affecting the smaller data cells.

4. CPUE from Sampled Strata Applied to Unsampled Strata

While the Foundation data set is the best, most recent data set available on turtle catch in commercial shrimp trawls, it does not include sampling in all possible depth strata and locations. For the catch estimates in Appendix I, the CPUEs from Jamir (1999) and the SCDNR data sets were applied to the shrimp effort for the Atlantic and nearshore and offshore Gulf. This approach essentially ignores the problem of incomplete sampling. Implicitly, however, it depends on the assumption that CPUEs from the sampled areas will be representative of the unsampled areas. In Epperly et al.'s approach, with the CPUE data broken into multiple subdivisions, the problem cannot be ignored, and they make explicit assignments of CPUE to unsampled strata from the most similar, sampled strata. For example, with no sampling in inshore waters, CPUEs in inshore strata were assigned from nearshore waters in the same sub-region and season. This approach, then, depends on the same assumption of similar CPUEs in the unsampled areas, but applies it explicitly and with more precision to individual strata.

5. CPUE from Unsampled Strata Adjusted using Aerial Survey Data

Epperly et al. (2002) applied an additional, novel technique to attempt to overcome the problem of unsampled strata in the Foundation data set. Aerial survey data from surveys in the Gulf in 1992, 1993, 1994, and 1996 and in the Atlantic in 2002 was reviewed for sea turtle sightings. In many cases, the aerial survey data could be used to characterize the relative abundance of a species of sea turtle between a stratum with CPUE data and a stratum without. The CPUE in the unsampled stratum can then be set based on the sampled stratum, multiplied by the relative abundance derived from aerial survey data for the strata. For example, the Atlantic north sub-region did not have a CPUE estimate for loggerhead turtles from the Foundation data, and aerial survey density of loggerheads in the north sub-region was approximately half the aerial survey density of loggerheads in the central sub-region, so loggerhead CPUE for the northern sub-region was set at approximately half of the CPUE from the central sub-region.

Adjusting CPUE based on relative abundance appears to be a valuable way to increase the accuracy of the bycatch estimates and is based on the reasonable assumption that turtle catch rates will vary directly with abundance. For the larger sea turtle species – loggerheads and leatherbacks – aerial surveys likely have a strong ability to detect and correctly identify animals. For the smaller species, however – Kemp's ridleys and greens – aerial surveys may not be uniformly effective. Epperly et al. (2002) particularly noted that the aerial surveys they used for the Atlantic did not detect any greens or Kemp's ridleys, even though they occur there and are frequently caught in shrimp trawls. These species' small size and cryptic coloration (compared to loggerheads, which stand out in aerial surveys) may also interact with regional differences in water color and clarity. Examination of the distribution of green and Kemp's ridley sightings in the Gulf of Mexico, presented in Epperly et al. (2002) shows a complete absence of sightings in the northern Gulf, from the Florida Panhandle to eastern Texas, despite the species' occurrence there, perhaps influenced by sighting conditions there. A similar examination of loggerhead and leatherback sightings shows them distributed across the northern Gulf, suggesting that the same regional sighting problem does not affect the larger, more visible species. Epperly et al. (2002) cautioned that application of the aerial survey adjustment to estimate shrimp trawl interactions and mortality of Kemp's ridley and green sea turtles may be rendered "especially inaccurate." We therefore calculated estimated shrimp trawl interactions and mortality for these species using the unadjusted CPUEs reported by Epperly et al., in addition to their reported, adjusted estimates.

6. *Capture in Trawls Equipped with TEDs*

TEDs approved for use by NOAA Fisheries have had to demonstrate a 97% effectiveness in controlled testing. For the past decade, most TED testing has been conducted with small, captive-reared turtles, which was particularly appropriate given the high concern over the status of Kemp's ridley turtles. Kemp's ridley nesting increases over that time demonstrate the strong effect TED use has had on reducing Kemp's ridley mortality. Despite the demonstrated success of TEDs for some species of sea turtles, recent information demonstrates that TEDs are not adequately protecting all species and size classes of turtles. A report by Epperly and Teas (2002) indicates that 33%-47% of stranded loggerheads and 1%-7% of stranded green turtles, annually, are too large to fit through the current TED openings. The strandings information, however, would be expected to be influenced by many factors, most importantly the bias that a selective mortality on larger turtles would produce. Using data from the Foundation study, NMFS SEFSC estimated that 2.5% of the loggerheads that interact with a shrimp trawl will be too large to fit through the current minimum Atlantic area TED opening (35 inches wide by 12 inches high) and up to 75% are too large to fit through the current minimum Gulf area TED opening (32 inches wide by 10 inches high) (NMFS unpublished data). None of the green or Kemp's ridley turtles captured in the Foundation study were too large to escape from TEDs. All leatherback turtles likely to be encountered on the shrimping grounds are too large to escape from TEDs with current regulatory minimum opening size.

In producing estimates of how many turtles, of those that enter the trawl and encounter the TED, are actually captured, we assume that 3% of the turtles – those physically small enough to escape – will fail to escape, based on the 97% effectiveness standard. Of the turtles that are physically too large to escape from the current minimum size TEDs – 100% of leatherbacks, 75% of loggerheads in the Gulf, and 2.5% of loggerheads in the Atlantic – all will be captured. These same capture factors were applied in the estimates from Appendix I and Epperly et al. (2002), with the exception that Epperly et al. also considered the effect of a South Carolina state law increasing the minimum escape openings in state waters, reducing the percentage of too-large loggerheads in the Atlantic overall to 2.3%. As a result of the proposed action, all TEDs will be large enough to exclude all sizes of turtles encountered, thus only the 3% capture rate would apply. Based on trawling done with video-equipped trawls in 2002 (NMFS Pascagoula Laboratory 2002, 2002a), 100% of the wild loggerheads encountering larger-opening TEDs that would be required under the proposed action escaped very quickly. To be conservative, however, we will apply the 3% capture figure, until additional testing shows, with greater statistical certainty, a higher TED effectiveness for the larger-opening TEDs.

7. *Mortality Factors for Captured Turtles*

As discussed previously, Henwood and Stuntz (1987) estimated sea turtle mortality resulting from capture in shrimp trawls at 29% in the Gulf and 21 % in the Atlantic, reflecting the shorter average tow times in the Atlantic. The NRC (Magnuson et al. 1990) suggested that the estimates could be low by as much as a factor of 3, implying an actual mortality rate of 63% (Atlantic) to 87% (Gulf). The NRC did not intend for their estimated factor of 3 difference to be applied this way as hard number, but rather as an estimate used to demonstrate the magnitude of the disparity between Henwood and Stuntz's numbers and what they believed was actually happening. In carrying forward our analyses and converting estimated interactions and captures to mortality, however, we applied these higher mortality rates for captured sea turtles that are unable to escape from shrimp trawls because they provide for a simple conversion and they are more conservative than the original estimates of Henwood and Stuntz. These mortality rates (63% and 87%) are applied to the capture estimates resulting from the Appendix I interaction and capture estimates.

Epperly et al.'s reanalysis of the Henwood and Stuntz data produced seasonally and sub-regionally subdivided mortality estimates based on updated fishery information. The Epperly et al. mortality estimation approach is superior to the more simplistic approach we applied to the Appendix I estimates, as it follows the NRC recommendation of considering comatose animals as unlikely to survive and to separate warm-water and cold-water seasons. It also uses more up-to-date average tow-time information for the fishery, and the sub-regional and multiple depth stratification should increase accuracy. Because of the sub-divisions used, their estimates could not be applied to the other bycatch estimation approaches considered. The simplistic mortality factor approach has similar, but less conservative estimates. The Epperly et al. mortality factors are reproduced here:

Table 2. Mortality factors from Epperly et al. (2002)

Area/Subregion	Depth Stratum	Season	
		Summer	Winter
Gulf of Mexico			
Eastern	Inshore	0.8899	0.9842
	Nearshore	0.8899	0.9842
	Offshore	0.9351	0.9885
Western	Inshore	0.9146	0.9826
	Nearshore	0.9146	0.9826
	Offshore	0.9588	0.9978
Atlantic			
North	Inshore	0.7303	0.8537
	Ocean	0.7303	0.8537
Central	Inshore	0.7303	0.8537
	Ocean	0.7303	0.8537
South	Inshore	0.4055	0.993
	Ocean	0.4055	0.993

8. Strandings Expansion

For hawksbill turtles, none of the CPUE data sets consulted included any captures of hawksbills, which may be the least abundant species of sea turtle and which certainly have the most limited distribution in the southeast U.S. Where hawksbills co-occur with the shrimp fishery (primarily in southwest Florida and south Texas), though, there is certainly the possibility of capture in trawls (e.g., see Epperly et al., 1995a with respect to observed hawksbill capture in trawls). Therefore, we applied an expansion to hawksibll stranding data to develop an estimate of hawksbill mortality and interaction with shrimp trawls. For leatherbacks, the calculated CPUEs were based on a very small sample of leatherbacks, in both the Foundation and Henwood and Stuntz data sets. Thus, we also applied the expansion to leatherback strandings data to investigate whether the strandings method would produce a more conservative estimate for that species.

Hawksbill stranding records from 1999-2001 show an average of 32 hawksbill turtles stranded per year in areas where shrimp trawling takes place. Considering that strandings make up 5-6% of the total at-sea mortality, it is estimated that the total at-sea mortality for hawksbill turtles in shrimp trawling areas in the Southeast United States is between 533-640 (32/6% and 32/5%) per year. We believe that all size classes of hawksbills are able to fit through current TED openings; assuming TEDs are 97% effective (meaning 3% will not escape), the estimated total hawksbill/trawl interactions is between 17,767-21,333 (533/3% and 640/3%) per year. However with numbers of this magnitude, it would be expected that hawksbill turtles would have been recorded during the GSAFF study or recorded much more often during NOAA Fisheries observed shrimping trips. We therefore consider this estimate of interactions not to be credible. The majority of these strandings occurred in Texas, and other than one adult, they were all small juveniles (about 30 cm) just coming out of the pelagic stage. Of those strandings, entangled individuals comprised a large proportion of the total, particularly offshore. From 1997-2001, 18 of 67 (26.9%) offshore stranded hawksbills were noted as entangled, with 14 of the 18 entangled in "onion sack"-type nylon bags, which are used offshore by Texas shrimp fishermen and the oil and gas industry (STSSN database). Therefore, trawl mortality for hawksbill turtles in the southeast U.S. is likely overestimated by this method. However, some unknown portion of the at-sea mortalities would be due to actions of the shrimp fishery. Therefore, the estimated at-sea mortality would represent a maximum estimate of annual hawksbill mortality due to actions of the shrimp fishery.

Leatherback stranding data from 1999-2001 indicate that an average of 63 leatherback turtles strand per year in the Southeast U.S. The TEWG (1998) report indicates strandings only account for between 5% and 6% of the total at-sea mortality (these are the most conservative of several estimates they cite) which would mean the total at-sea mortality is approximately between 1,050 to 1,260 (63/6% and 63/5%) leatherbacks per year. All of these mortalities are not expected to be a result of the shrimp fishery; however, the NRC (Magnuson et al. 1990) indicated that 86% of the human caused mortalities on juvenile and adult sea turtles were caused by shrimp trawling (this was prior to the implementation of TEDs; however, the current minimum standard TEDs do not release leatherbacks so their use is not a factor). These numbers for at-sea mortality do not take into account natural mortality which is difficult to determine in most cases. Using a conservative approach and assuming most of the at-sea mortalities are human related, approximately 903 to 1,084 (1,050/86% and 1,260/86%) leatherback turtles are killed per year as a result of turtle/trawl interactions based on strandings data. Assuming that these mortality rates are 63% of the total leatherback/trawl interactions, the total interactions between shrimp trawls and leatherbacks based on stranding data are approximately 1,433 to 1,720 (903/63% and 1,084/63%) per year. Use of stranding data may underestimate total leatherback mortality in the Southeast U.S. There is very little stranding information for Louisiana due to the lack of sea turtle stranding and salvage network (STSSN) coverage in that state; this is important because Louisiana makes up a major portion of the shrimping effort in the Gulf area.

Results of the Estimation Methods

Applying the various methods to our available data sets produces a range of estimates of the number of interactions between sea turtles and shrimp trawls. It is important to distinguish between interactions, captures, and mortality. Interactions are the total number of instances where turtles enter a shrimp trawl, which may result in the turtle escaping through the TED or failing to escape and being captured. (Assumed capture rates were discussed in *Analytical Approaches #6* above.) Of the turtles that are captured, a certain proportion will die as a result. (Mortality factors applied to captured turtles were discussed in *Analytical Approaches #7* above.) For the majority of turtles that escape through TEDs or survive capture, they are then available for possible recapture in the fishery. Thus, the estimate of interactions does not represent a total number of unique turtles encountering shrimp trawls once, but could include individual turtles interacting with trawls and TEDs multiple times within a fishing season. Epperly et al. (2002) reviewed existing data and estimated that at least 20% of individual turtles will experience recapture, but cautioned that their estimate is likely biased quite low because of the likely limited reporting of recaptures in the data sources they reviewed. Thus, the number of turtles recaptured is likely even higher and the number of individual turtles that interact with trawls would be correspondingly lower. Table 3 summarizes the estimated annual number of shrimp-turtle interactions from the various estimation techniques. These estimates of annual interactions apply both to the proposed action and the status quo situation, since the proposed action is not expected to affect shrimping effort or distribution. Table 4 summarizes the estimated annual number of *lethal* interactions under the proposed action, i.e. after implementation of larger opening TEDs. For those methods that produced confidence intervals (CI), the upper and lower 95% confidence estimates are shown on the row below the point estimate, in both tables.

Table 3. Estimated number of interactions between shrimp trawls and each sea turtle species, annually, for each of the methods listed in Table 1, with 95% confidence intervals (CI) where available. Values in bold are those determined to be the best available estimate for use in this Opinion.

Data Set and Analysis	Region	Leatherback	Loggerhead	Kemp's Ridley	Green	Hawksbill
CPUE from Foundation 97-98	Gulf		28,193	82,930	5,722	
	Atlantic		248,577	82,859	6,184	
	Total	1,236	276,770	165,789	11,906	
CPUE from SCDNR 2000	Atlantic		392,833	30,042	4,620	
CPUE from SCDNR 2001	Atlantic		416,053	23,504	7,055	
CPUE recalculated from Foundation 97-98 and adjusted for aerial surveys	Gulf	**2,270**	**88,856**	729,456	46,766	
	95% CI	0 8,821	7,876 236,681	54,145 3,331,787	0 296,749	
	Atlantic	**820**	**74,304**	17,748	1,473	
	95% CI	0 2,452	48,263 100,342	7,851 31,079	204 3,598	
	Total	3,090	163,160	747,204	48,239	
	95% CI	0 7,381	54,856 318,257	56,925 3,362,867	204 300,355	
CPUE recalculated from Foundation 97-98, without aerial survey adjustment	Gulf			**141,044**	**17,283**	
	95% CI			68392 228,539	0 77,572	
	Atlantic			**14,459**	**1,474**	
	95% CI			7,851 31,079	204 3,598	
	Total			155,503	18,757	
	95% CI			76,243 259,618	204 81,170	
CPUE from Henwood & Stuntz (1978-1984)	Southeast	650				
Strandings Expansion **	Southeast	1,433 1,720				17,767*** 21,333***

* Values reproduced here from Epperly et al. (2002) may not sum exactly to the values reported there, due to rounding error introduced in summarizing their data to Gulf and Atlantic regions.
** Values represent range of estimate, without confidence interval
*** Not considered credible, based on large estimate, with no corresponding verification of shrimp trawl capture of hawksbills

Table 4. Estimated number of lethal interactions between shrimp trawls and each sea turtle species, annually under the proposed action, for each of the methods listed in Table 1, with 95% confidence intervals (CI) where available. Values in bold are those determined to be the best available mortality estimate for use in this Opinion.

Data Set and Analysis	Region	Leatherback	Loggerhead	Kemp's Ridley	Green	Hawksbill
CPUE from Foundation 97-98	Gulf		736	2,165	150	
	Atlantic		4,698	1,566	117	
	Total	23	5,434	3,731	267	
CPUE from SCDNR 2000	Atlantic		7,425	568	87	
CPUE from SCDNR 2001	Atlantic		7,863	444	133	
CPUE recalculated from Foundation 97-98 and adjusted for aerial surveys (Epperly et al. 2002) *	Gulf	**63**	**2,416**	19,648	1,312	
	95% CI	0 244	216 6,439	1,490 89,507	0 8,338	
	Atlantic	**17**	**1,532**	324	28	
	95% CI	0 52	1,004 2,059	142 567	3 70	
	Total	80	3,948	19,972	1,340	
	95% CI	0 194	1,190 8,405	1,633 90,074	3 8,407	
CPUE recalculated from Foundation 97-98, without aerial survey adjustment (derived from Epperly et al. 2002)	Gulf			**3,884**	**486**	
	95% CI			1,883 6,295	0 2,202	
	Atlantic			**324**	**28**	
	95% CI			142 566	3 69	
	Total			4,208	514	
	95% CI			2,025 6,861	3 2,271	
CPUE from Henwood & Stuntz (1978-1984)	Southeast	12				
Strandings Expansion **	Southeast	27 33				**533 640**

* Values reproduced here from Epperly et al. (2002) may not sum exactly to the values reported there, due to rounding error introduced in summarizing their data to Gulf and Atlantic regions.
** Values represent range of estimate, without confidence interval

Discussion of Bycatch Estimation Results

We earlier identified the estimation methods we have determined to be the best available approach for each species (indicated in bold in tables 1, 3, and 4), and summarized the strengths and weaknesses of the various analytical approaches and data sets. Inspection of the results confirms our determination. Generally, the methods selected yielded the most conservative results (i.e., highest estimate of mortality for each species in total). An exception to that is loggerheads, for which the estimates from the selected method are lower overall and in the Atlantic. The additional sub-zones used in the Epperly et al. estimations for loggerheads in the Atlantic removed potential bias in the Foundation data set resulting from high observed catch rates in the south sub-region (which has the least amount of shrimping effort) being applied to other sub-regions with lower CPUEs (central) or lower aerial survey densities (north). We believe that the method in Epperly et al. (2002) is superior to the other methods applied for loggerhead estimation and that the estimate is likely to be more accurate, so we departed in that case from selecting the most conservative outcome. We also determined not to use the aerial survey adjustment for Kemp's ridleys and green turtles because of problems with sightability and introduction of bias from the distribution of the sightings (i.e., neither species sighted in the Atlantic or northern Gulf). The estimates produced for those species using the aerial survey adjustment bear out that decision: specifically, an annual interaction estimate was produced for Kemp's ridleys in the Gulf of Mexico of 730,000 in spite of the fact that the population has only recently increased to a level where it produces about 6,000 nests per year. For green turtles, while we do not have as clear an idea of the western Atlantic population as for Kemp's ridleys, the same source of high bias affecting Kemp's ridleys would affect the green turtle interaction estimates more dramatically (i.e., high aerial survey densities of turtles in southwest Florida producing a very high adjusted CPUE that is multiplied by high levels of effort in the whole eastern Gulf, including Lousiana). Since Epperly et al. (2002) cautioned that estimates using the aerial survey adjustment may be especially inaccurate for greens and Kemp's ridleys, and the actual estimates do not appear credible, we instead used the data and analytical approach of Epperly et al. (2002), but without the aerial survey adjustment, for greens and Kemp's ridleys. The without-aerial-survey-adjustment estimates are still more conservative than those produced by any of the other methods considered.

Effect of the Proposed Action on Level of Sea Turtle Interaction and Mortality

The revised sea turtle conservation regulations that are part of the proposed action are not expected to reduce shrimping effort and will therefore not reduce sea turtle/trawl interactions for any species. The mortality numbers for turtle species whose size range allows the majority of individuals to escape current TEDs (Kemp's ridleys and hawksbills) are not expected to be reduced as a result of the proposed action. A small but unquantifiable number of green turtles that do not fit through current TEDs (1-7% based on Epperly Teas (2002)) will now be able to escape. However, the use of TEDs with larger opening sizes in all areas will allow these turtles to escape faster, reducing the physiological stress on these animals caused by multiple captures, thereby reducing mortality by an unknown amount. This is also true for that portion of loggerhead turtles that can escape current TEDs.

The proposed action will require the use of TEDs capable of releasing all size classes of loggerhead turtles in all areas of the southeast United States. It also requires the use of a TED capable of releasing leatherback turtles in areas where they are predominantly found, such as all offshore waters and the inshore waters of Georgia and South Carolina. Leatherbacks and loggerheads, therefore, will experience a significantly improved chance of escape as a result of the proposed action, which will translate into a greatly reduced level of loggerhead and leatherback mortality under the proposed action, compared to current regulations. Epperly et al. (2002) calculated that implementation of the proposed action would result in annual leatherback mortality from shrimp trawling declining from 2,311 under current regulations to 80 under the proposed action and annual loggerhead mortality declining from 62,294 to 3,947.

Effect of Capture in Shrimping Activities that Use Tow Time Restrictions in Lieu of TEDs

The proposed action also includes numerous activities that allow for the use of tow times in lieu of TEDs. These activities include exempted gear, the issuance of TED exemption letters for fishery research and to test new TED designs, and the issuance of TED exemptions for times and areas when the NOAA Assistant Administrator for Fisheries determines that environmental conditions (e.g., the presence of algae, seaweed, or debris) make TED use impracticable or that TEDs do not work in a particular area to protect sea turtles (see *Proposed Action* section for details). Fishermen's compliance with tow times in the past has been low, and NOAA Fisheries has tried to restrict the tow time authorizations as much as possible to circumstances where tow times will naturally have to be limited out of physical or practical necessity. For example, recreational shrimpers who retrieve their nets by hand must keep their tow times short so the tail bag does not become so full as to not be able to pull in the net manually. As another example, bait shrimpers are also expected to have short tow times because they are expected to pull their nets in more frequently in order to keep the shrimp alive for use as bait. When fishermen comply with tow time limits, they can be an effective means of minimizing sea turtle mortality.

Over time, NOAA Fisheries has limited the situations in which tow times were authorized in lieu of TEDs, usually after NOAA Fisheries learned of non-compliance with the tow time limits. Tow time authorizations in inshore waters and the "small-boat exemption" in offshore waters were eliminated in the early 1990's. Try nets, which have been exempt from TED use and tow time limits until now, were restricted in size in the 1996 TED amendments, based on turtle captures and long tow times. The TED amendments of the proposed action would further make the small try nets subject to tow time limits. The amendments in the proposed action would also include a further restriction on the bait shrimp TED exemption so it would apply only to states that prohibit bait shrimpers from participating in the food shrimp fishery. This restriction was the result of bait shrimpers with food shrimp licenses using their dual licensing to subvert the legitimate use of the tow time authorization.

The amount of fishing effort that occurs under the tow time authorizations is not well quantified, but we believe it to be minor compared to the major commercial food shrimp effort using otter trawls. Epperly et al. (2002) conducted a review of some of the TED-exempt activities and gear and characterized their use in the southeast U.S. and their potential for interacting with sea turtles. They reviewed bait shrimping, roller-frame trawls, beam trawls, skimmer nets, and butterfly nets. Another important TED-exempt category is the up to 8,000 recreational shrimpers, primarily in Louisiana and North Carolina, who retrieve their nets by hand (J. Mitchell, NOAA Fisheries Pascagoula Laboratory, pers. comm.). Pusher-head trawls, another TED exempt gear type, are seldom used. There may be four to six vessels in Mississippi using them (D. Burrage, Mississippi State Coastal Research and Extension Center, pers. comm.). Skimmer trawls are more widely used in inshore waters in the Gulf of Mexico and in North Carolina and are becoming even more popular. The tail bag of a skimmer trawl fishes near the stern and allows for frequent haul-back while the rest of the rig is still fishing. Frequent dumping of the tail bag ensures better quality shrimp, with hopefully a better price to the fisherman, and is an economic incentive for tow time compliance. Butterfly nets, like skimmer trawls, are capable of incidental sea turtle capture. However, because the gear is fished off the bottom, in deeper parts of channels, the chance of turtle interaction with this gear may be somewhat less than skimmer gear. Butterfly nets can also have their tail bags hauled while the net continues to fish. Try nets will be required to follow tow times as part of the proposed action. In the past there have been significant numbers of observed captures of sea turtles in try nets with very little associated mortality (although there has been some). Try nets are used for a short tow to "try" an area before deploying the main trawls. If used correctly, try nets are unlikely to add significantly to the overall mortality of sea turtles as part of the proposed action. Based on their manner of fishing and their relatively low effort, we do not believe the use of tow times in lieu of TEDs in the above referenced gear will add to the total lethal take of sea turtles associated with the shrimp fishery in a statistically significant way.

TED exemption letters issued for fishery research and TED testing are not issued frequently. Since 1999, twenty seven exemption letters have been issued, 10 for fishery research and 17 for experimental TED testing. The exemption letters issued for fishery research allowed the use of trawls without a TED for an average of 30 days with average tow times of 30 minutes. There have been no reported sea turtle mortalities associated with these research projects. There also has not been a reported sea turtle capture or mortality associated with the 17 TED testing projects. TED exemptions (requiring the use of tow times in lieu of TEDs) issued by the Assistant Administrator for NOAA Fisheries because of environmental conditions have not been shown to cause significant problems. In areas where these exemptions have been issued NOAA Fisheries first gets a promise from the affected state's enforcement agencies to enforce tow times, this is in addition to NOAA Fisheries enforcement personnel and Coast Guard personnel. Since 1997 NOAA Fisheries has issued these exemptions in North Carolina, Mississippi, Alabama, Texas, and Louisiana with no observed increase in sea turtle strandings. Based on this information, we do not believe the use of tow times in lieu of TEDs in the above situations will add to the total lethal take of sea turtles associated with the shrimp fishery in a statistically significant way.

We note that the above conclusions about exempted gear and activities not posing a significant threat to sea turtles are based on knowledge of the gear and activities and the supposed desired outcomes (i.e. bait shrimpers wanting live shrimp) and the compliance with tow time restrictions. There have been no studies or comprehensive observer work done on these gears or activities to determine their actual effects on sea turtles. We expect that NOAA Fisheries will continue to review the appropriateness of continuing these tow time authorizations and restrict their use if the authorizations are not complied with or are otherwise harmful to sea turtles. The use of skimmer trawls, in which tow times are limited by economic and not practical reasons and whose use is becoming widespread in certain parts of the Southeast, should be carefully evaluated. If NOAA Fisheries finds, through research or observation, that the requirements of these exemptions are not being complied with or that exempted gear is being fished in a way that is harmful to turtles, then NOAA Fisheries should amend the sea turtle conservation regulations to require the use of TEDs in that gear or during those activities.

C. Species' Response to the Proposed Action

In the two sub-sections above, we have outlined how shrimp trawling can affect sea turtles through capture and forced submergence and the extent of those effects in terms of annual estimates of numbers of turtles captured and killed in the southeast U.S. Now we turn to an assessment of the species' response to this impact, in terms of overall population effects from the estimated take.

Loggerhead Population Response

Of the 5 species of sea turtles affected by shrimp trawling in the southeast U.S., the extent of take on loggerhead turtles is by far the greatest. Of course, loggerhead turtles are also the most abundant species in these coastal waters. A number of stock assessments (TEWG 1998, TEWG 2000, and NMFS SEFSC 2001) have examined the stock status of loggerheads, but have been unable to develop any reliable estimates of absolute population size. The latest and most extensive of these stock assessments (NMFS SEFSC 2001) was successful in assembling the best available information on loggerhead turtle vital rates and developing population models that can be used to predict the response of the loggerhead populations to changes in their mortality and survival. The loggerhead population modeling in NMFS SEFSC (2001) provides the best tools and incorporates the best available information, and we will use it primarily in our analysis of the overall effects of the proposed action on loggerhead populations.

As discussed in the status of the species section, 5 northwestern Atlantic loggerhead subpopulations have been identified (NMFS SEFSC 2001), with the south Florida-nesting and the northern-nesting subpopulations being the most abundant. The TEWG (2000) was able to assess the status of those two better-studied populations and concluded that the south Florida subpopulation is increasing, while no trend is evident for the northern subpopulation. The loggerhead population model developed in NMFS SEFSC (2001) was run with 3 different levels for population lambda, pre-1990 (before TED use might be expected to confound mortality estimates from strandings). Those lambdas are 0.95 (from Cape Island, S.C. – the most important nesting beach for the northern subpopulation – nesting trends [TEWG 2000]), 0.97 (from Cumberland Island, Georgia – one of the longest continuously monitored nesting sites for the northern subpopulation – nesting trends [Frazer 1983]), and 1.0 (from the nesting trends meta-analysis of multiple separate northern subpopulation nesting beaches [NMFS SEFSC 2001 Appendix 1]). NMFS SEFSC (2001) cautions with respect to the meta-analysis, however, that "it is an unweighted analysis and does not consider the beaches' relative contribution to the total nesting activity of the subpopulation and must be interpreted with some caution." We include it in our analysis because it is appropriate to bracket in a positive direction the singe-best point-estimate for lambda (0.97). The model itself may otherwise be pessimistic based on its simplicity and failure to consider the effects of other conservation measures implemented since 1990 (see *Environmental Baseline* section). In other words, depending on the analysis, the northern subpopulation nesting trend was probably declining but possibly stable prior to 1990 and, since 1990, probably stable but possibly increasing. The northern subpopulation is well below and not making any discernible progress towards its recovery goal of 3,100 nesting females per year, however.

Genetic analysis of stranded loggerheads throughout the southeastern U.S. has been used to identify the relative contributions of the various nesting subpopulations to the mixed in-water foraging ground assemblages. The relatively large south Florida subpopulation dominates everywhere. The northern subpopulation, although accounting for only about 10% of the total nesting, does appear disproportionate to its nesting abundance in strandings from Florida through North Carolina. In the Carolinas, it accounts for 25-28% of the animals, 24% off Georgia, and 20% off the Atlantic and Gulf coasts of Florida. In the western Gulf, the northern subpopulation is represented at a proportionally expected 10% (Bass et al. 1999). The disproportionate representation of northern subpopulation loggerheads in the Florida through

North Carolina strandings suggests that the effects of nearshore mortality, including shrimp trawling, are also being disproportionately borne by that subpopulation which is already smaller and in less robust condition than the south Florida subpopulation.

The NMFS SEFSC (2001) modeling efforts covered a range of scenarios and assumptions about the status and biological parameters of the modeled populations, with the intent that the model would be applicable to the different subpopulations and cover the range of available data. For our analysis here, we will focus on the model configurations that best represent the situation of northern subpopulation loggerheads, as they are more vulnerable. If effects on them are significant, then we would be concerned also about the effect of putting that subpopulation at risk on the whole species. If, on the other hand, the modeling indicates a positive outlook for this subpopulation, then we may assume that more robust subpopulations will fare as well or better. The model parameters in NMFS SEFSC (2001) we associate with the northern subpopulation are sex ratio = 35% female; model type 4 (assumes stage recruitment at average size-to-stage, rather than minimum size-to-stage, which may be more representative for slower maturing animals); and initial lambda = 0.97 or 1.0 (the lambda=0.95 scenario, while the most conservative, is not supported by other data sets in the region, and much of the Cape Island decline occurred long ago and may not be indicative of more recent population performance). The model has built in that the effect of introducing fully effective TEDs is a 30% reduction in total mortality on any life stages that are small enough to escape through the openings. Based on the findings of Epperly and Teas (2002), the NMFS SEFSC model assumes that small benthic juvenile loggerheads (<70 cm) have benefitted from TED requirements since 1990, but that large juveniles and adults have experienced no reduction in total mortality compared to pre-TED days.

The proposed action would require shrimp trawlers to use TEDs sufficiently sized to allow loggerheads of all sizes to escape from trawls. The model specifically evaluated the scenario of the full 30% mortality reduction benefit being extended to large juvenile and adult loggerheads. (This is not a 30% reduction in shrimp-related mortality, but a reduction from the total level of mortality from all sources. Epperly et al. [2002] estimated a 94% decrease in shrimp-related mortality for loggerheads in the southeast U.S. as a result of the proposed action.) Assuming an initial lambda of 0.97, the proposed action would have the effect of stopping an annual population decline of over 2%. Assuming an initial lambda of 1.0, the proposed action would have the effect of dramatically increasing the annual population growth rate from about 0.5% to around 3.0%. Since the available data on northern loggerhead subpopulation trends indicate stability in recent years, we interpret the modeling results as indicating that the subpopulation will move from stable to increasing as a result of the proposed action. The effects on the other subpopulations should be similarly positive.

Kemp's Ridley Population Response

Our evaluation of Kemp's ridley population response also benefits from the availability of two rigorous, relatively recent stock assessments (TEWG 1998, 2000) and the relative simplicity of understanding the population dynamics for this single-stock species which nests mostly on a single beach. The TEWG (2000) found that Kemp's ridley nesting has been increasing at an annual rate of 11.3% (95% confidence interval: 9.6%-13.0%) from the lowest nesting year (1985) through 1999. They also developed a population model to test and explain the Kemp's ridley population dynamics. The model could not be made to fit the nesting data without incorporation of a major reduction factor in total mortality after 1990.

We interpret this 'post-1990 multiplier' to reflect the effect of the coincidental introduction of required TED use in offshore waters. The size of this TED effect in the model varies depending upon choices for other model parameters, but its likely value is about a 45-50% reduction in total mortality on benthic juvenile and adult Kemp's ridley turtles. This effect is very large, larger than the 30% reduction used for loggerheads in NMFS SEFSC (2001), and this difference may be understandable based on the Kemp's ridley's concentration in shallow waters of the Gulf of Mexico and Atlantic coast where shrimping pressure is particularly high.

Epperly and Teas (2002) predict that even large adult Kemp's ridley turtles can escape through the current minimum-size TED escape openings. In recent years, however, an increasing number of adult-sized Kemp's ridley turtles have stranded along the Texas coast (STSSN unpublished data). This effect may be consistent with a growing overall population, but the sizes of some of these stranded Kemp's ridleys are not much different from the stranded loggerheads from the same area that are predicted to be too large to escape minimum opening size TEDs. We believe that the move of shrimp fishermen in recent years, particularly along the Texas coast, to very tight minimum size openings (J. Forrester, NOAA Fisheries Pascagoula Laboratory, pers. comm.) may also account for some of this mortality and stranding of adult-size Kemp's ridleys. The proposed action's large increase in TED opening sizes should make TED openings more than sufficient to ensure that no Kemp's ridley turtles will be too large to fit through the escape openings and will minimize escape times and any associated physiological injury.

In summary, the required use of TEDs in shrimp trawls in the U.S. under the sea turtle conservation regulations and in Mexican waters has already had dramatic effects on the recovery of Kemp's ridley turtles. Their population, which had declined to critical levels in the 1980s, has increased rapidly in the 1990s, although it is still at relatively low levels. The effect of the proposed action is likely to continue and possibly to improve the major reduction that TED use brought to Kemp's ridley mortality and therefore is likely to continue and possibly to improve the rapid recovery that the Kemp's ridley is currently experiencing.

Leatherback Population Response

The best available stock assessment for evaluating Atlantic leatherback populations is NMFS SEFSC (2001). That assessment is somewhat confounded by the near absence of data or high uncertainty for estimates of juvenile and adult survival and mortality and age and growth and also by the intermittence of nesting data from the major leatherback nesting beaches on the north coast of South America. Nevertheless, a very strong signal of declining nesting was detected for the nesting aggregation of Suriname and French Guiana, possibly the largest remaining leatherback nesting aggregation in the world. Nesting there has been declining at about 15% per year since 1987. From the period 1979-1986, the number of nests had been increasing at about 15% annually. The number of nests in Florida and the U.S. Caribbean has been increasing at about 13% and 8%, respectively, per year since the early 1980s, but the magnitude of nesting is much smaller than the nesting in the Guianas. Also, since leatherback females can lay 5 to 7 nests per season, the recent increases in Florida nesting to on the order of 400 nests per year may only represent about 60-80 individual female nesters per year.

The conflicting trends in nesting at U.S. versus South American beaches complicates our evaluation. NMFS SEFSC (2001) explored a series of hypotheses to explain the conflicting trends. Thinking about the hypotheses from the point of view of shrimp trawling impacts, the most likely hypothesis would seem to be higher mortality rates for adult females nesting at the South American beaches. Shrimp trawling capture and mortality of leatherbacks in the southeast U.S. has likely been affecting turtles from all western Atlantic origins, as those turtle migrate through or forage in U.S. waters. Although it seems reasonable to assume that there would be a proportionally larger effect on Florida-nesting leatherbacks, due to the relative proximity of their nesting beaches to the shrimping grounds, there is no evidence to support that assumption, and the genetic analyses used to determine loggerhead nesting origins (e.g., Bass et al. 1999) are unable to distinguish between some of the major leatherback nesting aggregations (Dutton et al. 1999). Regardless of the assumption of proportionality of impact, it is clear that the Florida-nesting leatherbacks have experienced a population increase, albeit from very low initial levels (on orders of magnitude from 10s to 100s). That increase has occurred over the past twenty years despite shrimp trawling pressure both without TEDs and then with TEDs with insufficient openings to allow leatherbacks to escape. The South American nesting numbers, on the other hand, have declined drastically (on orders of magnitude from 10,000s to 1,000s). Turtles from these nesting beaches have also been exposed to catch and mortality in southeast U.S. shrimp trawls during their migrations. A key difference between the U.S. and South American turtles' exposure to shrimp trawling risk is that the U.S. leatherback nesting beaches are far removed from the major shrimping grounds, while shrimping occurs adjacent to the nesting beaches in the Guyanas (Chevalier et al. 1999). The presence of shrimp trawling (and other coastal fisheries) next to the nesting beaches in South America, but not in the U.S., could easily account for the great declines seen in South America: internesting adult females would likely be particularly susceptible to trawl capture and mortality, and the population effects of eliminating active nesting females would be quick and dramatic.

In summary, the extent of the current shrimp trawl mortality on leatherback turtles from the southeast U.S. shrimp fishery (estimated to be as high as around 1,500 animals per year in the previous sub-section) was not so great as to prevent significant nesting increases in the U.S. The bulk of the leatherback population has drastically declined, however, probably as the result of high mortality along South American beaches. The death of leatherbacks in the U.S. shrimp trawl fishery has probably contributed to that decline. Under the proposed action, annual leatherback deaths in the U.S. shrimp fishery are expected to decline by up to 97%, with the required use of effective TEDs. The resulting extent of the mortality would be reduced from an estimated 2,300 animals to an estimated 80 animals annually. This very large reduction should have the population effect of enhancing the currently observed nesting increases on U.S. beaches and reducing the U.S. shrimp fishery contribution to the South American nesting decline to only a very minor, probably undetectable level.

Green Turtle Population Response

No recent, formal stock assessment information is available for Atlantic green turtles. As discussed in the *Status of the Species Section,* available information on green turtle nesting indicates that it is increasing at major rookeries in Florida and Costa Rica, and two long-term index studies of in-water abundance have shown increases in the numbers of immature green turtles along the Florida Atlantic coast. The Atlantic Green Turtle recovery plan (NMFS and USFWS 1991) identifies the required use of TEDs as a Priority 1 task (necessary to prevent extinction or irreversible decline). It is likely that the required use of TEDs has contributed to the apparent population increases. Extreme caution must be taken when making assessments of population status, particularly with green sea turtles, because their extremely slow maturation (Zug et. al. 2002) means that effects on certain parts of the population may not be evident for very long periods of time. For instance, the harvest of at least 10,000 large juvenile and adult green turtles annually for sale in Nicaragua (Bass et al. 1998) is a very large impact to Atlantic populations that has not been assessed for its sustainability.

Epperly and Teas (2002) estimate that only a small proportion (1-7%) of green turtles stranded in the southeastern U.S. were too large to fit through the current minimum size escape openings. Our estimates of the extent of take of green turtles in the subsection are based on the results of studies of actual turtle captures in shrimp trawls where no large green turtles were encountered. Still, the stranding data indicate that green turtles – probably a low proportion of the in-water population which is dominated by juveniles – are occasionally caught and killed in trawls with too-small escape openings. This selective mortality on the largest sizes of turtle would be expected to have the greatest population level effect, but it has not been so large in the past that it has precluded the observed population increases. The proposed action would eliminate this selective mortality, and we expect it will contribute to the recovery of green sea turtle populations.

Hawksbill Population Response

Shrimp trawl capture mortality of hawksbills in U.S. waters is likely rare and is not an important overall threat to the species. The recovery plan for Atlantic hawksbills (NMFS and USFWS 1993) does not identify any efforts to reduce shrimp trawl mortality on hawksbills as even low priority recovery tasks. Nonetheless, capture and mortality of hawksbills in shrimp trawls does at least occasionally occur, probably most frequently in the western Gulf, based on stranding records. The effect of the proposed action will be to maximize the effectiveness of TEDs and therefore to reduce further the frequency of capture and mortality of hawksbills in the southeastern U.S. shrimp trawl fishery to insignificant levels.

V. Cumulative Effects

Cumulative effects are the effects of future state, local, or private activities that are reasonably certain to occur within the action area considered in this biological opinion. Federal actions that are unrelated to the proposed action are not considered in this section because they require separate consultation pursuant to section 7 of the ESA. Within the action area, major future changes are not anticipated in ongoing human activities described in the environmental baseline. The present, major human uses of the action area (i.e., commercial fishing, recreational boating and fishing, and the transport of petroleum and other chemical products) are expected to continue in the near future at the present levels of intensity as are their associated risks of injury or mortality to sea turtles from incidental capture by fishermen, accidental oil spills, vessel collisions, marine debris, chemical discharges, and man-made noises. However, over the long term these pressures are expected to increase as human population and activity increase. As discussed in Section III, however, listed species of turtles migrate throughout the Gulf of Mexico, Caribbean Sea and the North Atlantic and may be affected during their life cycles by non-Federal activities outside the action area.

Beachfront development, lighting, and beach erosion control are all ongoing activities along the southeastern coast of the United States. These activities potentially reduce or degrade sea turtle nesting habitats or interfere with hatchling movement to sea. Nocturnal human activities along nesting beaches may also discourage sea turtles from nesting sites. The extent to which these activities reduce sea turtle nesting and hatchling production is unknown. However, more and more coastal counties have or are adopting more stringent protective measures to protect hatchling sea turtles from the disorienting effects of beach lighting. Some of these measures were drafted in response to law suits brought against the counties by concerned citizens who charged the counties with failing to uphold the ESA by allowing unregulated beach lighting which results in takes of hatchlings.

State-regulated commercial and recreational boating and fishing activities currently result in the incidental take of threatened and endangered species. It is expected that states will continue to license/permit large vessel and thrill-craft operations which do not fall under the purview of a Federal agency and will issue regulations that will affect fishery activities. Any increase in recreational vessel activity in inshore and offshore waters of the Atlantic Ocean and the Gulf of Mexico will likely increase the risk of turtles taken by injury or mortality in vessel collisions. Recreational hook-and-line fisheries have been known to lethally take sea turtles, including Kemp's ridleys. Future cooperation between NOAA Fisheries and the states on these issues should help decrease take of sea turtles caused by recreational activities. NOAA Fisheries will continue to work with states to develop ESA section 6 agreements and section 10 permits to enhance programs to quantify and mitigate these takes.

VI. Conclusion

After reviewing the current status of endangered green, leatherback, hawksbill, and Kemp's ridley sea turtles, and threatened loggerhead sea turtles, the environmental baseline for the action area, the effects of the proposed action, and the cumulative effects, it is NOAA Fisheries' biological opinion that shrimp trawling in the southeastern United States, under the proposed revisions to the sea turtle conservation regulations and as managed by the fishery management plans for shrimp in the South Atlantic and Gulf of Mexico is not likely to jeopardize the continued existence of endangered green, leatherback, hawksbill, and Kemp's ridley sea turtles, and threatened loggerhead sea turtles. Critical habitat has not been designated for these species in the action area; therefore, none will be affected.

With the exception of the northern nesting population of loggerheads, as explained in this Opinion (in the environmental baseline and species description), nesting for leatherbacks, loggerheads, Kemp's ridley, and green sea turtles has been increasing or remaining stable in the Southeast United States and Rancho Nuevo, Mexico (in the case of Kemp's ridleys), even under the current sea turtle conservation regulations. Based on information presented in Part IV section C of this Opinion, the increase in TED opening sizes associated with the proposed action is expected to allow the northern nesting population of loggerheads to increase. In part IV. B., NOAA Fisheries determines that shrimp trawling accounts for a very small portion of hawksbill mortality in the United States and as such will have very little effect on hawksbill populations, and any effects it does have will be lessened by the used of larger TED openings.

VII. Incidental Take Statement

Section 9 of the ESA and Federal regulations pursuant to section 4(d) of the ESA prohibit the take of endangered and threatened species, respectively, without special exemption. Take is defined as to harass, harm, pursue, hunt, shoot, wound, kill, trap, capture, collect, or to attempt to engage in any such conduct. Incidental take is defined as take that is incidental to, and not the purpose of, the carrying out of an otherwise lawful activity. Under the terms of section 7(b)(4) and section 7(o)(2), taking that is incidental to and not intended as part of the agency action is not considered to be prohibited taking under the ESA provided that such taking is in compliance with the terms and conditions of this incidental take statement.

The measures described below are non-discretionary and must be undertaken by NOAA Fisheries so that they become binding conditions of any grant or permit issued to an applicant, as appropriate, for the exemption in section 7(o)(2) to apply. NOAA Fisheries has a continuing duty to regulate the activity covered by this incidental take statement. If NOAA Fisheries fails to implement the terms and conditions, the protective coverage of section 7(o)(2) may lapse.

Amount or Extent of Anticipated Take

Based on stranding records, incidental captures aboard commercial shrimp vessels, and historical data, five species of sea turtles are known to occur in the action area. Current available information on the relationship between sea turtles and shrimp fishing indicates that injury and/or death of sea turtles is likely to occur from activities associated with the shrimp fishery, especially captures in shrimp trawls. Therefore, pursuant to section 7(b)(4) of the ESA, NOAA Fisheries anticipates an annual incidental take of up to:

Table 5

	Greens	Loggerheads	Kemp's ridleys	Hawksbills	Leatherbacks
Interactions	18,757	163,160	155,503	NA	3,090
Mortalities	514	3,948	4,208	640[1]	80

This level of take is anticipated for the shrimp trawl fishery in the Southeastern United States. In order to determine levels of takes, NOAA Fisheries will monitor changes in CPUEs, trawl mortality rates, shrimping effort, strandings, and TED efficiency to determine if take levels are being met or exceeded. If, based on monitoring of CPUEs, trawl mortality rates, shrimping effort, strandings, or TED efficiency, NOAA Fisheries believes that the incidental take levels are being met or exceeded NOAA Fisheries must immediately reinitiate formal consultation.

Effect of the Take

NOAA Fisheries believes that the aforementioned level of anticipated annual take, based on Part IV section C of this Opinion, is not likely to appreciably reduce the likelihood of the survival and recovery of

[1]As discussed in Part IV sections B and C of this opinion actual mortalities of hawksbills, as a result of turtle/trawl interactions, is expected to be much lower than this number. This number represents the estimated total number of mortalities of hawksbill turtles from all sources in areas where shrimp fishing takes place.

Kemp's ridley, green, loggerhead, hawksbill, or leatherback sea turtles in the wild by reducing their reproduction, numbers, or distribution.

Reasonable and Prudent Measures

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

1. NOAA Fisheries must continue to monitor the effort in the shrimp fishery, the fisheries' effects on sea turtles, and the effectiveness of TEDs.

2. NOAA Fisheries must continue to research and develop gear that limits the shrimp fisheries' effects on sea turtles.

3. NOAA Fisheries must continue outreach programs which train fishermen and net shop personnel in the proper installation and use of TEDs.

4. NOAA Fisheries must investigate ways to reduce effort in the shrimp fishery.

5. NOAA Fisheries must continue to work with other enforcement agencies (Coast Guard and state agencies) to enforce sea turtle conservation regulations.

Terms and Conditions

In order to be exempt from the prohibitions of section 9 of the ESA, NOAA Fisheries must comply with the following terms and conditions, which implement the reasonable and prudent measures described above and outline required reporting and monitoring requirements. These terms and conditions are nondiscretionary.

1. NOAA Fisheries will use a six step approach to monitor the shrimp fisheries' effects on sea turtles and the effectiveness of TEDs.

    a. NOAA fisheries will monitor on-going and new projects aimed at determining CPUE. If trends in new data indicate a significant shift in direction NOAA Fisheries will take appropriate action. A significant increase or decrease in CPUE throughout the entire Southeast United States or in any particular region may change the shrimp fisheries' effects on sea turtles and may represent information that would require NOAA Fisheries to reinitiate section 7 consultation.

    b. NOAA Fisheries will coordinate with the states to monitor shrimp fishing effort and will use this information to determine trends in the fishery and possible effects of these trends on sea turtles. A significant increase or decrease in effort throughout the entire Southeast United States or in any particular region may change the shrimp fisheries' effects on sea turtles and may represent information that would require NOAA Fisheries to reinitiate section 7 consultation.

c. NOAA Fisheries will continue to use observer information, strandings data, and other data as available to monitor mortality of turtles as a result of capture in trawls. If this information shows an increase from the percentages used in the Effects of the Action section of this Opinion, this may represent new information that would require NOAA Fisheries to reinitiate section 7 consultation.

d. NOAA Fisheries will continue to coordinate with the sea turtle standing and salvage network (STSSN) and the states to monitor strandings. If stranding trends indicate a significant shift in strandings, NOAA fisheries will analyze this information and take appropriate action. A significant increase or decrease in strandings throughout the entire Southeast United States or in any particular region may indicate a change in the shrimp fisheries' effects on sea turtles and may represent information that would require NOAA Fisheries to reinitiate section 7 consultation.

e. The use of larger TEDs will allow increased survival of large turtles, especially large loggerheads and therefore an increase in the concentration of large turtles in any given population. NOAA Fisheries must continue to ensure that the TEDs being used are capable of releasing large turtles. NOAA Fisheries will periodically test all approved TEDs for release of wild caught turtles. These tests will be video taped and the tapes analyzed to ensure that all approved TEDs are capable of releasing large turtles especially in light of the fact that there is expected to be an increase in the concentration of large turtles as a result of new sea turtle conservation regulations.

f. NOAA Fisheries will monitor activities (e.g. bait shrimping) and gear (e.g. skimmer trawls) that are exempted from TED use and rely on tow time restrictions to determine their compliance with tow times and to determine if there are any effects on sea turtles from the use of these gears or the continuation of these activities that were not previously known.

2. NOAA Fisheries will continue to work with industry to develop new gear, especially TEDs that will be effective at releasing all sizes and all species of sea turtles while still retaining catch.

a. NOAA Fisheries will continue to issue permits to industry to test industry-developed TEDs under 50 CFR § 223.207(e)(2)

b. NOAA Fisheries will continue to fund gear research and annual gear testing conducted by the NOAA Fisheries Southeast Science Center's Harvesting Systems Branch.

3. NOAA Fisheries gear technicians will continue to travel throughout the Southeastern United States training fishermen and net shop owners on the proper installation and use of TEDs. This will be especially important during the implementation of the new sea turtle conservation regulations that are part of this proposed action.

4. NOAA Fisheries will research ways to reduce effort in the shrimp fishery, thereby reducing the stress on sea turtles caused by multiple captures. This may include, but is not limited to, implementation of nighttime restrictions on shrimp fishing.

5. NOAA Fisheries will continue efforts to enforce sea turtle conservation regulations by maintaining its at-sea enforcement capabilities, especially the Protected Resources Enforcement Teams (PRETs), and researching the possibility of adding additional PRETs. NOAA Fisheries will also work closely with the Coast Guard and state law enforcement agencies regarding enforcement of the sea turtle conservation regulations. NOAA Fisheries will provide training to these agencies on the changes to the regulations.

See Table 5 for estimates of sea turtles that will be incidentally taken annually as a result of the proposed action. The reasonable and prudent measures and their implementing terms and conditions are designed to minimize the impact of incidental take that might otherwise result from the proposed action. If this level of incidental take is met or exceeded, such incidental take represents new information requiring reinitiation of consultation and review of the reasonable and prudent measures provided. NOAA Fisheries must immediately provide an explanation of the causes of the taking and review the need for possible modification of the reasonable and prudent measures.

Conservation Recommendations

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

1. NOAA Fisheries should research ways to better monitor the shrimp fisheries' effects on listed species.

2. NOAA Fisheries should provide the resources needed to properly observe the shrimp fishery.

3. NOAA Fisheries should provide the resources needed to increase the number of PRETs.

VII. Reinitiation of Consultation

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

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Appendix I

Summary Report – Description of methods, assumptions, and calculations used to estimate sea turtle catch per unit effort (CPUE), shrimp fishing effort, and sea turtle interactions with shrimp trawls for use in shrimp fishery biological opinion

SEA TURTLE CATCH PER UNIT EFFORT (CPUE)

An important step in estimating how many turtles are taken in the shrimp fishery per year was determining how many turtles are caught per a given effort of trawling. We sought to locate information which-

- quantified turtle catch rates;
- was available by region (Gulf vs. U.S. southeastern Atlantic);
- was available by species;
- was available by water depth, and;
- was based on data collected from observations during normal commercial U.S. shrimp trawling (or as close as possible to it)

We reviewed the analysis of sea turtle captures and mortality by Henwood and Stuntz (1987), the Gulf and South Atlantic Fisheries Development Foundation, Inc. (GSAFDF 1998, Jamir 1999) shrimp trawl study, the sea turtle abundance project work based on sampling with trawl gear currently underway by Whitaker et al. (Permit 1245 final reports for 2000 and 2001), the van Dolah and Maier (1993) work on the distribution of loggerhead turtles in the entrance channel of Charleston Harbor, South Carolina, turtle catch data contained in the shrimp trawl survey research work of the Texas Parks and Wildlife and Louisiana Department of Wildlife Fisheries, data from the Southeast Area Monitoring and Assessment Program (SEAMAP), and the work of Renaud et al. (1997) on incidental capture of sea turtles in shrimp trawls. Van Dolah and Maier (1993), the Texas information, the Louisiana, and the SEAMAP information were eventually eliminated for further use as possible CPUE figures because they were the least representative of actual shrimp trawl fishing. For example, the van Dolah and Maier work concerned very specialized trawling specific to the entrance channel of Charleston Harbor, South Carolina. Renaud et al. (1997) was not used because it was felt that it would be less conservative (provide for a less cautious analysis) than other information that could be used. We were not able to use the work by Whitaker et al. for two reasons. First, the Whitaker study did all its work in less than 7 fathoms (first year) and less than about 8 fathoms (the second year); and because shrimp effort was not broken out into depth categories in the detail available for the Gulf, we could not calculate take estimates. Additionally, even if we could have obtained the shrimp effort data broken out as needed, this study was not as representative of the shrimp fishery as the remaining studies. However, since their information is interesting, current, and could have value to the discussion of CPUEs in the U.S. southeast Atlantic, we decided to include it here.

Henwood and Stuntz as well as the GSAFDF study presented their data standardized to reflect hours towed with a single 100 ft (30.5 m) headrope length net using the formula-

$$E = (\text{nets} * \text{length} / 100 \text{ feet}) * (\text{minutes}/60)$$

where

nets = number of nets towed
length = headrope length of the net (feet)
minutes = minutes fished

Both studies used the total number of turtles captured divided by the sum of the trawling effort (standardized to 100' net hours) to calculate CPUE and create data tables broken down by region (Gulf of Mexico vs. U.S. South Atlantic), species, and depth. They chose depth ranges of 0-5 fathoms, 5-10 fathoms, 10-15 fathoms, and 15+ fathoms. We found it useful to analyze the data by region (to recognize and account for any potential regional differences that might be present) and species (in order to assess impacts on species individually). However, we did not use their depth categories exactly as provided. We decided to analyze and compare CPUE data grouped into two depth categories, which involved combining the first three depth ranges into one 0-15 fathoms category. The 15+ fathoms category was used as provided. Forty-six tows (400.84 net hours) and 4 tows (11.83 net hours) on the Henwood and Stuntz data sheets had no depth range listed with them, thus it could not be determined where to use them. This precluded them from being included in the individual species' CPUE calculations. Neither of these data lines recorded any turtle takes associated with these particular tows, thus the individual species CPUE figures calculated represent a cautious (conservative) number at worst. In the case of the "ALL" depth category we were able to include these tows (since this category contained all tows regardless of depth) or completeness, we have presented two "ALL" CPUE figures, one with these tows included, the other without.

Whitaker et al. Data CPUE Calculation
While the first two studies provided detailed standardized calculated CPUE data, Whitaker et al. did not. Therefore, it was necessary to calculate CPUE, standardized to 100' headrope in order to analyze and compare it with the two other studies. Phil Maier provided trynet adjusted data for us by email on July 23, 2002, as follows-

Fishery independent boats, during 2000 and 2001.

- 60' headrope turtle nets (trawls)
- 65' footrope
- 8" bar mesh in the body
- 4" bar mesh in the bag
- trawl doors were 8' x 40" with 3/4' in shoes
- towed for exactly 30 minutes

	2000	2001
# of nets towed	1241	1220
# Loggerhead	170	177
# Kemp's	13	10
# Green	2	3

Total overall effort was then calculated, standardized to 100' headrope as follows-

TOTAL OVERALL EFFORT = (nets towed * length/ 100) * (minutes/60)

TOTAL OVERALL EFFORT YEAR 1 (2000) = (1241 * 60/100) * (30/60) = 372.3 (standardized to 100' headrope)

TOTAL OVERALL EFFORT YEAR 2 (2001) = (1220 * 60/100) * (30/60) = 366 (standardized to 100' headrope)

Turtle CPUE figures were calculated as follows- CPUE per species = # of turtles of given species/TOTAL OVERALL EFFORT

Thus, for Year 1 of the study (2000), we have-

Loggerhead CPUE	= 170/372.3	= 0.45662
Kemp's CPUE	= 13/372.3	= 0.03492
Green CPUE	= 2/372.3	= 0.00537
ALL CPUE	= 185/372.3	= 0.49691

For Year 2 of the study (2001), we have-

Loggerhead CPUE	= 177/366	= 0.48361
Kemp's CPUE	= 10/366	= 0.02732
Green CPUE	= 3/366	= 0.00820
ALL CPUE	= 190/366	= 0.51913

The CPUE values for all studies used were entered into the attached spreadsheet to facilitate comparison and discussion. They are provided by region, by species, and by depth. In the case of the Henwood and Stuntz (1987) and GSAFDF (1998) work it was possible to provide two depth breakouts (0-15 fathoms and 15+ fathoms). As mentioned above, all trawling in the Whitaker work was done at depths of less than approximately 7 fathoms for the first year and less than approximately 8.3 fathoms during the second year. Thus, CPUE figures are not available for the "ALL" depths breakout nor the 15+ fathoms breakout.

Assumptions and cautions to CPUE data calculations above include-

-Turtle catches are directly proportional to the size of the nets being fished; thus a 100' headrope length net will catch twice as many turtles as a 50' headrope length net, if both are towed under similar conditions for the same timeframe.

-Power of vessels can vary and it was not possible to account for this. No standardization for tow speed was possible.

-The Gulf of Mexico portion of the GSAFDF study was done only in the western Gulf of Mexico.

-We trusted that vessels selected in the studies were representative shrimp vessels.

-Standardization based on number of boats assumes that all boats have the same amount of effort.

-The shrimp trawling done under the Henwood and Stuntz as well as the GSAFDF study was representative of the conditions encountered under a typical shrimping season (oceanic conditions, turtle distribution, etc.)

SHRIMP TRAWLING EFFORT

Shrimp trawling effort was needed to which the CPUE numbers could be applied. Data broken down into the Gulf of Mexico and the U.S. southeastern Atlantic was needed in order to apply the CPUE numbers as calculated above.

Gulf of Mexico

The Galveston lab (J. Nance, NOAA Fisheries, pers. comm. 2002) was able to provide the estimated U.S. Gulf of Mexico total shrimping effort values in 24 hour days. The headrope sizes of nets used by trawlers were not available (and it should be noted that even if they were available sizes would be mixed). It should also be noted that the power of vessels can vary, and that the effort estimates were from interviews. The Galveston lab explained that with all its flaws, the total effort file does represent our best estimate of shrimping effort in the Gulf of Mexico. However, they cautioned that attempting to create standardized effort may in fact make the effort estimate worst.

While we agreed with the concerns about estimating and standardizing, as mentioned above in this report, we did the best we could with available data and proceeded to attempt to standardize the Gulf effort data for use with the CPUEs.

We could not adjust Gulf effort for the issue of power of vessels, but we did standardize the data to 100' headrope to be able to then apply it to the turtle CPUE (which was based on 100' headrope trawling). Headrope length was not available for the Gulf of Mexico. However, footrope data was available, and the Galveston lab provided us with the following-

OTTER TRAWL SIZES FROM THE VOUF FILES
GEAR TYPE 215 ONLY
1998*
ALL GULF STATES REPRESENTED

	NUMBER TRAWLS	MEAN FEET	NOBS
OVERALL	2.8	44.0	3,810
	1	48.2	750
	2	42.3	1,241
	3	32.5	2
	4	43.4	1,817

* = Although 1999 data was available, Florida data was missing from it so it was not used.
Gear Type 215 = otter trawl
Mean Feet = foot rope length
NOBS = number of boats observed

NOTE- Headrope/VOUF standardization doesn't weight according to effort, only number of vessels (i.e, you might assume that the bigger vessels fish more hours, but that can't be weighted) -- this would yield a low bias; also the VOUF only includes vessels, not boats, so small boats are not included at all, which would tend to yield a high bias. We can't quantify either of these factors which would, to some extent, cancel each other out.

The Pascagoula lab (J. Mitchell, NOAA Fisheries, pers. comm. 2002) was consulted on how to convert footrope to headrope. They were able to contact gear shops and provided an estimate that footrope length would, on average, measure 8 ft. greater than the headrope length. Therefore, we subtracted 8ft. from the 44 mean feet footrope figure above resulting in an estimate for average headrope length for the Gulf of approximately 36 ft.

We then took the "Estimated U.S. Gulf of Mexico Total Shrimping Effort Values In 24 Hour Days" data provided by the Galveston lab, and calculated an average for the last five years (1997- 2001) and then converted it to hours-

Fathoms	Average Effort, 24 Hour Days	Average Effort, Hours
0-15	137,022.5	3,288,540
16-UP	69,793.4	1,675,042
ALL	206,815.9	4,963,582

Then, to standardize to 100' hours (with the given overall number of trawls calculated as 2.8 in VOUF data)-

= Average Effort in Hours * (Overall Number of Trawls * 36FT/100)

Fathoms	Effort Standardized to 100' Hours
0-15	3,314,848.32
16-UP	1,688,442.34
ALL	5,003,290.66

NOTE- There was discussion at the Pascagoula lab among the gear specialists on whether the 36 ft headrope might be too small, that perhaps the average could be higher. Thus they surveyed net shops and these shops indicated that they are selling larger nets than the average size in the VOUF. We used the "official VOUF" data for our effort calculations; however it should be noted that if headrope sizes are increasing, the effort values and thus the turtle take estimates would increase.

U.S. Southeast Atlantic

Unlike the Gulf for which effort is reported in 24 hour days, in the Atlantic number of trips is used. Trip length is shorter in the Atlantic than the Gulf of Mexico, and probably less variable (Nance, email 17 July 2002). Number of trips data was used from "Estimates of Bycatch of Mackerel and Cobia in U.S. South Atlantic Shrimp Trawls" by Vaughan and Nance (1998). We calculated an average number of trips for the period 1990 to 1997 (last year of data available) for Florida, Georgia, South Carolina, and North Carolina. We then added these together to get the total number of trips for the U.S. southeast Atlantic region. This figure was 52,963. Based on observer data (369 trips, 1,571 tows) for the southeast Atlantic provided to the SER in 2000 which had AVG. HROPE/TOW data and TOTAL HRS. TOWED/TRIP, we calculated an average headrope length and an average total hours towed per trip. With this information, we were able to calculate the number of hours towed-

52963 trips * 11.9 average total hours per trip = 630,260 hours towed

We then standardized these hours to 100' headrope-

630,260 hours * 136.5 average headrope/100 = 860,305 hours

NOTE- Effort broken out into 0-15 and 15+ fathoms was not available for the U.S. South Atlantic.

ESTIMATION OF NUMBER SEA TURTLE INTERACTIONS WITH SHRIMP TRAWLS

The estimated number of turtles taken (entering shrimp trawls) per year in the shrimp fishery was calculated by multiplying the turtle estimated CPUE figures by the standardized shrimping effort. As discussed earlier, this is an estimate based on the best information available.

Takes = CPUE * shrimping effort

The resulting range of takes (depending on the CPUE used) are presented on the attached spreadsheet for various CPUE values (depending on study, region, species, etc.).

After considering all of the studies and information available, we decided to use the GSAFDF study because it was more current than the Henwood and Stuntz work and was more representative of shrimping than the other studies.

Gulf of Mexico

In the case of the Gulf of Mexico, we used the depth categories of 0 to 15 and 15+ fathoms. We did this because-

- It was believed to be more accurate than lumping everything into one "ALL" category since the foundation study had a disproportionate amount of effort in the 15+ category. It had over 8,174.21 net hours in the 15+ fathom depth which captured only 5 turtles. In the 0-15 depth 21 turtles were captured with 601.07 net hours. Thus, the overall CPUE for the Gulf was biased (weighted) downward due to the heavy amount of effort at the 15+ depth whose lower capture rate figured more heavily into the overall CPUE calculation. Using the actual CPUE of the 0 to 15 fathom range and applying it to the shrimp effort for this range gave us a more accurate take estimate.
- Since we had the shrimp trawl fishing effort broken down into the 0 to 15 and 15+ fathom ranges, we were able to calculate the take estimates this way.

Using the CPUE rate for ALL species for 0-15 fathoms with the shrimp effort data for 0-15 fathoms, the estimate would be approximately 0.03494 *3,314,849 = 115,821 turtles taken at this depth category.

Using the CPUE rate for ALL species for 15+ fathoms and the shrimp fishing effort for 16 fathoms-UP, the estimate is as follows, 0.00061 *1,688,443 = 1,030 turtles.

Similarly, the estimates for the individual species are as follows-

Species	0 to 15 fathoms	15+ fathoms	
Loggerhead		27,573	620
Kemp's	82,723	207	
Green	5,516	206	

The overall sea turtle take for the Gulf of Mexico = 116,851

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U.S. Southeast Atlantic

The calculation for ALL species, All depths for the estimated take would be approximately

0.39388 * 860,305 = 338,857 turtles.

The estimates for individual species is as follows-

Species	All Depths
Loggerhead	248,577
Kemp's	82,859
Green	6,184

The approximate overall sea turtle take for the U.S. southeast Atlantic = 338,857 turtles.

TOTAL ESTIMATED TAKE GULF AND U.S. SOUTHEAST ATLANTIC COMBINED

= 455,708 loggerhead, kemp's, and green turtles
(Does not include hawksbills or leatherbacks.)

Note- If we apply the Whitaker et al. *southeast Atlantic* CPUEs to the shrimping effort figures that are available (all depths), which assumes that the CPUE are approximately valid for all depths or that most of the fishing effort is occurring at the depths the study fished at, we get the following estimates for the U.S. southeast Atlantic-

Year 1 (Whitaker et al.)

Species Estimated Take

All 3 species	427,495
Loggerhead	392,833
Kemp's	30,042
Green	4,620

(hawksbill and leatherback not included)

Year 2 (Whitaker et al.)

Species	Estimated Take
All 3 species	446,610
Loggerhead	416,053
Kemp's	123,504
Green	7,055

(hawksbill and leatherback not included)

TOTAL ESTIMATED TAKE GULF AND U.S. SOUTHEAST ATLANTIC COMBINED USING THE WHITAKER ET AL. CPUEs for the U.S SOUTHEAST ATLANTIC

= 544,346 to 563,461 loggerhead, Kemp's, and green turtles

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Appendix II

Comments on Proposed TED Rule from the Southeast Fisheries Science Center

Comments as related to turtle life history and best available information:

Revisions to TED regulations have been proposed to allow large sea turtles to escape (66 FR 50148, October 2, 2001). Currently, a significant number of loggerhead and some green turtles are too large to escape through existing minimum openings. Loggerheads fail to fit through the openings at a size/age many years prior to expected sexual maturity (Epperly and Teas (1999; in review). Epperly and Teas (Ibid.) reported that up to 47% of loggerheads stranding annually over the last decade on U.S. Atlantic and Gulf of Mexico coasts were too deep bodied to fit through existing minimum TED openings. Since 1995, the first full year of all areas-all times TED requirements (regulations were fully implemented in December 1994), over 30% were still too large. The problem exists in both inshore and offshore waters (Fig. 1). Strandings in inshore waters likely are severely underestimated due to the difficulty in surveying areas that generally are marshlands or do not have sandy beaches; for the same reasons, offshore strandings on much of the coastline of Louisiana are underestimated.

The greatest proportion of animals stranding that are too large occur in the Gulf of Mexico, where the current minimum height opening is 10 inches (compared to 12 inches in the Atlantic). In the Western Gulf of Mexico, an annual average of 63% offshore and 48% inshore were too large. In the Eastern Gulf of Mexico the values are 89% and 80%, respectively. The proportions are less in the Southeast U.S. Atlantic: 27% and 17%, respectively, but because the number of turtles stranding there is higher, the actual number of animals too large to fit through the openings is comparable to the number of strandings too large in the Gulf of Mexico. Based on 1995-99 data, each year approximately 250 animals that are too large to fit through existing TED openings strand in each region; approximately 13% of these occur in inshore waters.

Loggerheads are distributed ubiquitously in U.S. Southeast Atlantic and Gulf of Mexico waters, generally occurring in all areas, inshore and offshore (Figs. 2 and 3), and at all times when shrimp trawling activity is likely to occur. Thus, revised regulations need to be implemented in both regions, inshore and offshore.

The size of the revised opening should exclude all loggerhead turtles. An analysis of data from a few nesting beaches of the northern subpopulation indicated that body depths of most (97%) nesting females were less than 16 inches; body depths, however, were based on derived equations to estimate body depth from carapace length. Those estimates potentially could vary by several inches from observed measurements (see Fig. 2 of Appendix 1 in Epperly and Teas, 1999). The South Carolina Department of Natural Resources (SCDNR) provided NMFS measurements from 87 loggerheads nesting in 2000 at Cape Island, S.C. (S. Murphy, SCDNR, pers. comm.: FAX to J. Mitchell on Aug. 21, 2001 and e-mail to J. Mitchell on Aug. 22, 2001). The largest animal measured had a body depth of 20 inches. Thus, if the height opening of TEDs was revised to be 20 inches, based on size, virtually all loggerheads should be excluded.

Leatherbacks are distributed throughout U.S. Atlantic and Gulf of Mexico waters, but are not as abundant as loggerheads. Within the continental U.S. they nest on south Florida east coast beaches, but the largest Atlantic rookeries are on the beaches of the Guianas. Other rookeries in the western North Atlantic occur throughout the Caribbean and Central America. Based on tag returns, turtles from all western North Atlantic rookeries may forage in or migrate through U.S. waters (NMFS unpublished data; Wendy Teas, NOAA Fisheries SESC pers. comm. to Therese Conant, NOAA Fisheries Protected Resources, e-mail January 14, 2000).

Leatherbacks are predominately found in offshore waters but infrequently enter inshore waters (Figs. 4 and 5). In North Carolina 14% of all the leatherback sightings reported by the public were from inshore waters (Epperly et al., 1995). In the Gulf of Mexico 8% of leatherbacks stranding were found on inshore beaches and in the Southeast U.S. Atlantic 11% were reported from inshore waters (Fig. 6). The actual number of turtles stranding in inshore waters, however, is small: 7 in the Gulf of Mexico from 1995-1999 and 21 in the S.E. U.S., for an average of 6 turtles stranding annually in southeast inshore waters. Leatherbacks occur offshore during all seasons when shrimp trawling activity is expected to occur (Figs. 7-10) and the number stranding on offshore beaches is significantly more than in inshore waters: the average is 56 animals per year in the southeast.

No mature leatherbacks can escape conventional TED openings or are likely to escape openings enlarged to 20 inch in height. NMFS analysed morphometric data collected on leatherbacks nesting on St. Croix, U.S.V.I. (N=23) and on Suriname, S.A. beaches (N=30) in 2000 (NMFS, unpublished data). It was determined that the dimensions of the existing leatherback opening modification of the TED are adequate to release all leatherbacks measured on these beaches. A model based on the measurements of one of the largest turtles was constructed and used in trials of the leatherback TED modification off Panama City, FL; the model was able to pass through the TED (NMFS unpublished data). Thus, when used in areas where leatherbacks occur, such as in offshore waters, the leatherback modification of the TED should provide protection to these endangered animals.

In conclusion, available data support a proposal to require larger TED openings in both inshore and offshore waters. The proposed rule is to require the leatherback modification in inshore and offshore waters at all times. Data are too sparse to identify a significant conservation benefit in requiring a leatherback modification in inshore waters at this time. In inshore waters the concern is to adequately protect the loggerhead and a height opening of 20 inches used during all months should provide that protection. Offshore the leatherback modification of the TED would protect both the loggerhead and the leatherback and available data support the need to protect both species in offshore waters at all times.

Comments as related to gear specifications:

<u>GRID SIZE</u>

There is justification for increasing the minimum grid size from 28" in the Gulf and 30" in Atlantic to a 32" outside measurement in all areas to allow for the installation of larger escape openings.

Larger grid size has been shown to improve shrimp retention (increases sorting area.)

The proposed rule is incorrect and should be changed propose a 32" outside grid measurement. Such a change would have minimal effect on industry.

ESCAPE OPENINGS

An opening of the size to 35" x 20". This size opening could easily be adapted to 32" TEDs, which currently are in use in the Atlantic and is proposed to be the minimum grid size allowed.

Where there are leatherbacks the use of leatherback-sized openings, the 71" cut and/or double cover flap, is justified. Leatherback flaps are already in regular use by many offshore vessels.

NMFS collected shrimp loss data for offshore waters for the double cover and leatherback openings in GOM offshore waters. This data shows a 1 to 3% average loss for the 71" cut (minus outlier trip) and no loss for the double cover flap. The outlier trip showed a 34% loss of shrimp for the leatherback flap. This trip is suspect because: 1.) nets were in very poor condition and were not maintained, 2.) Captain did not agree to alternate net position of the experimental TED.

COULON TED

Developed by a Louisiana fisherman, it is a hooped hard TED reportedly used by some 40 fishermen.

If the minimum size opening were changed to 71" it would be impossible to construct a Coulon TED with these dimensions. It *would* be possible to construct the Coulon TED with a 35" x 20" opening.

This TED effectively reduces overall bycatch, but does not meet minimum requirements for certification for red snapper.

FUNNELS

Accelerator funnels have been shown to decrease shrimp loss, and can be used effectively with a leatherback sized opening requirement (71" or double cover).

A funnel would be effective with a 35" x 20" opening requirement.

References for Appendix II

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APPENDIX III

Sea Turtle Conservation Regulation History

The consultation history for this action is closely tied to the lengthy regulatory history for sea turtle conservation and particularly the regulations governing the use of Turtle Excluder Devices (TEDs). A summary of that regulatory history and the associated major consultations follows.

1970 - Hawksbill, Kemp's (Atlantic) ridley, and leatherback sea turtles are listed by FWS as endangered species under the Endangered Species Conservation Act of 1969.

December 28, 1973 - Enactment of the Endangered Species Act of 1973 (ESA).

May 20, 1975 - NOAA Fisheries and FWS publish a proposal to list green, loggerhead, and olive (Pacific) ridley sea turtles as threatened species under the ESA (40 FR 21982, 40 FR 21974). The proposal includes an exception to the ESA takings prohibitions for incidental catch of threatened sea turtles in fishing gear if (a) the fishing is not in an area of substantial sea turtle breeding or feeding and (b) the turtles are immediately returned to the water.

July 28, 1978 - NOAA Fisheries and FWS publish final regulations (43 FR 32800) listing loggerhead, green, and olive ridley sea turtles as threatened species, except for Florida green turtle breeding colony populations and Pacific coast of Mexico olive ridley and green turtle breeding colony populations, which were listed as endangered. Many commenters on the proposal had objected to the "areas of substantial breeding and feeding" language, fearing that a strict interpretation could put many shrimpers out of business. In the final rule, incidental capture of threatened turtles with fishing gear is exempted from the ESA takings prohibitions in all areas, if turtles are returned to the water following resuscitation attempts for unconscious animals.

The rule states that NOAA Fisheries has developed and is testing a turtle excluder panel installed across the mouth of a shrimp trawl to prevent or substantially reduce the capture of sea turtles, with the objective of completing the development and testing of the panel by the end of the 1978 shrimp season. NOAA Fisheries states its "goal is to promulgate regulations requiring the use of the panel to prevent, or substantially reduce, incidental catch of sea turtles without significantly reducing shrimp production."

1978 - Further testing of the turtle excluder panels yields poor results for turtle exclusion (only 75% exclusion) and shrimp retention (15 to 30% loss). Work on the excluder panels is abandoned (NMFS 1987).

1978-1981 - NOAA Fisheries' attention is turned toward testing and development of a rigid Turtle Excluder Device (TED) that can be inserted farther back in the net. Turtle exclusion and shrimp retention results for the TED are positive. By 1981, the NMFS TED – a large, cage-like device with a metal-framed trap door – has been developed and found to release 97 percent of the turtles caught in shrimp trawls with no loss of shrimp (52 FR 24244, June 29, 1987).

1981-1983 - NOAA Fisheries encourages voluntary use of TEDs in the shrimp fishery.

1983-1986 - NOAA Fisheries operates a formal program which builds and delivers TEDs to shrimp fishermen who agree to use them voluntarily in commercial shrimping operations. The program proves ineffective. By 1985, less than 1% of the shrimp fleet is using TEDs (NMFS 1992).

October - December 1986 - NOAA Fisheries sponsors mediated sessions involving environmental and shrimp industry groups. The negotiations attempt to develop a mutually acceptable implementation of TED requirements and avert threatened litigation from environmental groups. One party to the mediation sessions, the Concerned Shrimpers of Louisiana, refuses to sign the developed agreement and negotiations break down.

1987 - A report analyzing observer data from the southeast U.S. shrimp fishery from 1973-1984 conservatively estimates that the shrimp fishery in offshore waters kills 9,874 loggerhead, 767 Kemp's ridley, and 229 green turtles annually (Henwood and Stuntz 1987).

March 2, 1987 - NOAA Fisheries develops and publishes proposed regulations to require the use of TEDs in most offshore shrimp trawlers (52 FR 6179),

June 29, 1987 - NOAA Fisheries publishes final regulations implementing TED requirements (52 FR 24244). The regulations are codified at 50 CFR parts 217, 222, and 217. Many of the provisions of the rule phase in over a 20-month period. Ultimately, TEDs are required seasonally aboard all shrimp trawlers over 25 feet in length in offshore waters of the Gulf and South Atlantic, except for southwest Florida and the Canaveral area, where they are required year-round. Shrimp trawlers less than 25 feet in length and all trawlers in inshore waters are required to limit their tow-times to a maximum of 90 minutes seasonally, except in southwest Florida and the Canaveral area, where tow-times are required year-round.

Exemptions to the TED requirement are included for trawlers fishing for royal red shrimp and rock shrimp. Try nets up to 20 feet in headrope length are also exempted.

Four specific designs of hard TEDs – the NMFS TED, the Cameron TED, the Matagorda TED, and the Georgia TED – are included in the regulations as qualified TEDs. The minimum size of the TED escape openings is specified as 32 inches in the Gulf and 35 inches in the Atlantic, but how this opening is measured is not specified.

The regulations make provisions for testing and approving additional TED designs that may be developed by NOAA Fisheries or the shrimping industry. An appendix published with the regulations specifies a scientific protocol for evaluating new TEDs in the Cape Canaveral shipping channel. Candidate TEDs must demonstrate a reduction in the catch of wild turtles, compared to a net with no TED, of greater than 96%.

September 30, 1987 - NOAA Fisheries completes a biological opinion on the implementation of the 1987 regulations. The 1987 opinion addresses the potential adverse effects to listed species of implementation of the rule, and concludes that the regulations would have a positive impact on sea turtles by substantially reducing mortalities. At that time, NOAA Fisheries' policy on ESA section 7 consultation is to address the potential impacts to listed species of management actions and not to address potential adverse effects of the fishery itself. The policy is ultimately changed on October 18, 1990, when the Assistant Administrator for Fisheries advises all NOAA Fisheries Regional Directors that future ESA consultations on fishery management actions would address both the fishery and the proposed management action.

October 5, 1987 – NOAA Fisheries issues a final rule/technical amendment (52 FR 37152) to authorize an additional type of TED, the Morrison TED which is the first soft TED. It uses an upward-sloping panel of flexible webbing instead of the rigid grid used in hard TEDs.

October 1987 - May 1990 - A chaotic array of lawsuits, injunctions, suspensions of law enforcement, legislative actions by several states, legislation by Congress, and temporary rules issued by NOAA Fisheries and the Department of Commerce follows the initial effective date of the 1987 regulations. The result is a patchwork of times and areas where TEDs are and are not required/enforced. Except in limited times in states that separately required TEDs (South Carolina, Georgia, and Florida), TED use is probably very low throughout the region. (See NMFS (1992) for a detailed summary.)

October 7, 1988 - President Reagan signs a bill that requires a study by the National Academy of Sciences to review the question of sea turtle conservation status and the significance of mortality from commercial trawling.

September 1, 1988 - NOAA Fisheries issues a final rule/technical amendment (53 FR 33820) to authorize an additional soft TED, the Parrish TED. It uses a downward-sloping webbing panel leading to a rigid frame.

November 21, 1989 - President G. Bush signs Public Law 101-162. Section 609 requires the State Department, in consultation with the Department of Commerce, to initiate negotiations with foreign countries to develop agreements for sea turtle conservation, with emphasis on countries that have commercial fishing fleets that adversely affect sea turtles. It further requires the United States to ban the importation of commercially harvested shrimp unless the exporting country has been certified by the State Department as having a regulatory program for sea turtle incidental capture in shrimp trawls that is comparable to the United States' requirements. The certification is due on May 1, 1991, and annually thereafter.

May 1990 - The National Academy of Science report, "Decline of the Sea Turtles: Causes and Prevention," is released (Magnuson *et al.* 1990). The report concludes that:

(1) Combined annual counts of nests and nesting females indicate that nesting sea turtles continue to experience population declines in most of the United States. Declines of Kemp's ridleys on the nesting beach in Mexico and of loggerheads on South Carolina and Georgia nesting beaches are especially clear;

(2) Natural mortality factors – such as predation, parasitism, diseases and environmental changes – are largely unquantified, so their respective impacts on sea turtle populations remain unclear;

(3) Sea turtles can be killed by several human activities, including the effects of beach manipulations on eggs and hatchlings and several phenomena that affect juveniles and adults at sea :

collisions with boats, entrapment in fishing nets and other gear, dredging, oil-rig removal, power plant entrainment, ingestion of plastics and toxic substances, and incidental capture in shrimp trawls;

(4) Shrimp trawling kills more sea turtles than all other human activities combined, and the annual mortality estimate from Henwood and Stuntz (1987) may be low by as much as a factor of 4;

(5) Shrimp trawling can be compatible with the conservation of sea turtles if adequate controls are placed on trawling activities, especially the mandatory use of TEDs in most places at most times of the year; and

(6) The increased use of conservation measures on a worldwide basis would help to conserve sea turtles.

October 9, 1990 - NOAA Fisheries issues a final rule/technical amendment (55 FR 41088) to authorize an additional soft TED, the Andrews TED. It uses a net-within-the-net design.

October 9, 1990 - NOAA Fisheries publishes an alternative scientific protocol (55 FR 41092) to the Canaveral test for approving new TED designs. In 1989, there were not enough turtles in the Canaveral Channel to conduct TED testing, necessitating the development of a new protocol. The new, small turtle test protocol overcomes some of the other concerns over the Canaveral test. In particular, it uses turtles that are similar in size to wild Kemp's ridleys, the species of greatest conservation concern at the time, and it allows divers to videotape every turtle's encounter with the candidate TED, greatly increasing the understanding of the factors in a TED's design that affect sea turtle exclusion. The small turtle test's limitation, however, is that, since captive animals are used under experimental conditions, the metric used for decisions is a candidate TED's performance relative to a control TED, rather than its straight reduction in sea turtle captures.

April 1992 - The South Atlantic Fishery Management Council (SAFMC) requests consultation on the Shrimp Fishery Management Plan for the South Atlantic, and the Gulf of Mexico Fishery Management Council (GMFMC) requests consultation on Amendment 6 to the Gulf of Mexico Shrimp Fishery Management Plan.

April 30, 1992 - NOAA Fisheries proposes to amend the sea turtle conservation regulations to strengthen their effectiveness and enforceability (57 FR 18446). The proposal would require essentially all shrimp trawlers in the southeast U.S. to use TEDs year-round, even in inshore waters, with only limited exemptions.

August 19, 1992 - NOAA Fisheries completes section 7 consultation and issues a biological opinion that considers the two Council's FMPs, the shrimp fishery itself in the Gulf and South Atlantic, and the implementation of the 1992 revised sea turtle conservation regulations. The opinion concludes that shrimp trawling, as managed by the Councils and in compliance with the proposed sea turtle conservation regulations, is not likely to jeopardize the continued existence of listed species under NOAA Fisheries jurisdiction. With respect to leatherback turtles, however, the opinion states, "Leatherback mortalities remain a problem that must be addressed to avoid jeopardizing the recovery of this species."

The opinion's incidental take statement includes 6 reasonable and prudent measures (RPMs). Three have to do with items that are implemented through the regulations (required use of TEDs, limitations on the use of tow-times, and resuscitation of comatose turtles). A fourth is the requirement to implement an observer program to monitor turtle take whenever tow-times are authorized as an alternative to TEDs. NOAA Fisheries never implements such an observer program. Instead, on the future occasions when NOAA Fisheries does subsequently issue tow-time authorizations because of hurricane debris or algae blooms, NOAA Fisheries consults with the state fisheries directors who agree to provide elevated enforcement to ensure compliance with tow-times. A fifth reasonable and prudent measure states that NOAA Fisheries should develop a program so that all turtle mortalities are reported to the NOAA Fisheries, Southeast Regional Office, in person, by phone, or by letter, within 10 days of return from the fishing trip during which the incidental take occurred. This reporting program is never implemented. The final requirement is to develop and implement a contingency plan to eliminate the episodic take of leatherback turtles by shrimp trawlers. A contingency plan addressing some months along the Atlantic coast is ultimately developed.

September 8, 1992 - NOAA Fisheries publishes an interim final rule implementing some of the provisions of the April 1992 proposed rule.

December 4, 1992 - NOAA Fisheries publishes a final rule (57 FR 57348) implementing the April proposal. The rule includes a phase-in period for inshore vessels with small nets until December 1, 1994. The rule requires all shrimp trawlers in inshore and offshore waters from North Carolina to Texas to have TEDs installed in all nets that are rigged for fishing.

Exempted from the TED requirements are (1) royal red shrimp trawlers (but not rock shrimp fishermen), (2) beam and roller trawls if vertical bars on 4-inch spacings are attached across the mouth of the trawl, and (3) a single try net, up to 20 feet in headrope length, per boat.

Exempted from the TED requirements, if fishermen follow tow-time limits of 55 minutes from April-October and 75 minutes from November-March, are (1) trawls that are entirely hand-hauled, (2) bait shrimpers if all shrimp are kept in a live-well with no more than 32 pounds of dead shrimp aboard, (3) pusher-head trawls (chopsticks rigs), skimmer trawls, and wing nets (butterfly nets), (4) in an area and at a time where the Assistant Administrator determines that special environmental conditions make TED use impracticable, and (5) if the Assistant Administrator determines that TEDs are ineffective.

Resuscitation measures that fishermen must follow for incidentally caught turtles that come aboard in a comatose condition are modified, and fishermen are allowed to hold turtles on board under certain conditions, while they are being resuscitated.

The technical specifications for hard TEDs are rewritten to create more explicit and more flexible descriptions of the required construction characteristics of hard TEDs, rather than require shrimpers to use one of the 4 named styles of hard TEDs from the 1987 regulation. The specifications for the TED opening dimensions are clarified for single-grid hard TEDs: 35 inches horizontal and, simultaneously, 12 inches vertical in the Atlantic, and 32 inches horizontal and, simultaneously, 10 inches vertical in the Gulf of Mexico. Descriptions of accelerator funnels and webbing flaps – optional modifications to increase shrimp retention – are added.

A framework and procedures are established whereby the Assistant Administrator may impose additional restrictions on shrimping, or any other fishing activity, if the incidental taking of sea turtles in the fishery would violate an incidental take statement, biological opinion, or incidental take permit or may be likely to jeopardize the continued existence of a listed species.

May 17, 1993 - NOAA Fisheries issues a final rule/technical amendment (58 FR 28795) to authorize an additional soft TED, the Taylor TED. It is similar to the Morrison TED, but uses a smaller panel of smaller-mesh webbing and a flap over the escape opening. A modification of the Morrison TED to use a larger escape opening covered with a flap is also approved. The Taylor TED and modified Morrison TED have escape openings that are large enough to release leatherback turtles.

October 20, 1993 - NOAA Fisheries issues a final rule/technical amendment (58 FR 54066) to create a new category of hard TEDs – special hard TEDs – and to authorize a new special hard TED for the shrimp fishery, the Jones TED. The Jones TED features bars that are set diagonally, rather than vertically, in the face of the grid, and whose bar ends are not attached to other bars or to the TED frame.

May 18, 1994 - NOAA Fisheries issues a final rule/technical amendment (59 FR 25827) to specify a modification that can be made to the escape opening of single grid hard TEDs that will allow the TEDs to exclude leatherback turtles.

June 29, 1994 - NOAA Fisheries issues an interim final rule (59 FR 33447) to require bottom-opening hard TEDs to be modified by attaching floats to the TEDs to keep them from riding hard on the sea floor. Major increases in sea turtle strandings were observed that spring in Texas, and the absence of floats on bottom-opening TEDs was one contributing factor.

November 14, 1994 – NOAA Fisheries completes section 7 consultation and issues a biological opinion on the impacts of shrimp trawling in the southeastern United States (NMFS 1994). Consultation on the shrimp fishery had been reinitiated as the result of extraordinarily high strandings of sea turtles, particularly the critically endangered Kemp's ridley turtle, in Texas and Louisiana corresponding to periods of heavy nearshore shrimping effort. The opinion concludes that "[c]ontinued long-term operation of the shrimp fishery in the southeastern U.S., resulting in mortalities of Kemp's ridley turtles at levels observed in the Gulf of Mexico in 1994, is likely to jeopardize the continued existence of the Kemp's ridley population."

The jeopardy opinion included a reasonable and prudent alternative (RPA) that would allow the shrimp fishery to continue and avoid the likelihood of jeopardizing Kemp's ridley sea turtles. The RPA specified measures that NOAA Fisheries must take to improve TED regulation compliance: (1) Develop an emergency response plan (ERP) to address increases in sea turtle strandings or TEDs noncompliance; (2) Deploy a specially trained law enforcement team to respond to high strandings, TEDs noncompliance, or intensive shrimping effort in areas of expected sea turtle abundance; (3) Develop and implement a TED enforcement training program for U.S. Coast Guard boarding parties; (4) Amplify domestic TED technology programs; (5) Develop a permitting or registration system for offshore shrimpers that would allow sanctioning the permit for TED violations and failing to pay assessed fines. NOAA Fisheries must also re-examine the effectiveness of bottom-shooting hard

TEDs and soft TEDs and mitigate the impacts of intensive nearshore shrimping effort through the identification of areas requiring special turtle management. NOAA Fisheries ultimately implements all the elements of the RPA, with the exception of the shrimper permitting/registration system.

The opinion's incidental take statement, in addition to establishing incidental take levels based on observer coverage, sets indicated take levels, based on historical stranding levels. The ITS incorporates all of the RPMs from the 1992 opinion and also adds a number of new RPMs. NOAA Fisheries must improve the overall observer coverage in the shrimp fishery and improve stranding network coverage in poorly covered states. NOAA Fisheries must use this observer and stranding information to implement the actions of the ERP. NOAA Fisheries must also convene a team of population biologists, sea turtle scientists, and life history specialists to compile and examine information on the status of sea turtle species. The team should attempt to determine the maximum number of individual sea turtles of each species that can be taken incidentally to commercial fishing activities without jeopardizing the continued existence of the species and what the corresponding level of strandings would be. Lastly, NOAA Fisheries is required to evaluate other human-caused sources of sea turtle mortality and identify measure to reduce those sources of mortality.

March 14, 1995 - NOAA Fisheries issues the details of the ERP, required under the RPA of the 1994 opinion. The ERP is issued to identify monitoring, reporting and enforcement actions, as well as associated management measures that NOAA Fisheries would consider implementing by emergency rulemaking if strandings become elevated. Briefly, the ERP identifies interim sea turtle management areas (ISMAs) within which enforcement would be elevated from April through November. Two ISMAs were identified: Atlantic Interim Special Management Area, including shrimp fishery statistical Zones 30 and 31 (northeast Florida and Georgia) and the Northern Gulf Interim Special Management Area, including statistical Zones 13 through 20 (Louisiana and Texas from the Mississippi River to North Padre Island). NOAA Fisheries would implement gear restrictions on shrimp trawling through existing rulemaking authority (codified at 50 CFR 227.72(e)(6)) in response to 2 weeks of elevated strandings at levels approaching (within 75% of) the indicated take levels or higher in the ISMAs when no other likely causes of mortality were evident. Outside of the ISMA, implementation of similar restrictions would be considered after 4 weeks of elevated strandings. Areas monitored were delineated as the NOAA Fisheries shrimp fishery statistical areas, and restrictions would be implemented within zones of elevated strandings out to 10 nautical miles (nm) offshore.

March 24, 1995 - NOAA Fisheries issues a final rule/technical amendments (60 FR 15512) to finalize the float requirement and implement a variety of other minor changes to TED technical specifications. One of these specifies that the width of the cut for a hard TED's escape opening must extend at least from the outermost bar of the grid to the opposite outermost bar of the grid.

May - August 1995 - NOAA Fisheries implements gear restrictions based on the ERP through temporary rulemaking four times during 1995: twice in the Gulf of Mexico and twice in the Atlantic (60 FR 21741, May 3, 1995; 60 FR 26691, May 18, 1995; 60 FR 31696, June 16, 1995; 60 FR 32121, June 20, 1995; 60 FR 42809, August 17, 1995; 60 FR 43106, August 18, 1995; 60 FR 44780, August 29, 1995).

May 12, 1995- NOAA Fisheries issues an interim rule (60 FR 25620) to establish all inshore and offshore waters from Cape Canaveral, FL (28°24.6' N. lat.) to the North Carolina-Virginia border (36°30.5'N. lat.) as the leatherback conservation zone and to provide for short-term closures of areas in that zone when high abundance levels of leatherback turtles are documented ("the leatherback contingency plan"). Upon such documentation, NOAA Fisheries would prohibit, in the closed areas, fishing by any shrimp trawler required to have a TED installed in each net that is rigged for fishing, unless the TED installed is specified in the regulations as having an escape opening large enough to exclude leatherback turtles. NOAA Fisheries also proposes (60 FR 25663) to adopt as final this interim rule establishing the leatherback conservation zone.

June 2, 1995- NOAA Fisheries temporarily amends the regulations (60 FR 28741) protecting sea turtles to allow compliance with tow-time limits as an alternative to the use of TEDs in a 30-square mile (48.3-square km) area off the coast of North Carolina to allow shrimp fishermen to fish under conditions of high concentrations of red and brown algae (that make trawling with TEDs impracticable) while maintaining adequate protection for sea turtles in this area.

September 14, 1995-NOAA Fisheries issues a final rule (60 FR 47713) establishing the leatherback conservation zone and leatherback contingency plan in the Atlantic.

April 24, 1996- NOAA Fisheries proposes (61 FR 18102) prohibiting the use of all previously approved soft TEDs; requiring the use of approved hard TEDs in try nets with a headrope length greater than 12 ft (3.6 m) or a footrope length greater than 15 ft (4.6 m); establishing Shrimp Fishery Sea Turtle Conservation Areas (SFSTCAs) in the northwestern Gulf of Mexico, and in the Atlantic along the coasts of Georgia and South Carolina; and, within the SFSTCAs, prohibiting soft TEDs, imposing the new try net restrictions, and prohibiting the use of bottom-opening hard TEDs.

June 11, 1996 - NOAA Fisheries completes section 7 consultation and issues a biological opinion on the impacts of shrimp trawling in the southeastern United States (NMFS 1996). Consultation on the shrimp fishery had been reinitiated to evaluate the effects of the April 24 proposed rule and of a plan to implement a shrimp vessel registration system and to consider the effects of strandings-based incidental take levels that had been exceeded. The opinion concludes that continued operation of the shrimp fishery is not likely to jeopardize listed sea turtles, with implementation of the proposed TED rule changes and of a shrimp vessel registration system, which the opinion requires to be proposed formally by the end of 1996. The opinion also eliminates the strandings-based incidental take levels that had been in place since the introduction of the ERP in March 1995. The ERP is replaced instead with a more flexible requirement for NOAA Fisheries to consult with state stranding coordinators to identify significantly local stranding event and to implement 30-day restrictions on shrimping in response, as appropriate.

June 27, 1996 - NOAA Fisheries issues temporary additional restrictions (61 FR 33377) on shrimp trawlers fishing in the Atlantic Area in inshore waters and offshore waters out to 10 nautical miles (nm)(18.5 km) from the COLREGS line, between the Georgia-Florida border and the Georgia-South Carolina border. The restrictions include prohibitions on the use of soft TEDs and try nets with a headrope length greater than 12 ft (3.6 m) or a footrope length greater than 15 ft (4.5 m), unless the try nets are equipped with approved TEDs other than soft TEDs. The restrictions are in response to elevated sea turtle mortality.

November 13, 1996 - NOAA Fisheries completes section 7 consultation and issues a biological opinion on the impacts of shrimp trawling in the southeastern United States (NMFS 1996a). Consultation on the shrimp fishery had been reinitiated to evaluate the effects of the final rule implementing the April 24 proposed rule and of elevated loggerhead strandings that occurred during 1996. The opinion concludes that continued operation of the shrimp fishery is not likely to jeopardize listed sea turtles, with the publication of the final rule, which implements the RPA component of the 1994 opinion requiring NOAA Fisheries to address mortalities resulting from incorrect installation of TEDs and the certification of TEDs which do not effectively exclude sea turtles. The opinion extends the deadline for finalizing the shrimp vessel registration requirement through February 1997.

December 19, 1996 - NOAA Fisheries issues a final rule (61 FR 66933) requiring that TEDs be installed in try nets with a headrope length greater than 12 ft (3.6 m) and a footrope length greater than 15 ft (4.6 m); removing the approval of the Morrison, Parrish, Andrews, and Taylor soft TEDs; establishing Shrimp Fishery Sea Turtle Conservation Areas (SFSTCAs); and within the SFSTCAs, imposing the new TED requirement for try nets, removing the approval of soft TEDs, and modifying the requirements for bottom-opening hard TEDs.

March 24, 1998 - NOAA Fisheries completes section 7 consultation and issues a biological opinion on the impacts of shrimp trawling in the southeastern United States (NMFS 1998). Consultation on the shrimp fishery had been reinitiated to evaluate the effects of approving the use of a new soft TED, to discuss the decision not to implement a mandatory shrimp vessel registration system (part of the 1994 biological opinion's RPA), and to evaluate recent data on sea turtle populations and strandings. The opinion concludes that continued operation of the shrimp fishery is not likely to jeopardize listed sea turtles, with continued improved enforcement of the sea turtle conservation regulations and expanded education and outreach programs.

April 13, 1998 - NOAA Fisheries issues an interim final rule (63 FR 17948) authorizing the use of a new soft TED – the Parker TED – in certain trawl net styles for an 18 month trial period, during which its performance will be evaluated to ensure that it remains effective at excluding sea turtles during extended commercial use.

October 14, 1998 - NOAA Fisheries issues a rule (63 FR 55053) effective through November 6, 1998 to allow the temporary use of limited tow times by shrimp trawlers in Alabama inshore waters as an alternative to the requirement to use TEDs in order to address difficulty with TED performance due to large amounts of debris in Alabama's bays in the aftermath of a hurricane.

May-June 1999 - NOAA Fisheries issues four temporary rules (64 FR 25460, May 12, 1999; 64 FR 27206, May 19, 1999; 64 FR 28761, May 27, 1999; 64 FR 29805, June 3, 1999) to protect leatherback sea turtles within the leatherback conservation zone.

October 13, 1999 - NOAA Fisheries issues an interim final rule (64 FR 55434) extending the authorized use of the Parker TED for an additional 12 months, as the results of the Parker TED's evaluation have been inconclusive.

December 13, 1999- NOAA Fisheries issues a 30-day rule (64 FR 69416) imposing an additional restriction on shrimp trawlers required to have a TED installed in each net that is rigged for fishing, operating in Atlantic offshore waters out to 10 nm from the coast of Florida between 28° N. latitude and the Georgia-Florida border. Shrimp vessels operating in this area must use the leatherback modification for hard TEDs or the leatherback modification for the Parker soft TED. The restrictions are in response to greatly elevated leatherback sea turtle strandings in the area. The strandings occur during a time when the leatherback contingency plan does not apply, necessitating the use of the 30-day rule.

October 25, 1999- NOAA Fisheries issues a temporary rule (64 FR 57397) to allow the use of limited tow times by shrimp trawlers as an alternative to the use of TEDs in the Matagorda Bay area of Texas. This action is required due to extraordinarily high concentrations of a bryozoan lodging in TEDs, rendering them ineffective in expelling sea turtles as well as negatively impacting fishermen's catches.

April 5, 2000- NOAA Fisheries issues an advance notice of proposed rulemaking to announce that it is considering technical changes to the requirements for TEDs. NOAA Fisheries proposes to modify the size of the TED escape opening, modify or decertify hooped hard TEDs and weedless TEDs, and change the requirements for the types of flotation devices allowed. NOAA Fisheries also proposes to consider modifications to the leatherback conservation zone regulations to provide better protection to leatherback turtles.

April 25, 2000- NOAA Fisheries issues a 30-day rule (65 FR 24132) imposing an additional restriction on shrimp trawlers required to have a TED installed in each net that is rigged for fishing, operating in Gulf of Mexico offshore waters out to 10 nm between Port Mansfield Channel and Aransas Pass, Texas. Shrimp vessels operating in this area must use the leatherback modification for hard TEDs or the leatherback modification for the Parker soft TED. The restrictions are in response to leatherback sea turtle strandings in the area. The strandings occur in an area where the leatherback contingency plan does not apply, necessitating the use of the 30-day rule.

May 2000- NOAA Fisheries issues two temporary rules (65 FR 25670, May 3, 2000; 65 FR 33779, May 25, 2000) to protect leatherback sea turtles within the leatherback conservation zone.

August 29, 2000- NOAA Fisheries issues a temporary rule (65 FR 52348) to allow the use of limited tow times by shrimp trawlers as an alternative to the use of TEDs in inshore waters of Galveston Bay, Texas. Dense concentrations of marine organisms documented in this area were clogging TEDs, rendering them ineffective in expelling sea turtles from shrimp nests as well as negatively impacting fishermen's catches.

January 9, 2001 - NOAA Fisheries issues a final rule (66 FR 1601) permanently approving the use of the Parker soft TED. Although industry use of the Parker TED is extremely low, NOAA Fisheries' evaluation of its effectiveness does not find significant problems with compliance with the TED's specifications or with sea turtle captures.

May 14, 2001 - NOAA Fisheries issues an interim final rule (66 FR 24287) approving the use of an additional style of single-grid hard TED – the double cover flap TED.

October 2, 2001 - NOAA Fisheries issues a proposed rule (66 FR 50148) to amend the sea turtle conservation regulations to enhance their effectiveness in reducing sea turtle mortality resulting from shrimp trawling in the Atlantic and Gulf Areas of the southeastern United States. NOAA Fisheries determines that modifications to the design of TEDs need to be made to exclude leatherbacks and large loggerhead and green turtles; several approved TED designs are structurally weak and do not function properly under normal fishing conditions; and modifications to the trynet and bait shrimp exemptions to the TED requirements are necessary to decrease lethal takes of sea turtles.

December 20, 2001 - NOAA Fisheries issues a 30-day rule (66 FR 65658) imposing an additional restriction on shrimp trawlers required to have a TED installed in each net that is rigged for fishing, operating in Atlantic offshore waters out to 10 nm from the coast of Florida between 28° N. latitude and the Georgia-Florida border. Shrimp vessels operating in this area must use the leatherback modification for hard TEDs or the leatherback modification for the Parker soft TED. The restrictions are in response to greatly elevated leatherback sea turtle strandings in the area. The strandings occur during a time when the leatherback contingency plan does not apply, necessitating the use of the 30-day rule.

December 31, 2001 - NOAA Fisheries issues a final rule (66 FR 67495) amending the sea turtle handling and resuscitation regulation.

April-May 2002 - NOAA Fisheries issues three temporary rules (67 FR 20054, April 24, 2002; 67 FR 21585, May 1, 2002; 67 FR 34622, May 15, 2002) to protect leatherback sea turtles within the leatherback conservation zone.

May 30, 2002 - NOAA Fisheries issues a 30-day rule (67 FR 37723) imposing additional restrictions on shrimp trawlers in offshore Atlantic waters west of approximately Cape Fear, N.C. and north of approximately St. Augustine, Florida. Shrimp fishermen operating in this area are required to use TEDs with escape openings modified to exclude leatherback turtles and are prohibited from fishing at night between 1 hour after sunset and 1 hour before sunrise. These restrictions are implemented in response to greatly elevated strandings of loggerhead turtles and an apparent change in effort and behavior of the local fishery.

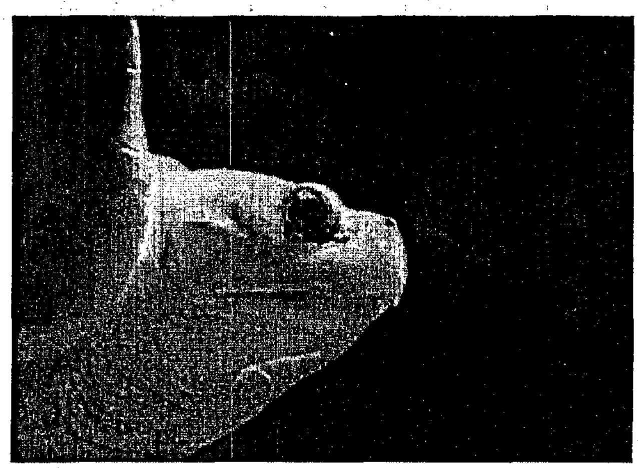
Office of Protected Resources

NOAA FISHERIES National Marine Fisheries Service

Kemp's Ridley Turtle (*Lepidochelys kempii*)

Endangered Species

The Kemp's ridley was listed as endangered throughout its range on December 2, 1970, and its status has remained unchanged. The Kemp's ridley population has declined since 1947 when an estimated 42,000 females nested in one day to a nesting population of approximately 1000 in the mid 1980's. The decline of this species was primarily due to human activities including collection of eggs, fishing for juveniles and adults, killing adults for meat and other products, and direct take for indigenous use. In addition to these sources of mortality, Kemp's ridleys have been subject to high levels of incidental take by shrimp trawlers. Today, under strict protection, the population appears to be in the earliest stages of recovery. The increase can be attributed to two primary factors: full protection of nesting females and their nests in Mexico, and the requirement to use turtle excluder devices (TEDs) in shrimp trawls both in the United States and Mexico.



Biology

The Kemp's ridley and olive ridley sea turtles are the smallest of all extant sea turtles, with the weight of an adult generally being less than 45 kg and the straight carapace length around 65 cm. Adult Kemp's ridleys' shells are almost as wide as long. Coloration changes significantly during development from the grey-black carapace and plastron of hatchlings to the lighter grey-olive carapace and cream-white or yellowish plastron of adults. There are two pairs of prefrontal scales on the head, five vertebral scutes, five pairs of coastal scutes and generally twelve pairs of marginals on the carapace. In each bridge adjoining the plastron to the carapace, there are four scutes, each of which is perforated by a pore. This is the external opening of Rathke's gland which secretes a substance of unknown (possibly a pheromone) function. Males resemble the females in size and coloration. Secondary sexual characteristics of male sea turtles include a longer tail, more distal vent, recurved claws and, during breeding, a softened mid-plastron. Eggs are 34-45 mm in diameter and 24-40 g in weight. Hatchlings range from 42-48 mm in straight line carapace length, 32-44 mm in width and 15-20 g in weight.

Neonatal Kemp's ridleys feed on the available sargassum and associated infauna or other epipelagic species found in the Gulf of Mexico. In post-pelagic stages, the ridley is largely a crab-eater, with a preference for portunid crabs. Age at sexual maturity is not known, but is believed to be approximately 7-15 years, although other estimates of age at maturity range as high as 35 years.

Distribution

The major nesting beach for Kemp's ridleys is on the northeastern coast of Mexico. This location is near Rancho Nuevo in southern Tamaulipas. The species occurs mainly in coastal areas of the Gulf of Mexico and the northwestern Atlantic Ocean.

Human Impacts on Kemp's Ridley Sea Turtles

I) Impacts in the nesting environment

Threats to the nesting beach in Mexico are presently few, but potentially serious. Human population growth and increasing developmental pressure will result in increased threats to the nesting beach. Only the central part of the prime nesting area is protected by Mexican presidential decree. A primary concern is human encroachment and access along the entire nesting area. However, the wording of the Mexican decree is vague and construction of commercial fishing facilities proceeded in 1987 immediately adjacent to the main turtle camp at Rancho Nuevo. Occasionally plans for massive expansion of La Pesca (just to the north of the nesting area) as a fishing center or dredging of the Gulf Intercoastal Waterway from Brownsville, Texas to Barra del Tordo (in the south part of the nesting beach) are reported. These plans are alarming because of the assuredly detrimental and possibly disastrous effects that they could have on the nesting population if they were to be completed.

A threat resulting from management practices at Ranch Nuevo is relocating all of the nests in one corral to prevent poaching and predation. This concentration makes the eggs more susceptible to reduced viablility from the manipulation, disease vectors and inundation.

II)Impacts in the marine environment

1. It is estimated that before the implementation of TEDs, the commercial shrimp fleet killed 500-5000 Kemp's ridleys each year. Besides shrimp trawls, Kemp's ridleys have been taken in pound nets, trawls, gill nets, hook and line, crab traps, and longlines. Beginning in 1976, the U.S. and Mexican governments agreed to phase out U.S. shrimping in Mexican waters by 1979. U.S. shrimp vessels continued to illegally operate off Mexico through the mid 1980s. The Mexican shrimp fleet has declined and consists of only approximately 600 vessels, many of which do not operate. Also since 1978, Mexico has closed the nearshore waters off Rancho Nuevo to fishing during the nesting season. However, this closure has not been strictly enforced.
2. The Gulf of Mexico is an area of high density offshore oil extraction with chronic low-level spills and occasional massive spills. The two primary feeding grounds for adult Kemp's ridley turtles in the northern and southern Gulf of Mexico are both near major areas of near shore and offshore oil exploration and production. The nesting beach at Rancho Nuevo is also vulnerable and has been affected by oil spills.
3. The vast amount of floating debris in the Gulf of Mexico constitutes an increasingly serious threat to Kemp's ridley turtles of all ages. Plastics, monofilament, discarded netting and many other waste items are either eaten by Kemp's ridleys or become

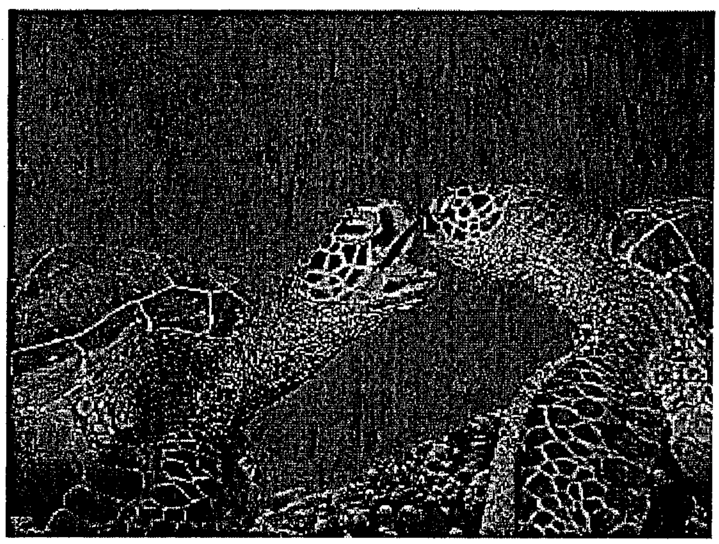
death traps when the turtles become entangled. Injestion of plastic, rubber, fishing line and hooks, tar, cellophane, rope amd string, wax, styrofoam, charcoal, aluminum cans and cigarette filters has occurred in sea turtles. NMFS is currently analyzing stranding data and available necropsy information to determine the magnitude of debris ingestion and entanglement.

4. Dredging operations affect Kemp's ridley turtles through incidental take and by degrading the habitat. Incidental take of ridleys has been documented with hopper dredges. In addition to direct take, channelization of the inshore and nearshore areas can degrade foraging and migratory habitat through spoil dumping, degraded water quality/clarity and altered current flow.

Green Sea Turtle (Chelonia mydas)

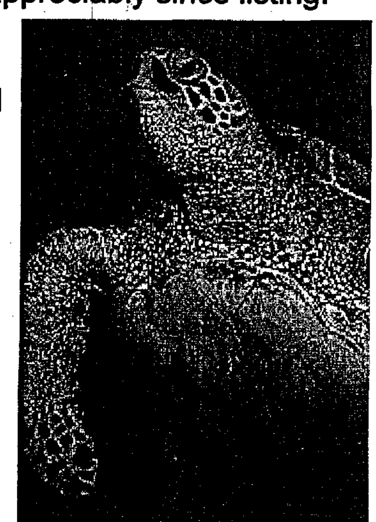
Threatened Species

(Endangered: Florida and Mexican Breeding Populations)



The green sea turtle was listed as endangered/threatened on July 28, 197 breeding populations off Florida and the Pacific coast of Mexico are listed as endangered while all others are threate

Total population estimates for the greer are unavailable, and trends are particul difficult to assess because of wide year year fluctuations in numbers of nesting females, difficulties of conducting resea early life stages, and long generation tir Present estimates range from 200-1,10 females nesting on U.S. beaches. The r of nests has increased on Hutchinson Is Florida, over the period 1971 - 1989, alt nesting levels have been low on other nesting beaches. Population estimates given are for t number of nesting females in Florida. Populations in Surinam, and Tortuguero, Costa Rica, stable, but there is insufficient data for other areas to confirm a trend. The recovery team for green turtle concluded that the species status has not improved appreciably since listing.



The greatest cause of decline in green turtle populations is commercial harvest for eggs and food. Other turtle parts are used for leather and jewelry, and small turtles are sometimes stuffed for curios. Incidental catch during commercial shrimp trawling is a continuing source of mortality that adversely affects recovery.

Biology

Adult green turtles may reach a size of 1 m long and 180 kg mass. The carapace is smooth and is colored gray, green, brown and black. The plastron is yellowish white. Hatchlings weigh about 25 g, and are about 50 mm long. Hatchlings are black on top and white on the bottom. Age at sexual maturity is estimated at 20-50 years.

Distribution

In the southeastern United States, green turtles are found around the U.S. Virgin Islands, Pu Rico, and the continental U.S. from Texas to Massachusetts. Important feeding grounds in F include Indian River Lagoon, the Florida Keys, Florida Bay, Homosassa, Crystal River and C Key. The primary nesting sites in U.S. Atlantic waters are along the east coast of Florida, wit additional sites in the U.S. Virgin Islands and Puerto Rico.

Green turtles are found throughout the North Pacific, ranging as far north as Eliza Harbor, Admiralty Island, Alaska, and Ucluelet, British Columbia. In the eastern North Pacific, green have been sighted from Baja California to southern Alaska. In the central Pacific, green turtl be found at most tropical islands. In U.S. Hawaiian waters, green turtles are found around m the islands in the Hawaiian Archipelago. The primary nesting site is at French Frigate Shoal:

Human Impacts on Green Sea Turtles

I) Impacts to nesting activities:

1. In the United States, killing of nesting green turtles is infrequent. However, in a numbe areas, egg poaching is still a concern.
2. Erosion of nesting beaches can result in loss of nesting habitat.
3. Development of beachfronts results in fortification to protect property from erosion, res in loss of a dry nesting beach by preventing females from getting to nesting sites.
4. Beach nourishment during the nesting season buries nests and disturbs nesting turtles
5. Artificial lighting can cause disorientation and misorientation of both adults and hatchli Turtle hatchlings are attracted to light, ignoring or coming out of the ocean to go towar light source, increasing their chances of death or injury. In addition, as nesting females areas with intense lighting, highly developed areas may cause problems for turtles tryi nest.
6. Repeated mechanical raking of nesting beaches by heavy machinery can result in con sand and causes tire ruts which may hinder or trap hatchlings. Rakes can penetrate th surface and disturb or uncover a nest. Disposing of debris on the high beach can cove and may alter nest temperature.
7. The most serious threat of nighttime use of a beach is the disturbance of nesting fema Heavy utilization of nesting beaches by humans may also result in lowered hatchling s due to sand compaction.
8. The placement of physical obstacles on a beach can hamper or deter nesting attempts well as interfere with the incubation of eggs and the emergence of hatchlings.
9. The use of off-road vehicles on beaches is a serious problem in many areas. It may re decreased hatchling success due to sand compaction, or directly kill hatchlings. Tire ru also interfere with the ability of hatchlings to get to the ocean.
10. The invasion of a nesting site by non-native beach vegetation can lead to increased er and destruction of a nesting habitat. Trees shading a beach can also change nest temperatures, altering the natural sex ratio of the hatchlings.

II) Impacts in the marine environment

1. Dredging can result in habitat destruction by disrupting nesting or foraging grounds. H(dredges can also kill turtles caught in dragheads.
2. Green turtles eat a wide variety of marine debris such as plastic bags, plastic and styr(pieces, tar balls, balloons and plastic pellets. Effects of consumption include interferen metabolism or gut function, even at low levels of ingestion, as well as absorption of to› byproducts. NMFS is currently analyzing stranding data and available necropsy inform determine the magnitude of debris ingestion.
3. Commercial fishing
   - It is estimated that before the implementation of TED requirements, the offshore commercial shrimp fleet captured about 925 green turtles a year, of which approximately 225 would die. Most turtles killed are juveniles and sub-adults. Blu croaker and flounder trawl fishing are also serious threats.
   - Turtles are be taken by purse seine fisheries in the Atlantic and Gulf of Mexico, b magnitude of take is currently not known.
   - Several thousand vessels are involved in hook and line fishing for various coasta species. The capturing of turtles is not uncommon, but the number is not known.
   - Significant numbers of turtles may be killed by gill and trammel net fisheries off tl eastern coast of central Florida. An exact number is not known.
   - Pound net fisheries are primarily a problem in waters off of Virginia, where turtles tangled in the gear and drown. In North Carolina, live turtles are often released fr pound nets.
   - Over 330 sea turtles of various types (a few of which were green) were captured Atlantic and Gulf of Mexico EEZ in the Japanese tuna longline fishery from 1978- Due to expansion of this type of fishing, it may have a significant impact on sea t recovery. The number of deaths is unknown.
   - Green turtles become entangled in trap lines and drown. The impact on the popu has not been determined.
4. In areas where recreational boating and ship traffic is intense, propeller and collision ir are not uncommon.
5. Marine turtles are at risk when encountering an oil spill. Respiration, skin, blood chemi and salt gland functions are affected.
6. Pesticides, heavy metals and PCB's have been detected in turtles and eggs, but their unknown.
7. Marina and dock development can cause foraging habitat to be destroyed or damagec also lead to increased boat traffic, increasing the risk of turtle/vessel collisions.
8. Turtles have been caught in saltwater intake systems of coastal power plants. The mo rate of the turtles involved is estimated at 7%.
9. Underwater explosions (e.g. gas and oil structure removal and testing using explosives kill or injure turtles, and may destroy or damage habitat.
10. Turtles get caught in discarded fishing gear. The number affected is unknown, but is potentially significant.
11. Illegal harvesting of green turtles is uncommon in the U.S. No estimates of take exist. I take of green turtles in the Caribbean, particularly near Puerto Rico, is a significant prc

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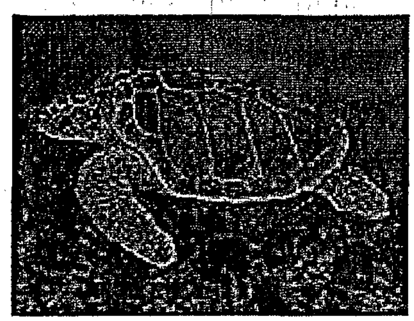
Office of Protected Resources

NOAA FISHERIES National Marine Fisheries Service

Loggerhead Sea Turtles (Caretta caretta)

Threatened Species

The loggerhead turtle was listed as threatened throughout its range on July 28, 1978 (43 FR 82808), and its status has not changed. Most recent evidence suggests that the number of nesting females in South Carolina and Georgia may be declining, while the number of nesting females in Florida appears to be stable.



News and Updates: On January 14, 2002, the National Marine Fisheries Service (NMFS) received a petition to reclassify the Northern and Florida Panhandle subpopulations of the loggerhead turtle as distinct population segments with endangered status and to designate critical habitat. NMFS published a 90-day finding stating the petition presented substantial information that the reclassification may be warranted and announcing the initiation of a status review.

Four nesting subpopulations of loggerheads in the western North Atlantic have been identified based on genetic research: (1) the Northern Subpopulation, producing approximately 6,200 nests/year from North Carolina to Northeast Florida; (2) the South Florida Subpopulation, occurring from just north of Cape Hatteras on the east coast of Florida and extending up to Naples on the west coast. The Northern Subpopulation declined through the mid 1980s and thereafter a trend is not detected. Recent surveys of South Carolina nesting beaches (where more than 30% of the nesting of the Northern Subpopulation occurs) indicate a downward trend and thus the subpopulation is stable or declining. The South Florida Subpopulation appears to have shown significant increases over the last 25 years, suggesting the population is recovering, although the trend could not be detected over the most recent 7 years of nesting. An increase in the numbers of adult loggerheads has been reported in recent years in Florida waters without a concomitant increase in benthic immatures. These data may forecast limited recruitment to South Florida nesting beaches in the future. Since loggerheads take approximately 20-30 years to mature, the effects of decline in immature loggerheads might not be apparent on nesting beaches for decades. The recovery team concluded that nesting trends for the loggerhead are generally declining. The most significant threats tot he loggerhead populations is coastal development, commercial fisheries, and pollution.

Loggerhead populations in Honduras, Mexico, Colombia, Israel, Turkey, Bahamas, Cuba, Greece, Japan, and Panama have been declining. This decline continues and is primarily attributed to shrimp trawling, coastal development, increased human use of nesting beaches, and pollution. Loggerheads are the most abundant species in U.S. coastal waters, and are often captured incidental to shrimp trawling. Shrimping is thought to have played a significant role in the population declines observed for the loggerhead.

Biology

Adults and sub-adults have a reddish-brown carapace. Scales on the top and sides of the head and top of the flippers are also reddish-brown, but have yellow borders. The neck, shoulders and limb bases are dull brown on top and medium yellow on the sides and bottom. The plastron is also medium yellow. Adult average size is 92 cm straight carapace length; average weight is 115 kg. Hatchlings are dull brown in color. Average size at hatching is 45 mm long; average weight is 20 g. Maturity is reached at between 16-40 years. Mating takes place in late March-early June, and eggs are laid throughout the summer.

Distribution

Loggerheads are circumglobal, inhabiting continental shelves, bays, estuaries, and lagoons in temperate, subtropical, and tropical waters. In the Atlantic, the loggerhead turtle's range extends from Newfoundland to as far south as Argentina. During the summer, nesting occurs in the lower latitudes. The primary Atlantic nesting sites are along the east coast of Florida, with additional sites in Georgia, the Carolinas, and the Gulf Coast of Florida. In the eastern Pacific, loggerheads are reported as far north as Alaska, and as far south as Chile. Occasional sightings are also reported from the coast of Washington, but most records are of juveniles off the coast of California. Southern Japan is the only known breeding area in the North Pacific.

Human Impacts on Loggerhead Sea Turtles

I) Impacts in the nesting environment

1. In the United States, killing of nesting loggerheads is infrequent. However, in a number of areas, egg poaching is common.
2. Erosion of nesting beaches can result in loss of nesting habitat.
3. Development of beachfronts results in fortification to protect property from erosion, resulting in loss of a dry nesting beach. It can also prevent females from getting to nesting sites and wash out nests.
4. Beach nourishment impacts turtles by burial of nests, disturbance to nesting turtles, and changes in sand compaction and temperature which may affect embryo development.
5. Artificial lighting can cause disorientation or misorientation of both adults and hatchlings. Turtles are attracted to light, ignoring or coming out of the ocean to go towards a light source, increasing their chances of death or injury. In addition, as nesting females avoid areas with intense lighting, highly developed areas may cause problems for turtles trying to nest.
6. Repeated mechanical raking of nesting beaches by heavy machinery can result in compact sand and causes tire ruts which may hinder or trap hatchlings. Rakes can penetrate the surface and disturb or uncover a nest. Disposing of debris on the high beach can cover nests and may alter nest temperature.
7. A serious threat of nighttime use of a beach is the disturbance of nesting females. Heavy utilization of nesting beaches by humans may also result in lowered hatchling success due to sand compaction.

8. The placement of physical obstacles on a beach can hamper or deter nesting attempts as well as interfere with incubating eggs and the sea approach of hatchlings.
9. The use of off-road vehicles on beaches is a serious problem in many areas. It may result in decreased hatchling success due to sand compaction, or directly kill hatchlings. Tire ruts may also interfere with the ability of hatchlings to get to the ocean.
10. The invasion of a nesting site by non-native beach vegetation can lead to increased erosion and destruction of a nesting habitat. Trees shading a beach can also change nest temperatures, altering the natural sex ratio of the hatchlings.

II) Impacts in the marine environment

1. Dredging can destroy resting or foraging habitats. The use of hopper dredges can also kill turtles caught in dragheads.
2. Loggerhead turtles eat a wide variety of marine debris such as plastic bags, plastic and styrofoam pieces, tar balls, balloons and raw plastic pellets. Effects of consumption include interference in metabolism or gut function, even at low levels of ingestion, as well as absorption of toxic byproducts. NMFS is currently analyzing stranding data and available necropsy information to determine the magnitude of debris ingestion and entanglement.
3. Commercial Fishing:
    1. 5,000-50,000 loggerheads each year. Most turtles killed are juveniles and sub-adults. Inshore catch and mortality for shrimp trawlers is not known, but is thought to be significant. Bluefish, croaker and flounder trawl fishing are also a serious threat.
    2. Turtles are taken by gillnet fisheries in the Atlantic and Gulf of Mexico, but the number is currently not known.
    3. Several thousand vessels are involved in hook and line fishing for various coastal species. The capturing of turtles is not uncommon, but the number is currently not known.
    4. Pound net fisheries are primarily a problem in waters off of Virginia and North Carolina, however generally turtles are released alive.
    5. From 1978-1981, 330 turtles were captured in the Atlantic and Gulf of Mexico EEZ in the Japanese tuna longline fishery. Due to expansion of this fishery, it may have a large impact on turtle recovery.
    6. Loggerhead turtles are vulnerable to entanglement in trap fishery lines, and subsequent drowning. The impact on the population has not been determined.

4. In areas where recreational boating and ship traffic is intense propeller and collision injuries are not uncommon.
5. Sea turtles are at risk when encountering an oil spill. Respiration, skin, blood chemistry and salt gland functions are affected.
6. Pesticides, heavy metals and PCB's have been detected in turtles and eggs, but the effect on them is unknown.
7. Marina and dock development can cause foraging habitat to be destroyed or damaged. It also leads to increased boat traffic, increasing the risk of turtle/vessel collisions.
8. Turtles have been caught in saltwater intake systems of coastal power plants. The mortality rate is estimated at 2%.
9. Underwater explosions can kill or injure turtles, and may destroy or damage habitat.
10. The effects of offshore lights are not known. They may attract hatchlings and interfere with proper offshore orientation, increasing the risk from predators.
11. Turtles get caught in discarded fishing gear. The number affected is unknown, but potentially significant.
12. Illegal harvesting of loggerhead turtles is uncommon in the U.S. and Caribbean. No

estimates of take exist.

This web page was last updated on:

NCDENR
2005

Permit #	Owner	Facility	County	Region	Assigned	Type	Class	Applied	Drafted	Noticed	Issued	Expires	Flow	Pre?	Subbasin	Receiving	Contact P	Address1	Address2	City	State	Zip	Telephone
NC0074942	Green's Oyster Company Inc	Green's Oyster Company Incorporated	Brunswick	Wilmington	joe.corporon	Industrial Process & Commercial	Minor	3/3/2004				8/31/2004	5000	None	30759	Shallotte	F Yangelyn	PO Box 3156		Shallotte	NC	28459	(252) 573-3241
NC0003263	DAK Americas LLC	Cape Fear Site/Wilmington Brunswick	Brunswick	Wilmington	teresa.rodriguez	Industrial Process & Commercial	Major	5/23/2001	8/31/2005	6/17/2002	4/5/2002	11/30/2006	3500000	None	30617	CAPE FEA	Owen J M	PO Box 2042		Wilmington	NC	28402	(910) 362-3543
NC0003905	Progress Energy Carolinas, Inc.	Brunswick Steam Electric Plant (OH WWTP)	Brunswick	Wilmington	joe.corporon	Industrial Process & Commercial	Major	5/24/2001	2/8/2002	3/27/2002	6/3/2002	11/30/2008	55000	None	30617	Atlantic Oc	Winston T	200 Cpl		Arden	NC	28704-1551	(828) 687-5547
NC0007065	Archer Daniels Midland Company	Southport, NC Manufacturing Facility	Brunswick	Wilmington	mark.mcintire	Industrial Process & Commercial	Major	8/4/2001	3/15/2002	4/17/2002	6/21/2002	11/30/2006	3560000	None	30617	Southport	Eric E Wa	1730 E Moore St Ste		Southport	NC	28461	(910) 457-5011
NC0086819	Brunswick County	Northeast Brunswick WWTP	Brunswick	Wilmington	teresa.rodriguez	Municipal, Large	Major	12/5/2001	1/28/2002	2/20/2002	5/21/2002	11/30/2005	1950000	None	30617	CAPE FEA	Marty K Le	PO Box 249		Bolivia	NC	28422-0249	(910) 253-2950
NC0029122	U S Army	Military Ocean Terminal / Sunny Point	Brunswick	Wilmington	jackie.nowell	100% Domestic < 1MGD	Minor	6/4/2001	6/13/2001	8/31/2005	10/5/2005	11/30/2005	30000	None	30617	CAPE FEA	Gregory G	Public Wo	Attn: Attn	Fort Bragg	NC	28310	(910) 396-4009
NC0085006	Cogentrix Energy Inc	Southport Cogen plant	Brunswick	Wilmington	joe.corporon	Industrial Process & Commercial	Minor	6/4/2001	4/2/2004	5/5/2004	6/30/2004	11/30/2008	not limited	None	30617	Atlantic Oc	Gary Hada	PO Box 1155		Roxboro	NC	27573	(252) 442-0991
NC0021334	City of Southport	Southport WWTP	Brunswick	Wilmington	jackie.nowell	Municipal, < 1MGD	Minor	5/17/2004	7/15/2004	7/23/2005	8/23/2005	11/30/2008	800000	None	30617	Intracoastal	Robert S	201 E Moore St		Southport	NC	28461	(910) 457-7930
NC0073580	North Brunswick Sanitary District	Belville WWTP	Brunswick	Wilmington	charles.weaver	Municipal, < 1MGD	Minor	11/5/2001	1/4/2002	1/16/2002	3/25/2002	11/30/2005	800000	None	30617	Brunswick	Vernell H	PO Box 2230		Leland	NC	28451-2230	(910) 371-6543
NC0043081	Brunswick County	Beaverdam Creek WTP	Brunswick	Wilmington	charles.weaver	Water Treatment Plant	Minor	5/18/2001	8/18/2001	8/26/2001	12/7/2001	11/30/2005	not limited	None	30617	Beaverdam	Marty K Le	PO Box 249		Bolivia	NC	28422-0249	(910) 253-2500
NC0057533	Brunswick County	Hood Creek (Northwest) WTP	Brunswick	Wilmington	charles.weaver	Water Treatment Plant	Minor	4/25/2001	8/18/2001	5/22/2001	12/7/2001	11/30/2006	not limited	None	30617	Hood Cree	Marty K Le	PO Box 249		Bolivia	NC	28422-0249	(910) 253-2500
NC0065553	Bald Head Island Devel Co	Bald Head Island WTP	Brunswick	Wilmington	charles.weaver	Water Treatment Plant	Minor	6/22/2001	8/18/2001	8/22/2001	4/12/2002	11/30/2006	not limited	None	30617	Bald Head	James W E	6337 Indigo Plantation		Bald Head Island	NC	28461	(910) 457-5000
NC0064673	Brunswick County	Carolina Shores WWTF	Brunswick	Wilmington	dean.pickler	100% Domestic < 1MGD	Minor	3/3/2004	7/27/2004	8/11/2004	9/27/2004	8/31/2009	530000	None	30757	Persimmon	Marty K Le	PO Box 249		Bolivia	NC	28422-0249	(910) 253-2500
NC0045250	Brunswick County Schools	Bolivia Elementary School	Brunswick	Wilmington	[illegible]	100% Domestic < 1MGD	Minor	3/3/2004	6/4/2004	8/11/2004	9/27/2004	8/31/2009	10000	None	30759	Bolivia Bra	Marion Wi	PO Box 189		Bolivia	NC	28422	(910) 253-3930
NC0045276	Brunswick County Schools	Waccamaw Elementary School	Brunswick	Wilmington	[illegible]	100% Domestic < 1MGD	Minor	3/3/2004	6/4/2004	8/11/2004	9/27/2004	8/31/2009	5700	None	30757	Bear Bran	Marion Wi	PO Box 189		Bolivia	NC	28422	(910) 253-3560
NC0076830	Lloyd's Oyster Company	Lloyds Oyster Company	Brunswick	Wilmington	mike.myers	Industrial Process & Commercial	Minor	5/13/2004	6/15/2004	6/26/2004	7/20/2004	8/31/2009	5000	None	30759	Shallotte F	Lloyd R M	1842 Village Point Rd		Shallotte	NC	28459	(910) 754-8953
NC0022225	Fortron Industries	Fortron Industries	New Hanover	Wilmington	sergei.chernikov	Industrial Process & Commercial	Major	7/5/2004				12/31/2004	417000	None	30617	CAPE FEA	Thomas S	P.O. Box 327		Wilmington	NC	28402-0327	(910) 341-5877
NC0061736	New Hanover County Water and Sewer	Airport WWTP	New Hanover	Wilmington	tom.belnick	Municipal, Large	Major	1/10/2005				11/30/2006	4000000	None	30617	CAPE FEA	Gregory T	230 Marke	Ste 180	Wilmington	NC	28403	(910) 798-7433
NC0039527	New Hanover County Water and Sewer	Walnut Hills WWTP	New Hanover	Wilmington	christie.jackson	100% Domestic < 1MGD	Minor	8/11/2001	10/22/2001	11/7/2001	1/25/2002	11/30/2006	100000	None	30617	Northeast	Gregory T	230 Marke	Ste 180	Wilmington	NC	28403	(910) 798-7132
NC0046743	New Hanover County Water and Sewer	Landfill WWTF	New Hanover	Wilmington	tom.belnick	Industrial Process & Commercial	Minor	5/2/2001	11/29/2001	12/19/2001	3/22/2002	11/30/2006	64000	None	30623	Northeast	Gregory T	230 Marke	Ste 180	Wilmington	NC	28403	(910) 798-7132
NC0058971	New Hanover County Water and Sewer	Wasteco site	New Hanover	Wilmington	tom.belnick	Industrial Process & Commercial	Minor	4/25/2001	12/6/2001	12/15/2001	3/1/2002	11/30/2006	not limited	None	30617	Northeast	Gregory T	230 Marke	Ste 180	Wilmington	NC	28403	(910) 798-7139
NC0025763	Town of Kure Beach	Kure Beach WWTP	New Hanover	Wilmington	christie.jackson	Municipal, < 1MGD	Minor	7/2/2001	10/21/2001	12/5/2001	3/28/2002	11/30/2006	285000	None	30617	CAPE FEA	Haney E B	PO Box 3		Kure Beach	NC	28449	(910) 458-8216
NC0001422	Progress Energy Carolinas, Inc.	Sutton Steam Electric Plant	New Hanover	Wilmington	[illegible]	Industrial Process & Commercial	Major	7/2/2001	10/7/2002	11/24/2002	12/27/2002	11/30/2006	not limited	None	30617	CAPE FEA	Winston T	200 Cpl		Arden	NC	28704-1551	(828) 687-6247
NC0003234	BASF Corporation	BASF Corporation Wilmington	New Hanover	Wilmington	natalie.sierra	Industrial Process & Commercial	Major	7/6/2001	10/2/2001	12/18/2001	3/29/2002	12/31/2006	333000	None	30617	CAPE FEA	Terry Kelley	101 Vitamin Dr		Wilmington	NC	28401	(910) 343-6305
NC0023256	Town of Carolina Beach	Carolina Beach WWTP	New Hanover	Wilmington	teresa.rodriguez	Municipal, Large	Major	7/6/2001	9/18/2001	6/15/2005	8/26/2004	12/31/2006	3000000	None	30617	CAPE FEA	Calvin R P	1121 N Lk Park Blvd		Carolina Beach	NC	28428	(910) 458-2998
NC0023965	City of Wilmington	Northside WWTP	New Hanover	Wilmington	joe.corporon	Municipal, Large	Major	7/6/2001	6/3/2005	7/13/2005		12/31/2006	16000000	Complete	30617	CAPE FEA	Sterling C	PO Box 1810		Wilmington	NC	28402	(910) 341-7810
NC0023973	City of Wilmington	Southside WWTP	New Hanover	Wilmington	joe.corporon	Municipal, Large	Major	7/6/2001	7/1/2002	8/21/2002	10/14/2004	12/31/2006	12000000	Complete	30617	CAPE FEA	Sterling C	PO Box 1810		Wilmington	NC	28402	(910) 341-7810
NC0057703	Aqua North Carolina, Inc	Fairways - The Cape WWTP	New Hanover	Wilmington	christie.jackson	100% Domestic < 1MGD	Minor	4/10/2001	10/23/2001	11/7/2001	1/25/2002	12/31/2006	350000	None	30617	CAPE FEA	Neil Philip	PO Box 35047		Greensboro	NC	27425	(800) 582-6142
NC0056871	Aqua North Carolina, Inc	Ocean Forest WWTP	New Hanover	Wilmington	christie.jackson	100% Domestic < 1MGD	Minor	4/10/2001	11/14/2001	11/21/2001	1/25/2002	12/31/2006	400000	None	30617	CAPE FEA	Neil Philip	PO Box 35047		Greensboro	NC	27425	(800) 582-6142
NC0086450	Aqua North Carolina Inc	Beau Rivage Plantation	New Hanover	Wilmington	christie.jackson	100% Domestic < 1MGD	Minor	7/20/2001	11/2/2001	11/21/2001	1/25/2002	12/31/2006	100000	None	30617	CAPE FEA	Neil Philip	202 MacKenan Ct		Cary	NC	27511	(919) 467-8712
NC0085856	AAS-McCrory Inc	Heelhorst remediation site	New Hanover	Wilmington	mark.mcintire	Groundwater Remediation	Minor	12/11/2002	7/25/2003	8/6/2003	9/30/2003	12/31/2006	360000	None	30617	Barnards C	Lonnie Wa	PO Box 1551		Minneapolis	MN	55440	(612) 553-6484
NC0003794	Corning Inc	Wilmington Plant	New Hanover	Wilmington	natalie.sierra	Industrial Process & Commercial	Minor	7/3/2001	8/17/2001	9/18/2002	3/11/2002	12/31/2006	not limited	None	30623	Spring Bra	Christy H	PO Box 1700		Concord	NC	28026	(704) 569-6245
NC0003417	Southern States Chemical Inc	Southern States Chemical Inc	New Hanover	Wilmington	mark.mcintire	Industrial Process & Commercial	Minor	12/27/2003	6/5/2004	7/14/2004	8/7/2004	12/31/2009	not limited	None	30617	Northeast	Kay Comp	PO Box 545		Savannah	GA	31402	(912) 232-1101
NC0065537	Worsley Companies Inc	Kids Bay No. 6	New Hanover	Wilmington	charles.weaver	Industrial Process & Commercial	Minor	10/23/2001	1/23/2002	1/30/2002	3/25/2002	12/31/2006	4000	None	30617	Northeast	Wilkins A J	PO Box 3227		Wilmington	NC	28406	(910) 390-1600
NC0066711	Amerada Hess	Amerada Hess Corporation	New Hanover	Wilmington	teresa.rodriguez	Industrial Process & Commercial	Minor	6/12/2001	10/15/2001	11/7/2001	12/28/2001	12/31/2006	not limited	None	30617	CAPE FEA	Peter Hor	1 Hess Plz		Woodbridge	NJ	07095-0961	(732) 750-7236
NC0003172	Vopak Terminal Wilmington Inc	Wilmington Terminal	New Hanover	Wilmington	teresa.rodriguez	Industrial Process & Commercial	Minor	7/12/2001	11/29/2001	1/16/2002	3/18/2002	12/31/2006	not limited	None	30617	CAPE FEA	Jim Dubos	2000 W Loop S		Houston	TX	77027-3567	(713) 561-7200
NC0003581	Exxon Mobil Chemical Company	South Wilmington Terminal	New Hanover	Wilmington	teresa.rodriguez	Industrial Process & Commercial	Minor	7/6/2001	11/12/2001	1/16/2002	3/18/2002	12/31/2006	not limited	None	30617	CAPE FEA	Oatline D	2000 W Loop S		Houston	TX	77027-3567	(713) 561-7276
NC0076732	Flint Hills Resources LP	New Hanover Terminal	New Hanover	Wilmington	mark.mcintire	Industrial Process & Commercial	Minor	8/20/2001	4/7/2004	4/14/2004	6/7/2004	12/31/2005	10000	None	30617	CAPE FEA	James J	3325 River Rd		Wilmington	NC	28406	(910) 795-0185
NC0032970	CTI of North Carolina Inc	CTI Of North Carolina	New Hanover	Wilmington	joe.corporon	Industrial Process & Commercial	Minor	7/24/2001	10/15/2002	11/17/2002	2/10/2003	12/31/2006	11400	None	30617	CAPE FEA	G N Alba	PO Box 576		Savannah	GA	31402	(912) 251-1020
[illegible]	City of Wilmington	Sweeney WTP	New Hanover	Wilmington	charles.weaver	Water Treatment Plant	Minor	2/7/2001	11/6/2001	11/17/2001	1/16/2002	12/31/2006	not limited	None	30617	Northeast	Sterling C	PO Box 1810		Wilmington	NC	28402	(910) 341-7810
NC0003875	Elementis Chromium LP	Castle Hayne, NC Manufacturing Facility #4	New Hanover	Wilmington	natalie.sierra	Industrial Process & Commercial	Major	4/6/2001	11/6/2001	11/8/2002	4/15/2002	1/31/2007	1170000	None	30623	Northeast	Gene Fills	5408 Holly Shelter Rd		Castle Hayne	NC	28429	(910) 675-7222
NC0061093	Brookes Nursing Home Inc	Hermitage House Rest Home WWTP	New Hanover	Wilmington	christie.jackson	100% Domestic < 1MGD	Minor	4/10/2001	10/13/2001	11/12/2001	1/18/2002	1/31/2007	2400	None	30623	Prince Ge	Susan B H	4721 Castle Hayne Rd		Castle Hayne	NC	28429	(910) 675-2562
NC0065137	Aqua North Carolina, Inc	Dolphin Bay WWTP	New Hanover	Wilmington	christie.jackson	100% Domestic < 1MGD	Minor	4/13/2001	10/22/2001	11/7/2001	1/25/2002	1/31/2007	45000	None	30617	Brown Cr	Neil Philip	PO Box 35047		Greensboro	NC	27425	(800) 582-6142
NC0040151	LaQue Center for Corrosion Technology	LaQue Center For Corrosion Tech	New Hanover	Wilmington	charles.weaver	Industrial Process & Commercial	Minor	7/31/2001	1/4/2002	1/24/2002	3/25/2002	1/31/2007	not limited	None	30626	Banks Cha	W Tincher	PO Box 656		Wrightsville Beach	NC	28480	(910) 256-2271
NC0001228	Global Nuclear Fuel	Global Nuclear Fuel-Americas	New Hanover	Wilmington	tom.belnick	Industrial Process & Commercial	Major	7/3/2001	9/3/2003	10/13/2003	2/3/2004	2/28/2009	1875000	None	30623	Northeast	Herbert R	PO Box 780	Mc J26	Wilmington	NC	28402	(910) 675-5666
NC0001112	Kreva Specialties, SARL dba KoSa	Invista, S.A.R.L.	New Hanover	Wilmington	tom.belnick	Industrial Process & Commercial	Major	7/5/2001	12/15/2004	12/30/2004	2/14/2005	2/28/2010	1700000	None	30617	Northeast	Williams M	P.O. Box 327		Wilmington	NC	28402-0327	(910) 341-5500

These data are a subset of those found at
http://h2o.enr.state.nc.us/NPDES/documents/BIMS_031505.xls
(Brunswick & New Hanover counties

NCDENR 2002

CAPE FEAR RIVER BASIN WATER SUPPLY PLAN

SECOND DRAFT

March 2002

NC Division of Water Resources

Division of Water Resources
Department of Environment and Natural Resource

NCDENR

http://www.ncwater.org/Reports_and_Publications/Jordan_Lake_Cape_Fear_River_Basin/CFRBWSPdraft2.pdf

Executive Summary

The Cape Fear River Basin Water Supply Plan evaluates the long term water needs of water supply systems through 2050, and the effects of surface water withdrawals on the flows of the Cape Fear River. The plan looks at municipal water systems that use water from the Haw River, the Deep River or the Cape Fear River above Lock & Dam #1, and municipal systems that discharge treated wastewater into the waters of these river basins. The plan includes information from 94 water systems in the following 19 counties: Rockingham, Guilford, Randolph, Alamance, Orange, Durham, Wake, Chatham, Montgomery, Moore, Lee, Harnett, Johnston, Cumberland, Hoke, Bladen, New Hanover, Brunswick and Columbus.

Our approach was to group water supply systems based on their existing interconnections, shared sources of supply, or interdependence, and then determine if there is enough water available within each mutually dependent group of systems to meet the projected needs of all systems within the group. Among the 94 water systems included in this analysis there are only four that are not connected to at least one other system for regular or emergency supply. For this analysis we evaluated each system independently, but within the context of the group of water systems that are mutually dependent on the same sources.

This analysis answers the question: is there enough water available in a particular area to meet the 2050 demands of the water supply systems in that area? The results of this analysis show that there appears to be enough water to meet the demands reflected in the 2050 estimates, if communities can develop the infrastructure to make use of it. However, the ability to develop efficient distribution systems and the ability to have additional water available by the time it is needed will depend on other factors such as funding and regional cooperation. Once again, the focus of the analysis was to determine if there is enough water available in the region to meet water supply needs over the next fifty years.

For our analysis of wastewater disposal, we again grouped water systems by their interconnections. The movement of wastewater does not necessarily follow the same pattern as the movement of drinking water, so the two means of grouping systems result in somewhat different groups.

While our analysis shows that there appears to be enough water available for communities in these basins to meet their projected demands, this may become a moot point if they cannot handle the wastewater they will generate. If the amounts of treated wastewater that a community or group can discharge to the waters of the state exceed NPDES limits and these limits cannot be increased, then they may have to develop alternative disposal systems. An effective demand management program could help control growth in water demand as populations increase, but as a community adds more people it will use more water and generate more wastewater. The actual amount of land will vary with soil and the amount of water to be applied. An inability to increase discharges could limit a community's ability to grow because of the difficulty of dealing with wastewater and/or the amount of land that would be required to deal with wastewater.

The Regulation of Surface Waters Transfer Act and its associated administrative rule list specific criteria and standards for managing interbasin transfers of water. Analyzing and projecting future interbasin transfers, as defined by the statute and rule, requires information about the quantities and locations of water withdrawals, water discharges and consumptive uses. We have not done such an analysis for this plan. Our analysis of interbasin water movement is limited to withdrawal and discharge quantities on an average day basis and water movement across major basin boundaries, only. This analysis differs from the Interbasin Transfer Law in that it does not consider the location of consumptive losses, is not on a maximum day basis, ignores the 2 mgd threshold, and does not consider subbasin boundaries. This analysis only describes the movement of water into and out of the major Cape Fear River Basin.

Based on these assumptions, in 1997 there was a net movement of 2.0 mgd from the Yadkin River Basin to the Cape Fear River Basin, 10.5 mgd from the Neuse River Basin to the Cape Fear River Basin, and 5.6 mgd from the Cape Fear River Basin to the Lumber River Basin; a total net water movement of 6.9 mgd into the Cape Fear River Basin on an average day basis. By 2030, the net movement of water from the Yadkin to the Cape Fear could be 2.3 mgd, 4.3 mgd from the Neuse to the Cape Fear, and 10.6 mgd from the Cape Fear to the Lumber; a total net water movement of 4.0 mgd out of the Cape Fear River Basin.

We developed two modeling scenarios with the Cape Fear River Basin Hydrologic Model to evaluate long-term water supply needs in the basin. Scenario 1 evaluates the long-term water supply needs in the basin projected for 2050. Scenario 2 evaluates the basin water supply needs and recommended Jordan Lake water supply storage allocations for 2030. Lacking definitive information, we assumed that wastewater discharge permits would be adjusted to accommodate the amount of wastewater generated by the projected water demands for all water supply systems. We did not incorporate any drought management measures for Jordan Lake withdrawals or releases in these scenarios. We assumed that self-supplied industrial withdrawals and agricultural withdrawals would remain constant.

We had to make additional assumptions regarding individual water supply systems to develop the modeling scenarios. Our method of grouping systems based on water supply or wastewater interconnections is appropriate for analyzing water supply needs, but for modeling we must assign specific water withdrawal and wastewater discharge locations for each water supply system. Each scenario is consistent with our analysis of water supply system groups. These modeling scenarios allow us to analyze the predicted impacts of an entire set of projected basinwide water withdrawals and discharges. Other modeling scenarios could be developed with differing assumptions about specific water withdrawals and wastewater discharges, and still be consistent with our system groups analysis.

The results of modeling Scenario 1 indicate that, with a couple of exceptions, there is enough water to meet the 2050 projected needs for the water systems included in the analysis, without significant effects on the reliability of the Jordan Lake low-flow augmentation pool, the ability to meet the flow target at the Lillington stream gage, or downstream flows of the Cape Fear River. The exceptions are the towns of Robbins, Carthage and Vass. The present water supply sources of these towns may not be adequate to reliably meet their projected demands.

Note that Jordan Lake water supply storage allocations do not impact the water supplies available to these communities in any way.

The results of modeling Scenario 1 and Scenario 2 indicate that the reliability of the low-flow augmentation pool will not change by 2030 and will decrease only slightly by 2050, compared with 1998. The 1998 model scenario results indicate that the flow augmentation pool has a 0.13 percent chance of being depleted on any given day, or is depleted during one year out of the 68 years modeled. Scenario 2 results indicate the same reliability for the year 2030. Scenario 1 results indicate that the flow augmentation pool has a 0.37 percent chance of being depleted on any given day, or is depleted 4 years out of the 68 years modeled for the year 2050.[1] This small decrease in reliability is a result of the large increases in projected demands for the water supply systems withdrawing water from the Deep River Basin and from the segment of the Cape Fear River between Jordan Dam and Lillington. The total projected increase in these withdrawals is 68 mgd by 2030 (an increase of 182 percent compared with 1998 withdrawals) and 113 mgd by 2050 (an increase of 302 percent compared with 1998 withdrawals). This means that multiplying the total withdrawals of all water supply systems affecting the flows at Lillington by four results in less than a one percent decrease in the daily reliability of the low-flow augmentation pool. Model scenario results also indicate that the slight decrease in reliability will not significantly affect the ability to meet the flow target at the Lillington stream gage. The flow profile at Lillington remains almost unchanged among the model scenarios.

The total projected increase in withdrawals upstream of Fayetteville is 114 mgd by 2030 (an increase of 93 percent compared with 1998 withdrawals) and 197 mgd by 2050 (an increase of 161 percent compared with 1998 withdrawals). Despite these large projected increases in upstream withdrawals, the flow profile at Fayetteville shows even less change among the model scenarios than the flow profile at Lillington. The Cape Fear River flows at Lock & Dam #1 are virtually unchanged among the model scenarios. Note that these modeled impacts on reliability do not incorporate any drought management for Jordan Lake or any water supply systems in the Basin. Drought management measures will improve the reliability of water supplies.

We expect this planning effort to continue as new information, such as the 2002 Local Water Supply Plans, becomes available. Information from this planning effort will be provided to the Division of Water Quality for use in the Cape Fear River Basinwide Water Quality Management Plan. Our next steps include:

1. developing additional modeling scenarios;
2. including additional model output analysis;
3. revising this draft document based on comments and corrections; and
4. incorporating drought management.

For additional information about the Cape Fear Hydrologic Model, model scenarios, or Jordan Lake allocations, please refer to our website at www.ncwater.org. Please direct any comments, corrections or concerns to Sydney Miller (919-715-3044 or sydney.miller@ncmail.net), or Don Rayno (919-715-3047 or don.rayno@ncmail.net).

[1] Note that during one of the four years that the low flow augmentation pool is depleted in Scenario 1, the pool is depleted for only one day.

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Appendices

Introduction

The Cape Fear River Basin Water Supply Plan evaluates the long term water needs of water supply systems through 2050, and the cumulative effects of surface water withdrawals on the flows of the Cape Fear River. We expect this planning effort to continue as new information, such as the 2002 Local Water Supply Plans, becomes available. Information from this planning effort will be provided to the Division of Water Quality for use in the Cape Fear River Basinwide Water Quality Management Plan.

This document begins with an analysis of water supply systems by groups of systems and continues with a similar analysis focusing on wastewater. Following this general analysis we describe the more detailed analysis we used for hydrologic modeling and provide summaries of the model output analyses for the various modeling scenarios. Several appendices at the end include more detailed information than is provided in the general discussions.

Cape Fear River Basin

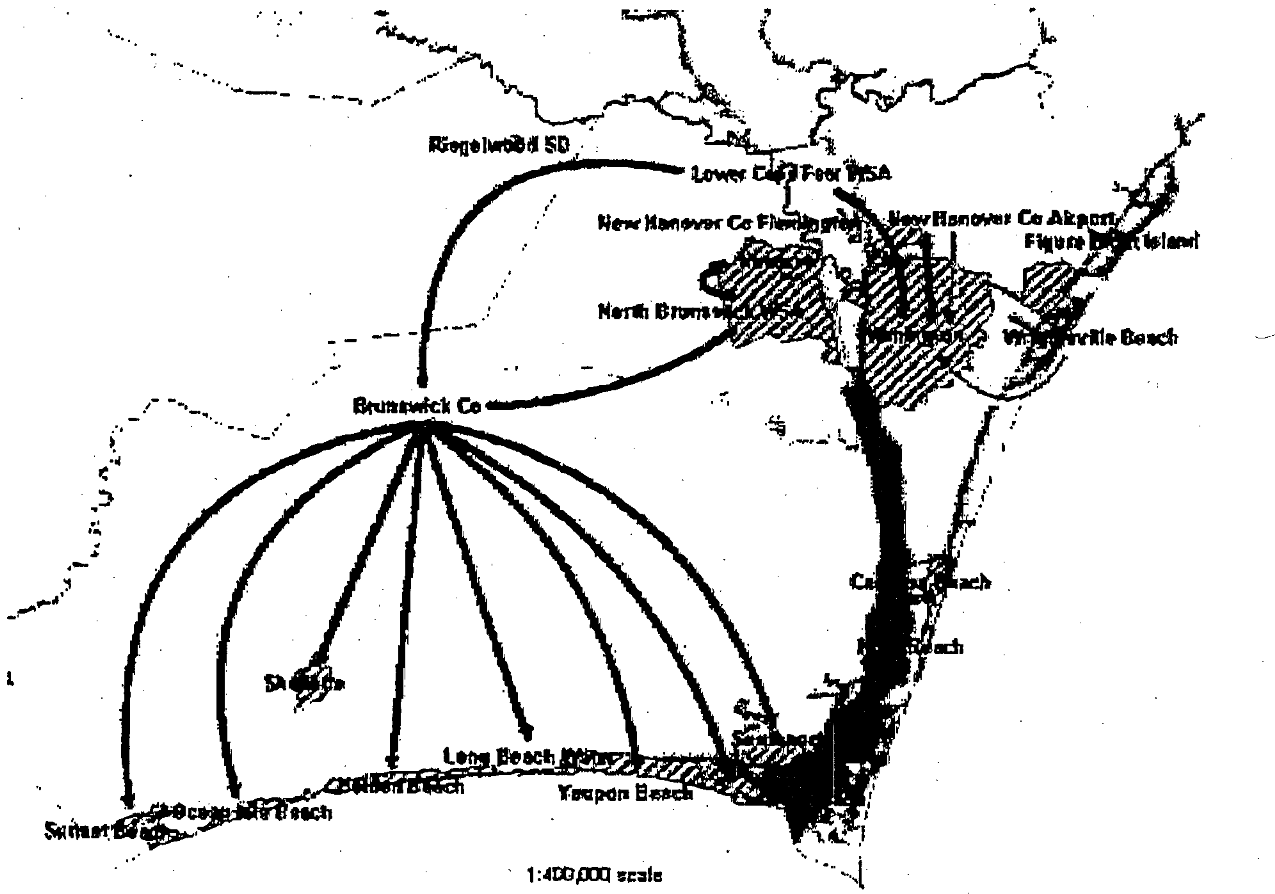
The Cape Fear River Basin is located entirely within North Carolina. It is the largest river basin in the state, draining 9,149 square miles from the headwaters in the northern Piedmont to the mouth at Cape Fear, south of Wilmington. The Cape Fear River major basin is composed of the Haw River, Deep River, Cape Fear River, South River, Northeast Cape Fear River and the New River Basins. The Haw River and Deep River merge near Moncure to form the Cape Fear River which flows southeasterly to the Atlantic Ocean. The South River, Northeast Cape Fear River and New River Basins drain most of Sampson, Duplin, Pender and Onslow counties in the Coastal Plain. Most of the water systems in the Coastal Plain areas of the basin use ground water, except for water systems supplied by the Lower Cape Fear Water and Sewer Authority and the City of Wilmington, both of which have surface water intakes on the Cape Fear River. The rest of the water systems in the Cape Fear River Basin largely rely upon surface water supplies.

The Haw River is impounded by the B. Everett Jordan Dam, just upstream of its confluence with the Deep River. Jordan Lake stores water to reduce downstream damage from flooding, to provide water supply and to supplement downstream flows. In addition, the lake provides recreational opportunities, including boating, swimming and fishing. Water supply storage in the lake is controlled by the State of North Carolina and is allocated by the Environmental Management Commission (EMC).

Water Systems Included

The plan looks at municipal water systems that use water from the Haw River, the Deep River or the Cape Fear River above Lock & Dam #1, and municipal systems that discharge treated wastewater into the waters of these river basins. The plan includes information from 94 water systems in the following 19 counties: Rockingham, Guilford, Randolph, Alamance, Orange, Durham, Wake, Chatham, Montgomery, Moore, Lee, Harnett, Johnston, Cumberland, Hoke, Bladen, New Hanover, Brunswick and Columbus. We selected these water systems based

Lower Cape Fear WSA Group and Riegelwood



PWSID	Notes	COUNTY	WATER SYSTEM	SOURCE BASIN	WHY INCLUDED
04-65-010		NEW HANOVER	WILMINGTON	02-3	source
04-65-510		NEW HANOVER	NEW HANOVER CO AIRPORT	02-3	source
04-65-020		NEW HANOVER	WRIGHTSVILLE BEACH	02-6	source
04-65-226		NEW HANOVER	APPLE VALLEY	02-5	source
04-65-191		NEW HANOVER	NEW HANOVER CO FLEMINGTON	02-3	source
04-65-119		NEW HANOVER	FIGURE EIGHT ISLAND	02-6	source
04-65-015		NEW HANOVER	CAROLINA BEACH	02-3	source
04-65-025		NEW HANOVER	KURE BEACH	02-3	source
04-65-999		NEW HANOVER	LOWER CAPE FEAR WSA	02-3	source
04-10-045		BRUNSWICK	BRUNSWICK CO	02-3	source
04-10-035	3, 12	BRUNSWICK	NORTH BRUNSWICK WSA (LELAND SD)	02-3	source
04-10-065		BRUNSWICK	NAVASSA	02-3	source
04-10-055		BRUNSWICK	CASWELL BEACH	02-3	source
04-10-060		BRUNSWICK	HOLDEN BEACH	02-3	source
04-10-015		BRUNSWICK	LONG BEACH WATER	02-3	source
04-10-035		BRUNSWICK	OCEAN ISLE BEACH	02-3	source
04-10-025		BRUNSWICK	SHALLOTTE	02-3	source
04-10-010		BRUNSWICK	SOUTHPORT	02-3	source
04-10-050		BRUNSWICK	SUNSET BEACH	02-3	source
04-10-020		BRUNSWICK	YAUPON BEACH	02-3	source
04-65-137		NEW HANOVER	MONTEREY HEIGHTS	02-3	source
04-65-232		NEW HANOVER	MURRAYVILLE	02-5	source
04-65-154		NEW HANOVER	WALNUT HILLS	02-5	source
04-65-190		NEW HANOVER	RUNNYMEADE	02-5	source
04-65-188		NEW HANOVER	PRINCE GEORGE	02-5	source
04-65-229		NEW HANOVER	WESTBAY	02-6	source
04-65-192		NEW HANOVER	BRICKSTONE - MARSH OAKS	02-6	source
04-24-035		COLUMBUS	RIEGELWOOD SD	02-3	source

Available Water Supply

A crucial factor in determining whether a community has an adequate water supply is estimating the amount of water available to them. The methods used to estimate how much water is available differ depending on the source of water supply. It is important to remember that this analysis only looks at the quantity of water available. There may be water quality concerns at a particular intake location that limits the amount of water that can be withdrawn because of the affect on water quality.

Ground Water Supply

A practical definition of "yield" for a ground water well is the long-term rate at which water can be withdrawn without exceeding the natural recharge capability of the aquifer or, in coastal areas, without causing saltwater intrusion into the aquifer. Systems using ground water conduct a drawdown test, at least at initial well construction. The drawdown test determines how much water can be withdrawn from a well without exceeding the natural recharge capability of the associated aquifer. The results of the drawdown test are used to determine the maximum sustainable pumping rate, or yield, for the well. North Carolina requires at least a 24-hour drawdown test to determine well yield for public water supply wells (NCAC Title 15A, Subchapter 18C, Section .0402(f)(1)).

The Division of Environmental Health (DEH) requires that the combined yield of all wells of a water supply system be adequate to meet the average daily demand in 12 hours pumping time (Title 15A, Subchapter 18C, Section .0402(f)(3)). This requirement is intended to ensure that the system can provide adequate water to its customers during heavy use periods. The combined 12-hour supply for the wells supplying a water system is used in the water supply plan to determine the adequacy of the existing supplies. If the system needs to pump more than 12 hours a day to meet average system demands, the system administrators face the question of whether to encourage people to use less water or to develop additional sources of supply.

We used the data on existing 12-hour yield from the Local Water Supply Plans as the available supply from ground water sources for the systems included in this analysis.

Surface Water Supply

Reservoirs and run-of-river intakes are the two basic types of surface water supplies. Reservoirs impound surplus water during high flow periods for later use when stream flows would otherwise be insufficient to meet demand. Run-of-river intakes, on the other hand, simply withdraw a portion of the water in the stream or river as it flows by. The concept of safe yield or available supply is the same for both reservoir and run-of-river intake systems, but the methods for determining their safe yields are different. For a surface water source, the safe yield is the allowable draft rate at which water can be withdrawn during a low flow or drought event. The recurrence interval of a drought is an indication of the frequency at which a particular drought event is expected to occur on the average. A severe drought occurs less frequently than does a milder one and consequently has a greater recurrence interval.

Run-of-River Intake

Run-of-river intake systems differ from reservoirs in that they typically do not have the ability to augment water supply during extended dry weather periods; they simply withdraw a portion of the water in the stream or river as it flows by. During moderate to high flows this is not a problem. However, during low-flow periods this inability to augment flows through storage can be extremely critical. In some cases, even short-term low-flow events can result in water shortages if offstream storage is not available to augment water supply during these low flow periods.

A commonly used estimate of expected low flow levels is a measure of flow called the "7Q10". The 7Q10 low flow is the lowest consecutive seven-day average flow expected to occur once on the average in 10 years. The 7Q10 is not the lowest flow of record, but rather the lowest 7-day average flow with a 10-year recurrence interval. It is also the minimum flow on which the Division of Water Quality bases its calculations of wasteload allocations for pollution discharge permits. A 10-year recurrence interval is frequent enough to warrant planning for such a flow. To protect aquatic ecosystems, run-of-river intakes are designed to withdraw only a portion of the 7Q10 low flow.

The impact of a water withdrawal on the local aquatic habitat can be evaluated on a site-by-site basis when determining the allowable withdrawal amount for a run-of-river intake. An instream-flow study is used to examine the affects of a withdrawal on the aquatic habitat at a particular location. The local habitat is assessed at various flow levels and a determination is made as to the quality of the habitat and the potential impacts of varying levels of withdrawals. These studies are time consuming and can be expensive. But, they provide a site-specific evaluation of the effects of potential withdrawals and help in designing intakes for specific conditions at a particular location. The alternative is to use a planning guideline that limits withdrawals to an amount that is unlikely to have serious effects on aquatic habitat during low flow conditions. In North Carolina this planning guideline is 20 percent of the 7Q10 flow.

If a proposed withdrawal will not take more than 20 percent of the 7Q10 flow there is a general presumption that it will have minimum effect on local habitat and additional studies are not automatically required. The 20 percent of the 7Q10 flow is not a limit on withdrawals, but rather a general planning guideline. If there are specific concerns at the proposed site, such as potential impacts on an endangered species, in-depth environmental studies can be required at any level of withdrawal. The 20 percent of the 7Q10 flow guideline is also the threshold that would trigger the need for an environmental assessment under the North Carolina Environmental Policy Act. A proposal to withdraw more than 20 percent of the 7Q10 flow of a watercourse will require the completion of an environmental assessment before a decision can be made on necessary permits.

If 20 percent of the 7Q10 does not provide enough water to meet the expected water demands of a particular system then an instream-flow study will help determine if more water can be withdrawn without seriously harming aquatic habitat. In addition, an environmental assessment will be required to identify any other environmental factors that may limit the withdrawal of water.

We used 20 percent of the 7Q10 flow to determine the available supply for run-of-river intakes unless we had more specific information. Remember that 20 percent of the 7Q10 only indicates the point at which a greater withdrawal would require additional study. The Cape Fear River Hydrologic Model provides a much more meaningful indication of available supply for run-of-river intakes. This is discussed later.

Reservoir Intakes

Water supply reservoirs impound water during high flow periods for later use when stream flows would be less than demand. Stream flows and reservoir storage capacity will determine how much water is available, or how many days of supply are available given a particular daily rate of use. Water can be stored by damming a stream channel or by developing an off-stream storage facility. In either case the recurrence interval of drought has to be considered. For any given impoundment the estimated safe yield is qualified by the drought recurrence interval the calculation is based on.

Typically, a drought event with a 20-year or 50-year recurrence interval is used for public water supply planning purposes. A 20-year safe yield (SY20) is the allowable draft rate that the supply can be expected to sustain 19 years out of 20. This implies that in any given year there would be a 5 percent risk that the SY20 cannot be sustained. For water systems serving less than 50,000 people a 20-year safe yield analysis is probably adequate. For systems serving more than 50,000 people a 50-year safe yield analysis is recommended. This provides an estimated withdrawal that can be sustained 49 years out of 50 with a resulting 2 percent risk that the withdrawal cannot be sustained in any year.

We used the safe yield figures provided in each water system's Local Water Supply Plan for systems reservoir intakes. Most surface water systems cannot use the entire amount of their available supply because of treatment limitations. We assumed that if water were available at the current intake, then systems would expand facilities to produce more water when demand approached treatment capacity.

Purchased Supply

Many water systems buy water from a neighboring system. The Division of Water Resources encourages systems that buy or sell water to develop contracts for the transactions. Contracts make clear to all parties the amount of water to be available and the length of time it will be available. Systems that buy water need to know how much water they can get and for how long. While sellers need to plan to have the committed amount of water available when needed. We used the contract limits for purchases not designated as "emergency" in the Local Water Supply Plan database as the existing available supply from bulk water sellers for systems purchasing water. For systems for which purchasing water is their only supply, we assumed the existing arrangements would remain in place over the fifty year planning horizon. We also assumed that sellers would provide the amount needed for purchasers to meet estimated demands, regardless of current contract limits.

Water Demand v. Supply

It is important to remember that this analysis does not answer the question: will this system have enough water to meet its projected demand in 2050? This analysis answers the question: is there enough water available in a particular area to meet the 2050 demands of the water supply systems in that area? The results of this analysis show that there appears to be enough water to meet the demands reflected in the 2050 estimates, if communities can develop the infrastructure to make use of it. However, the ability to develop efficient distribution systems and the ability to have additional water available by the time it is needed will depend on other factors such as funding and regional cooperation. The demand projections and available supply figures for each water system in our analysis are listed in the following tables, organized by the system groups previously discussed. Our analysis of individual water system supplies is in Appendix C. Once again, the focus of the analysis was to determine if there is enough water available in the region to meet water supply needs over the next fifty years.

Reidsville Group

WATER SYSTEM	Notes	2000 SA Demand MGD	2010 SA Demand MGD	2020 SA Demand MGD	2030 SA Demand MGD	2040 SA Demand MGD	2050 SA Demand MGD	Total Available Supply MGD
REIDSVILLE		3.537	3.628	3.674	3.836	3.961	4.000	18.000
ROCKINGHAM CO	1	0.175	0.178	0.176	0.180	0.181	0.182	0.000
Group Total for Cape Fear RB		3.712	3.802	3.850	4.016	4.142	4.288	18.000

(17)

(TTP 2005)

TOPSAIL TURTLE PROJECT

The Karen Beasley
Sea Turtle Rescue and Rehabilitation Center

Topsail Island, North Carolina, USA

INDEX OF SEA TURTLES BY ADMISSION DATE

[1996-97][1998][1999][2000][2001][2002][2003][2004][2005]

Admitted 2005				
TURTLE	SPECIES	INJURY OR ILLNESS	ADMIT	OUTCOME
EMERALD II	Chelonia mydas	Internal - Viral, Fungal or Unknown	4-04-05	Current patient
HAMMOCK	Caretta caretta	Internal - Viral, Fungal or Unknown	4-25-05	Current patient
SULLIVAN	Caretta caretta	Internal - Viral, Fungal or Unknown	6-07-05	Current patient
QUARTER	Caretta caretta	Internal - Viral, Fungal or Unknown	6-08-05	Current patient
STACY III	Caretta caretta	Fracture - Flipper, Carapace, Plastron, or Cranial	6-15-05	Current patient
HANOVER	Caretta caretta	Internal - Viral, Fungal or Unknown	7-01-05	Current patient
BORYK	Caretta caretta	Internal - Viral, Fungal or Unknown	7-04-05	Current patient
HOPE	Caretta caretta	Internal - Viral, Fungal or Unknown	7-06-05	Current patient
POUNDER II	Caretta caretta	Internal - Viral, Fungal or Unknown	7-19-05	Current patient
BRUNWICK II	Caretta caretta	Fracture - Flipper, Carapace, Plastron, or Cranial	7-26-05	Current patient
SPLASH	Caretta caretta	Internal - Viral, Fungal or Unknown	8-03-05	Current patient
BRIGGY	Lepidochelys kempi	Fracture - Flipper, Carapace, Plastron, or Cranial	8-06-05	Current patient

Admitted 2004

TURTLE	SPECIES	INJURY OR ILLNESS	ADMIT	OUTCOME
ATLANTIC II	Caretta caretta	Internal - Viral, Fungal or Unknown	4-04	Released 6-8-05
BREAKERS	Caretta caretta	Internal - Viral, Fungal or Unknown	5-12-04	Released 9-15-04
DUB	Caretta caretta	Internal - Viral, Fungal or Unknown	5-13-04	Died 5-13-04
WAVES	Caretta caretta	Internal - Viral, Fungal or Unknown	5-13-04	Died 5-13-04
P.E.	Caretta caretta	Fracture - **Flipper,** Carapace, Plastron, or Cranial	5-14-04	Died 5-21-04
IV	Caretta caretta	Internal - Viral, Fungal or Unknown	5-20-04	Died 5-27-04
OBEY	Caretta caretta	Internal - Viral, Fungal or Unknown	6-07-04	Released 6-8-05 Resighted nesting 7-25-05
MOREHEAD	Caretta caretta	Fracture - **Carapace**, Plastron, or **Cranial**	6-13-04	Released 6-8-05
DOREY	Caretta caretta	Floater	6-16-04	Released 10-14-04
BRUCE	Caretta caretta	Floater	6-16-04	Released
MARLIN	Caretta caretta	Floater	6-16-04	Released 10-06-04
NEMO	Caretta caretta	Floater	6-16-04	Released 9-15-04 **Satellite tracked**
SHINN	Caretta caretta	Internal - Viral, Fungal or Unknown	6/20/04	Released 6-8-05
SUNSET	Caretta caretta	Fracture - **Carapace**, Plastron, or **Cranial**	7-08-04	Died 8-04-04
CRUSH II aka PROGRESS	Caretta caretta	**Hook** , Entanglement or Other	7-09-04	Released 9-15-04 **Satellite tracked**
BOGUE	Caretta caretta	Internal - Viral, Fungal or Unknown	7-09-04	Released 6-8-05
BLUE	Caretta caretta	Fracture - Carapace, Plastron, or **Cranial**	7-18-04	Died 8-20-04
HOLDEN II	Chelonia mydas	Fracture - Carapace, Plastron, or **Cranial**	8-05-04	Current patient
MARSH	Lepidochelys kempi	Fracture - Carapace, Plastron, or Cranial	8-17-04	Released 6-8-05
BRUNSWICK II	Caretta caretta	Fracture - **Carapace**, Plastron, or Cranial	8-24-04	Died 8-25-04
SHACKLEFORD	Chelonia mydas	Fracture - Carapace, Plastron, or **Cranial**	8-27-04	Released 6-8-05
BEECHWOOD	Caretta caretta	Internal - Viral, Fungal or Unknown	8-28-04	Died 8-31-04
OCEANA	Caretta caretta	Drown	8-28-04	Died 8-28-04
LINE	Lepidochelys kempi	Hook , Entanglement or **Other - Swallowed monofilament line**	9-7-04	Released 6-8-05
	Lepidochelys			

MASON	kempi	Puncture - Carapace	9-8-04	Released 6-8-05
CORENETTA	Caretta caretta	Hook , Entanglement or **Other - Possible shark bite**	10-19-04	Current patient
NOAA	Caretta caretta		11-04	Released 6-8-05
CB	Chelonia mydas	Hook , Entanglement or **Other**	12-04	Released 6-8-05

Admitted 2003

TURTLE	SPECIES	INJURY OR ILLNESS	ADMIT	OUTCOME
SEA II	Chelonia mydas	Cold-Stunned w/ other complications	3/00/03	Released 09/24/03
STORMY	Chelonia mydas		4/03	Released 9//24/03
SWAN	Caretta caretta	Fracture **Carapace,** Plastron or **Cranial**	5/10/03	Released 6-8-05
WICK	Lepidochelys kempi	Fracture Humerus bone of flipper	5/17/03	Released 9//24/03
CASPER	Caretta caretta	Hook , Entanglement or Other FP	5/17/03	Released 6-8-05
NET	Caretta caretta	Internal - Viral, Fungal or Unknown	5/22/03	Released 9//24/03
CORE	Caretta caretta	Internal - Viral, Fungal or Unknown	5/28/03	Released 9//24/03
C.S.TA	Caretta caretta	Internal - Viral, Fungal or Unknown	6/05/03	Released 6//02/04
PINE	Chelonia mydas	Internal - Viral, Fungal or Unknown	6/06/03	Released 9//24/03
OAKLEY	Caretta caretta	Fracture **Carapace,** Plastron or **Cranial**	6/10/03	Released 6-3-05
VIVA	Caretta caretta	External - Viral, Fungal or Unknown	7/26/03	Released 6//02/04
MYRTLE	Caretta caretta	Internal - Viral, Fungal or Unknown	7/26/03	Died 9/14/03
CARETTA	Caretta caretta	Fracture **Carapace,** Plastron or Cranial	7/29/03	Current patient
CAP'N HOOK	Caretta caretta	**Hook** , Entanglement or Other	8/08/03	Released 9-24-03
RICHIE	Caretta caretta	Fracture **Carapace,** Plastron or Cranial	8/10/03	Released 9-15-04
GALVESTON	Caretta caretta	Fracture **Carapace,** Plastron or Cranial	8/15/03	Released 6//02/04
CHEYENNE	Chelonia mydas	Fracture **Carapace,** Plastron or Cranial	9/09/03 re-admit 6/7/04	Release A 6-2-04 Release B 6-8-05
CRUSH	Caretta caretta	Fracture **Carapace,** Plastron or Cranial	10/17/03	Released 6//02/04
SQUIRT	Chelonia mydas	Internal - Viral, Fungal or Unknown	10/22/03	Released 6//02/04
GT	Chelonia mydas	Internal - Viral, Fungal or Unknown	10/25/03	Released 6//02/04

CHILLY	Caretta caretta	Cold-Stunned w/ other complications	11/15/03	Released 6//02/04 Satellite tracked
DUKE	Caretta caretta	Fracture **Carapace, Plastron** or Cranial	11/26/03	Released 9-15-04
BEAUFORT	Caretta caretta	Fracture **Carapace,** Plastron or Cranial	12-03	Released 9-15-04
KANE	Chelonia mydas	Cold-Stunned	12/19/03	Released 6//02/04

Admitted 2002

TURTLE	SPECIES	INJURY OR ILLNESS	ADMIT	OUTCOME
NEUSE Re-admit	Caretta caretta	Internal - Viral, Fungal or Unknown	3/04/02	Re-Released 06/05/02
BANKS	Lepidochelys kempi	Hook , Entanglement or Other (hopper dredge)	4/11/02	Released 9/18/02
STACY II	Caretta caretta	Internal - Viral, Fungal or Unknown	5/16/02	Released 9/18/02
MARKER	Caretta caretta	Internal - Viral, Fungal or Unknown	5/17/02	Released 9/18/02
FLIP	Caretta caretta	Internal - Viral, Fungal or Unknown	5/20/02	Released 9/18/02
INDIA	Caretta caretta	Fracture **Carapace,** Plastron or Cranial	5/31/02	Released 9-15-04
HILTON	Lepidochelys kempi	Fracture Carapace, **Plastron** or Cranial	6/6/02	Released 9/18/02
FISHER II	Caretta caretta	Fracture Carapace, Plastron or Cranial **Soft tissue/flipper**	6/13/02	Released 9/18/02
ATLANTIC	Caretta caretta	Internal - Viral, Fungal or Unknown	6/17/02	Released 06/4/03
JAYBIRD	Caretta caretta	**Hook** , Entanglement or Other	7/10/02	Released 9/18/02
BOSTON	Lepidochelys kempi	Cold-Stunned w/ other complications	7/19/02	Released 9/18/02
ABBOTT	Caretta caretta	Hook , **Entanglement** or Other	7/26/02	Released 06/4/03
LINER	Caretta caretta	Hook , **Entanglement** or Other	7/26/02	Released 9/18/02
SOUNDER	Caretta caretta	Internal - Viral, Fungal or Unknown	7/26/02	Released 06/4/03
WALKER	Caretta caretta	Fracture **Carapace,** Plastron or Cranial	8/03/02	Released 06/4/03
BRUNSWICK	Caretta caretta	Fracture Carapace, Plastron or Cranial **Soft tissue/flipper**	8/06/02	Released 06/4/03
CJ	Caretta caretta	Internal - Viral, Fungal or Unknown	10/02/02	Released 6//02/04
CATHERINE	Caretta caretta	Internal - Viral, Fungal or Unknown	10/24/02	Released 9//24/03
		Fracture		

SHELLIE	Lepidochelys kempi	Carapace, Plastron or **Cranial**	11/13/02	Released 06/4/03
DAVIS	Chelonia mydas	Cold-Stunned w/ other complications	11/14/02	Released 06/4/03
CARTERET	Lepidochelys kempi	Probable Cold-Stun	11/29/02	Released 06/4/03
CP	Chelonia mydas	Power Plant Grate	11/30/02	Released 06/4/03
HARK	Chelonia mydas	Cold-Stunned	12/01/02	Released 06/4/03
COASTIE	Chelonia mydas	Fracture **Carapace, Plastron or Cranial**	12/02/02	Released 09/24/03
HATTERAS	Chelonia mydas	Cold-Stunned	12/08/02	Released 06/4/03

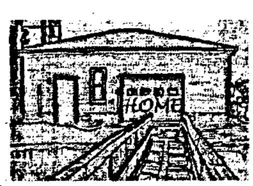
Admitted 2001

TURTLE	SPECIES	INJURY OR ILLNESS	ADMIT	OUTCOME
MACON	Chelonia mydas	Internal - Viral, Fungal or Unknown	03/30/01	Released 06/20/01
HOOK	Caretta caretta	Hook , Entanglement or Other	05/13/01	Released 10/03/01
STACY (NMFS)	Lepidochelys kempi	Internal - Viral, Fungal or Unknown	05/21/01	Released 10/03/01
KIAWAH	Caretta caretta	Internal - Viral, Fungal or Unknown	06/04/01	Released 06/05/02
BALDY aka marsh	Chelonia mydas	Internal - Viral, Fungal or Unknown	06/07/01	Released 10/03/01
BAY	Chelonia mydas	Fracture Carapace, Plastron or Cranial	06/08/01	Current patient
ISLE	Caretta caretta	Hook , Entanglement or Other	06/18/01	Released 10/03/01
CAPE	Caretta caretta	Internal - Viral, Fungal or Unknown	07/12/01	Released 06/05/02
SEA	Caretta caretta	Internal - Viral, Fungal or Unknown	07/16/01	Released 06/05/02
NiMFS	Caretta caretta	Internal - Viral, Fungal or Unknown, (floater)	07/20/01	Released 10/03/01
A.T.	Caretta caretta	Internal - Viral, Fungal or Unknown, (floater)	07/20/01	Released 06/05/02
Corey II	Caretta caretta	Internal - Viral, Fungal or Unknown, (floater)	07/23/01	Released 06/05/02
CALO	Caretta caretta	Fracture Carapace, Plastron or Cranial	08/2/01	Died 08/01
OK	Caretta caretta	Fracture Carapace, Plastron or Cranial	08/21/01	Died 09/07/01
CARTER	Caretta caretta	Fracture Carapace, Plastron or Cranial	09/14/01	Died 10/09/01
BARNIE	Caretta caretta	Internal Viral, Fungal or Unknown	09/28/01	Released 06/05/02
CHARLESTON	Lepidochelys kempi	Internal Viral, Fungal or Unknown	10/2/01	Died 12/18/01
CEDAR II	Caretta caretta	Hook , Entanglement or Other	10/25/01	Released 06/05/02
		Internal - Viral, Fungal or		

CHANNEL	Caretta caretta	Unknown, (floater)	10/26/01	Died 11/29/01
PAMLICO	Caretta caretta	Hook , Entanglement or Other	11/29/01	Released 06/4/03
GILL	Caretta caretta	Internal - Viral, Fungal or Unknown	12/19/01	Released 9/18/02
BALTIMORE	Chelonia mydas	Internal - Viral, Fungal or Unknown - Cold Stun	12/27/01	Released 9/18/02
Admitted 2000				
RIVER	Caretta caretta	Cold-Stunned w/ other complications	01/21/00	Released 6/21/00
LEWIS	Caretta caretta	Cold-Stunned w/ other complications	01/21/00	Released 6/21/00
CHEESECAKE	Chelonia mydas	Cold-Stunned w/ other complications	04/08/00	Released 6/21/00
TIDES	Chelonia mydas	Hook , Entanglement or Other	05/17/00	Released 7/17/00
BEAR	Carretta caretta	Fracture Carapace, Plastron or Cranial	06/04/00	Released 06/05/02
FISHER	Chelonia mydas	Hook , Entanglement or Other	06/13/00	Released 7/17/00
ZEKE	Lepidochelys kempi	Hook , Entanglement or Other	06/13/00	Released 09/12/00
SHARKY	Caretta caretta	Fracture Carapace, Plastron or Cranial	06/19/00	Released 10/03/01
ROCKY	Lepidochelys kempi	Hook , Entanglement or Other	06/20/00	Released 7/17/00
RAY	Caretta caretta	Hook , Entanglement or Other	07/08/00	Released 06/20/01
STING	Caretta caretta	Hook , Entanglement or Other	07/10/00	Released 10/12/00
AVON	Caretta caretta	Fracture Carapace, Plastron or Cranial	07/12/00	Released 10/03/01
NEUSE Re-admit	Caretta caretta	Internal - Viral, Fungal or Unknown (floater) re-admit - net enatnglement	07/13/00 03/04/02	Released 06/20/01 Re-Released 6/02 **DEAD STRAND 6/03**
OAKIE	Caretta caretta	Something from each category	07/23/00	Released 10/03/01
RODEO	Caretta caretta	Hook , Entanglement or Other	08/12/00	Released 06/20/01
HOLDEN	Caretta caretta	Hook , Entanglement or Other	08/19/00	Released 06/20/01
COQUINA	Caretta caretta	Fracture Carapace, Plastron or Cranial	08/29/00	Released 06/05/02
POWER	Lepidochelys kempi	Hook , Entanglement or Other	09/07/00	Released 06/20/01
GRID	Chelonia mydas	Hook , Entanglement or Other	09/07/00	Released 10/12/00
JERSEY II	Lepidochelys kempi	Hook , Entanglement or Other (floater)	09/07/00	Released 06/20/01
HONEY	Caretta caretta	Fracture Carapace, Plastron or Cranial	09/27/00	Released 6//02/04
TRUMP	Caretta caretta	Internal - Viral, Fungal or Unknown	10/03/00	Released 06/20/01 **Dead strand 7/01**

Admitted 1999				
TOPPER	Caretta caretta	Cold-Stunned w/ other complications	03/04/99	Released 06/23/99
REEF	Lepidochelys kempi	Cold-Stunned w/ other complications	03/25/99	Released 06/23/99
DARE	Lepidochelys kempi	Internal Viral, Fungal or Unknown	06/15/99	Died 03/10/05
PEPPER	Chelonia mydas	Internal Viral, Fungal or Unknown	07/03/99	Released 10/03/01
BETTIE	Caretta caretta	Internal Viral, Fungal or Unknown	7/07/99	Released 10/27/99
JR	Caretta caretta	Hook or Entanglement	7/28/99	Released 10/27/99
MARINA	Caretta caretta	Fracture Carapace, Plastron or Cranial	8/10/99	Died 08/16/99
EMERALD	Caretta caretta	Hook or Entanglement	10/15/99	Released 12/13/99
CEDAR	Caretta caretta	Hook or Entanglement	11/04/99	Released 06/21/00
POUNDER	Caretta caretta	Cold-Stunned w/ other complications	11/29/99	Released 06/21/00
ANDY	Caretta caretta	Cold-Stunned w/ other complications	12/17/99	Released 06/21/00
UNO	Lepidochelys kempi	Cold-Stunned w/ other complications	12/17/99	Released 09/12/00
DOS	Lepidochelys kempi	Cold-Stunned w/ other complications	12/17/99	Released 06/20/01
TRES	Lepidochelys kempi	Cold-Stunned w/ other complications	12/17/99	Released 09/12/00
CUATRO	Lepidochelys kempi	Cold-Stunned w/ other complications	12/17/99	Released 6/21/00
CINCO	Lepidochelys kempi	Cold-Stunned w/ other complications	12/17/99	Released 6/21/00
SEIS	Lepidochelys kempi	Cold-Stunned w/ other complications	12/17/99	Released 6/21/00
SIETE	Lepidochelys kempi	Cold-Stunned w/ other complications	12/17/99	Released 09/12/00 **Dead strand in VA 6/18/01**
Admitted 1998				
PIER	Lepidochelys kempi	Hook or Entanglement	06/06/98	Released 06/10/98
BEAU	Caretta caretta	Fracture Carapace, Plastron or Cranial	06/18/98	Euthanized 06/22/98
SNEAD	Caretta caretta	Fracture Carapace, Plastron or Cranial	08/09/98	Died 09/26/98
JERSEY	Lepidochelys kempi	Hook or Entanglement	08/18/98	Released 11/12/98
HARKER	Caretta caretta	Fracture Carapace, Plastron or Cranial	09/27/98	Died 01/04/99

WINDY	Caretta caretta	Internal Viral, Fungal or Unknown	05/31/98	Released 10/27/99 **DEAD STRAND** **5/09/2003**
CHARLIE	Caretta caretta	Fracture Carapace, Plastron or Cranial	06/22/98	Released 09/12/00
SMYRNA	Caretta caretta	Fracture Carapace, Plastron or Cranial	06/24/98	Released 10/27/99
OCEAN	Caretta caretta	Internal Viral, Fungal or Unknown	08/23/98	Released 09/12/00
HUNTINGTON	Caretta caretta	Internal Viral, Fungal or Unknown	09/4/98	Released 06/23/99
PIVER	Caretta caretta	Fracture Carapace, Plastron or Cranial	11/01/98	Released 10/03/01
DRUM	Chelonia mydas	Hook , Entanglement or Other	11/09/98	Released 06/23/99
Admitted 1996 and 1997				
KAREN	Caretta caretta	Fracture Carapace, Plastron or Cranial	1996	Released 07/24/97
COREY	Caretta caretta	Fracture Carapace, Plastron or Cranial	Fall 1996	Released 06/10/98
HUFFY	Caretta caretta	Fracture Carapace, Plastron or Cranial	08/96	Released 07/24/97
KITTY	Caretta caretta	Fracture Carapace, Plastron or Cranial	05/23/97	Released 06/23/99
CORNCAKE	Caretta caretta	Prolapsed cloaca Hemiovariosalpingectomy	July 1997	Released 10/22/97 ***Resighted*** **Nesting** **06/09/99**
CC	Caretta caretta	Cold-Stunned w/ other complications	12/11/97	Released 06/10/98



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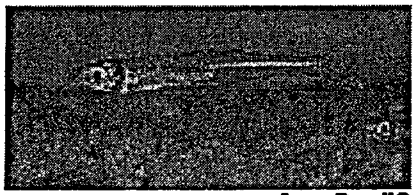

James Parnell©

Waccamaw Silverside in North Carolina

WACCAMAW SILVERSIDE

Menidia extensa

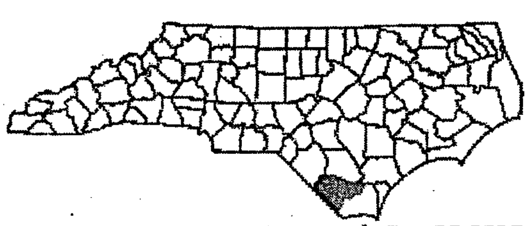
STATUS: Threatened

DESCRIPTION: The Waccamaw silverside, also known as skipjack or glass minnow, is a small (growing to about 2.5 inches), slim, almost transparent fish with a silvery stripe along each side. Its body is laterally compressed, the eyes are large, and the jaw is sharply angled upward. This fish spawns from April through June, but spawning reaches its peak when water temperatures are between 68 and 72 Fahrenheit. Fully developed larvae form small isolated schools by early May. No parental care of the young has been noted. The silversides reach sexual maturity by the following spring, spawn, and then shortly thereafter most of the adults die off. A few may survive a second winter.

RANGE AND POPULATION LEVEL: Known only from Lake Waccamaw and the upper Waccamaw River in Columbus County, North Carolina, the silverside is found in the upper Waccamaw River only during periods of high water and is not a permanent resident. Lake Waccamaw (not to be confused with the town of Lake Waccamaw) is the property of the State of North Carolina and is administered by the North Carolina Department of Natural Resources and Community Development's Division of Parks and Recreation. The species' population is estimated to be in the millions.

HABITAT: Lake Waccamaw is a natural lake with an approximate surface area of 8,934 acres and an average depth of 7.5 feet. Although it is fed by acidic swamp streams, the lake has a virtually neutral composition. This neutral condition, unusual among North Carolina's coastal plain lakes, is believed to be caused by the buffering effect of the calcareous Waccamaw Limestone formation, which underlies the lake and is exposed on the north shore. The Waccamaw silverside inhabits open water throughout the lake, where schools are commonly found near the surface over shallow, dark-bottomed areas.

Species Distribution from known occurrences. Species may occur in similar habitats in other counties. Green counties indicate observed within 20 years. Yellow counties indicate an obscure data reference to the species in the county. Red counties indicate observed more than 20 years ago.



Map Generated Oct. 22 2003

Species Location Map based on information provided by the North Carolina Natural Heritage Program. For additional information regarding this Web page, contact David Rabon, in Raleigh, NC, at david_rabon@fws.gov

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Keywords={same keywords listed above - used for search tools}