Sea Turtle Interactions With North Carolina Fisheries
Review and Recommendations To

The
North Carolina Marine Fisheries Commission

By The
Sea Turtle Advisory Committee

North Carolina Division of Marine Fisheries
Morehead City, NC 28557

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The first stage of this process consisted of gathering information from presentations provided by panel members as well as those from outside the group. Presenters from outside the group included Dennis Klemm, NMFS, Protected Resources Division, St. Petersburg, Fla; Therese Conant, NMFS, Office of Protected Species, Silver Spring, Md.; Elizabeth Griffin and Lindsay Fullencamp, Atlantic States Marine Fisheries Commission; Wendy Cluse, North Carolina Wildlife Resources Commission; Brian Cheuvront and Alan Bianchi, North Carolina Division of Marine Fisheries; and Mark Dodd, Georgia DNR. Panel members who presented to the STAC included Catherine McClellan, Duke University; Joanne Braun McNeill, NMFS, Beaufort, NC; Matthew Godfrey, North Carolina Wildlife Resources Commission; and Blake Price, North Carolina Division of Marine Fisheries. Each of these presenters provided the committee with relevant information pertaining to federal and state regulations, fisheries characterizations, socioeconomics, and management of fisheries in relation to protected species issues. These materials greatly contributed to the knowledge base and formation of the bulk of this report.

In addition to informative presentations, the panel had many assistants who were a part of this committee from its inception. Most importantly, these include Wendy Cluse, NC WRC; Alan Bianchi, NC DMF; and Katy West, NC DMF. These individuals participated in this process since the beginning and their knowledge, expertise and opinions were valued and incorporated into every stage of shaping this document.

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Introduction

The Sea Turtle Advisory Committee (STAC) was formed by the North Carolina Marine Fisheries Commission (NCMFC) in response to continuing problems with protected species interactions in fisheries throughout North Carolina. The committee began the process of gathering relevant information pertaining to many issues surrounding federally and state protected sea turtles (ESA 1973) and North Carolina commercial and recreational, estuarine fisheries in late 2003. Although the committee decided to concentrate its efforts on estuarine fisheries, it did recognize that oceanic commercial fisheries in North Carolina state waters can and do result in bycatch of sea turtles (e.g. Epperly et al. 1995b). The committee recognized the need for future consultations among stakeholders to address sea turtle bycatch in oceanic fisheries in state waters, with similar objectives as those stated for the present committee. Presented in this report are the findings of the committee along with a background summary provided to the committee. The background summary includes four parts: 1) federal and state management, 2) sea turtle natural history, 3) sea turtle strandings, and 4) North Carolina estuarine fisheries characterization. The document concludes with identification of problems, development of solutions, and recommendations by the STAC for the reduction of commercial and recreational fishery interactions with sea turtles, while maintaining North Carolina fisheries.

The STAC is comprised of stakeholders concerned with the bycatch of protected species in commercial and recreational fisheries. There are currently ten committee members and one meeting facilitator (Table 1). Recreational and commercial fishermen represent the fishing community. These fishermen were selected for their knowledge, experience, and common operating (fishing) grounds, thus were able to provide representation for the larger community. From the scientific community, panel members are comprised from state and federal agencies (National Marine Fisheries Service - NMFS, the North Carolina Wildlife Resources Commission -NCWRC, the North Carolina Division of Marine Fisheries - NCDMF, academia (Duke University) and one environmental organization (Environmental Defense)). Panel members from these groups work integrally with marine fisheries issues and protected species interactions.

Objective

The primary goal of the STAC is to develop solutions for the reduction of sea turtle interactions in commercial and recreational (rod and reel) fishing gear, while maintaining *economically viable* fisheries throughout the estuarine waters of North Carolina. The committee agreed that *economically viable* fisheries would be defined as any commercial fishery where an income can be obtained. However, the committee recognized that it was limited in its ability to adequately assess the economic impacts of bycatch and regulations aimed at reducing bycatch. This limitation implies that recommendations made by the committee do not fully address the associated economic ramifications. The committee presents the findings to the NCMFC and NMFS in this final report. The progress of the working group was assessed through various milestones (Table 2).

Table 1. The North Carolina Marine Fisheries Commission - Sea Turtle Advisory Committee.

Last Name	First Name	Position	City
Panel Members			
Beresoff *	David	Commercial Fisherman	Wilmington
Daniels	Henry	Commercial Fisherman	Bellhaven
Duval	Dr. Michelle	Environmental Defense Technical Advisor	Raleigh
Foster	Bill	Commercial Fisherman	Hatteras
Godfrey	Dr. Matthew	NCWRC Technical Advisor	Beaufort
Hilton *	David	Commercial Fisherman	Ocracoke
McClellan	Catherine	DUML Technical Advisor	Beaufort
McNeill	Joanne Braun	NMFS Technical Advisor	Beaufort
Price	Blake	NCDMF Technical Advisor	Morehead City
Radford	Jim	Recreational Fisherman	Raleigh
Read	Dr. Andy	DUML Technical Advisor	Beaufort
Salisbury	Charles Van	Commercial Fisherman	Englehard
Panel Assistants			
Bianchi	Alan	NCDMF	Morehead City
Cluse	Wendy	NCWRC	Atlantic Beach
Lewis	Parks	NCDMF	Morehead City
West	Katy	NCDMF	Washington
Panel Facilitators			
Scarborough **	Jenny	Non-voting facilitator	Ocracoke
Hawkins ***	Jess	NCDMF - Non-voting facilitator	Morehead City

* David Beresoff and David Hilton were initially STAC members, but were appointed as NC MFC members in the course of the STAC.

** Jenny Scarborough served as the STAC facilitator from 10/2003 - 2/2006.

*** Jess Hawkins facilitated the final 4 meetings in Ms. Scarborough's absence.

Table 2. Phases, milestones, and the timeline for the North Carolina Marine Fisheries Commission Sea Turtle Advisory Committee.

Phase	Milestone	Timeline
1 - Informative	Completion of information gathering and stakeholder presentations	October 2003 - December 2004
2 - Compilation	Completion of fact summaries from presentations	January 2005 - August 2005
3 - Problem Identification *	Identify current management problems/develop solutions	May 2005 - November 2005
4 - Completion Report	Submit final report to NCMFC and NMFS	November 2005 - June 2006

* some overlap will occur by design as problems and solutions are identified and discussed during compilation

Background

The potentially lethal interaction of commercial and recreational fisheries with federally protected endangered or threatened sea turtle species in North Carolina coastal estuarine waters presents a challenge to state and federal fishery managers. Managers will often establish seasonal closures, area closures, gear restrictions (bycatch reduction devices (BRDs)), and implement monitoring programs to reduce sea turtle incidental capture in fishing gear. As sea turtle populations continue to increase under the protection of the Endangered Species Act (ESA), the number of

interactions will likely increase, resulting in the imposition of restrictions on other fisheries. Unfortunately, these protective measures can be difficult for state and federal managers to implement and may be costly to the fishing industry.

Such was the case for Pamlico Sound in 1999, when a significant increase in strandings in the southeastern portion of Pamlico Sound, coupled with observed incidental takes in the flounder gill net fishery, resulted in the National Marine Fisheries Service issuing an emergency closure of this area to large mesh ($\geq$ 5 inch stretched mesh) gillnets. Since this initial closure (Figure 1), the entire Pamlico Sound from N 35^0 46'.300 south to N 35^0 00'.000 and west to 76^0 30'.000 has had restrictions in place for all gillnet operations from September through December of each year. This area is referred to as the Pamlico Sound Gillnet Restricted Area (PSGNRA). This has brought economic hardship during this time to the commercial fishermen in this area who depend upon the valuable southern flounder (*Paralichthys lethostigma*) fishery.

To maintain this fishery, the North Carolina Division of Marine Fisheries (NCDMF), in conjunction with the National Marine Fisheries Service (NMFS) – Office of Protected Resources (OPR), applied for and received Section 10 permits under the ESA inclusive with comprehensive habitat conservation plans (HCP) in 2000, 2001, 2002 – 2004, and 2005. The incidental take permit (ITP) authorizes protected species interactions, allowing the fishery to operate under certain restrictions. Although the fishery continues to operate in the shallow-water fishing grounds along the Outer Banks, and mainland side of Pamlico Sound, the deep-water fishing grounds are permanently closed at this time.

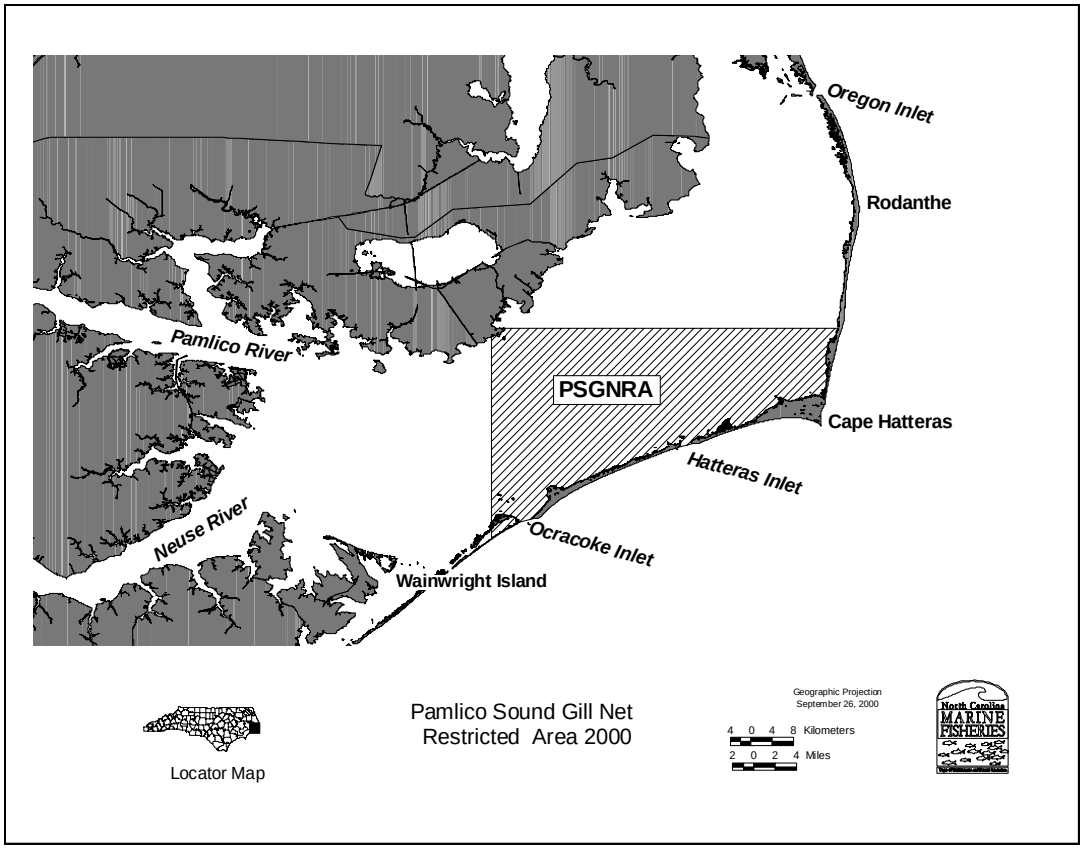

Figure 1. Map of southeastern Pamlico Sound and the 2000 NMFS closure line initially establishing the Pamlico Sound Gillnet Restricted Area (PSGNRA).

Endangered Species Act (1973) Overview

The Endangered Species Act (ESA) was enacted in 1973, "to provide a means whereby the ecosystems upon which endangered and threatened species depend may be conserved, (and) to provide a program for the conservation of such endangered species and threatened species." The ESA is a comprehensive act with eighteen sections that cover many aspects of endangered species protection and management. The sections most relevant to the relationship between the federal government (NOAA Fisheries) and the state of North Carolina (the North Carolina Division of Marine Fisheries, or NCDMF) regarding the protection of sea turtles include:

- Section 3 - Definitions
- Section 6 - Cooperation With the States
- Section 7 - Interagency Cooperation
- Section 9 - Prohibited Acts
- Section 10 – Exceptions

Section 3 defines the terms used throughout the ESA. Within this section, the definitions most important to the meaning and intent of the ESA include:

-endangered species- *any species which is in danger of extinction throughout all or a significant part of its range.*

-threatened species- *any species which is likely to become an endangered species within the foreseeable future.*

- take- *to harass, harm, pursue, hunt, shoot, wound, kill, trap, capture, or collect, or to attempt to engage in any such conduct.*

Section 6(C)(1) of the ESA states that the federal government can enter into cooperative agreements with states that establish and maintain adequate and active programs for the conservation of endangered and threatened species. These cooperative agreements are enacted to assist the state in the implementation of their program. For a state to have an "adequate and active" program they must: have the authority to conserve resident listed species; have established acceptable conservation programs consistent with the purposes of the ESA; have authority to conduct investigations into the status and requirements of the species and habitats; have authority to establish conservation programs, including land/habitat acquisition; and have a provision for public participation in the designation process. Once a state's program is deemed to be "adequate and active", NOAA Fisheries is then authorized to allocate funds to the state in order to assist in the implementation of the state's conservation programs. These allocations are based upon considerations such as funds available, urgency of need, number of species, readiness of the state to commence the program, potential for success, etc. As a general rule, the federal share shall not exceed 75% of the estimated program cost. The section 6 program must be reconfirmed annually. In 2000, the North Carolina Wildlife Resources Commission (NCWRC) entered a Section 6 cooperative agreement with the National Marine Fisheries Service (NMFS) allowing NCWRC to operate the North Carolina Sea Turtle Stranding and Salvage Network.

Section 7 of the ESA relates to interagency cooperation amongst federal agencies. There are two primary provisions to this section: 1) all federal agencies shall utilize their authorities towards the furtherance of the goals of the ESA; 2) and each federal agency must consult with NOAA or USFWS to insure that any action funded, authorized, or carried out by the agency is not likely to jeopardize the continued existence of a listed species or result in the destruction or adverse modification of critical

habitat. Although this section relates to federal agency cooperation, it can impact state projects through a federal nexus. If a project has federal authorization, funding, or other participation, it is subject to section 7 consultation between the federal agency and NOAA Fisheries.

The prohibition against the take of listed species is detailed in section 9 of the ESA. As stated in section 9, it is unlawful for any person subject to the jurisdiction of the United States to import, export, take within the US or territorial sea of the US, take upon the high seas, possess, sell, deliver, carry, transport, ship, receive, or offer for sale, any endangered species, or to violate any regulation pertaining to such species or to a threatened species under section 4(d). Exemptions to this are provided under section 6(g)(2) and section 10 of the ESA.

Section 10 of the ESA provides for exceptions to the take prohibitions in the form of permits. These permits can be for either intentional take - section 10(a)(1)(A), or for incidental take – section 10(a)(1)(B). Intentional take permits are intended for scientific purposes or to enhance the propagation or survival of the affected species and include activities such as: capture, tag, measure, release studies; hatchery operations; relocations; telemetric monitoring; laboratory experiments; and research resulting in mortality of a listed species. Section 10 incidental take permits are for activities that are otherwise lawful but are expected to incidentally take a listed species. This would include fishery experiments (experimental fisheries, gear testing), management plans/measures by the state, and other work by the state or its agents that do not target listed species but are expected to likely result in take. Permit holders must develop and implement conservation plans that reduce and minimize the impacts of the take. Once a section 10 permit application is reviewed and deemed appropriate, a permit is given to authorize a specified level of take for the project. Along with the specified take that is authorized, the permits always include reporting requirements, and often include other conditions that must be met (tagging, handling guidelines, data analyses, conservation plans for 10(a)(1)(B) permits, etc.). The section 10 permit provision is very important to the regulated community, including the states, because it can allow a fishery to continue (under constraints) that would otherwise have to be shut down under the ESA mandates. Likewise, it allows the applicant the opportunity to try management measures to see if they would be successful in allowing the fishery to continue to operate in some capacity in the future.

Currently, the North Carolina Division of Marine Fisheries manages the fall flounder gillnet fishery throughout Pamlico Sound from September through December through a Section 10 permit. This management area is known as the Pamlico Sound Gillnet Restricted Area (PSGNRA), and has been in effect since 2000.

What is the PSGNRA?

The PSGNRA is an example of an ESA section 10(a)(1)(B) incidental take permit, which authorizes exceptions to the strict take prohibitions established under the ESA. In order to receive such exception to the take prohibition, the activity must be lawful and the resulting take must be incidental to the otherwise lawful activity. The fisheries operating under the PSGNRA permit are lawful, and incidental take of sea turtles have been documented in certain components. Thus, the North Carolina Division of Marine Fisheries (NCDMF) developed and implemented a conservation plan to reduce incidental capture of sea turtles. The plan includes monitoring, enforcement, and funding provisions. The permit anticipates a take level that is likely to result from the conservation plan. As long as this take level is not exceeded, the incidental take is authorized under the ESA.

NCDMF is the official permit holder, however each fishery operation under the permit is included through permits/certificates of inclusion.

Why is the PSGNRA needed?

The PSGNRA is needed to reduce and minimize the effects of sea turtle take consistent with ESA recovery goals and to allow shallow water fishermen to operate in a federally closed area. Sea turtles were documented to strand along the beaches of Pamlico Sound in high numbers in 1999. NCDMF began an at-sea monitoring program to determine the cause of strandings. Deepwater, large mesh gillnets were a likely source of the dramatic increase in strandings. As a result, NMFS closed the Pamlico Sound to fishing with large mesh gillnets. However, the shallow water fishery was documented not to be the major source, and NCDMF applied for and was issued an incidental take permit which allowed this fishery to operate in the closed area as long as certain measures to reduce the interactions were implemented.

Sea turtle interactions with fisheries and other human activities must be reduced because these species have declined dramatically from their historical abundances. Turtles were once so abundant major directed sea turtle fisheries existed in Texas, Louisiana, and Florida. Although some of these fisheries operated up through the 1960's, many had documented dramatic declines in sea turtle landings by the 1940's. An example of historical abundance was documented in a film shot in Tamaulipas, Mexico, 1947, of an arribada of Kemp's ridleys. Experts have looked at the film and estimate that over 40,000 females were on that beach in one day. Today, the estimate of breeding females for the entire population is approximately 3,000. Sea turtles play various roles in the ecosystem, including acting as an important predator. Depending on their species, they have a wide variety of food sources that they depend on, which include jellyfish, sponges, sea grass, and algae. They are also a protein source for the other top predators in the marine environment, such as sharks. Their shells provide a platform for transport of epibionts, and their eggs provide a source of nitrogen and other nutrients to the nesting beaches.

Because sea turtle populations have declined, they were listed for protection under the ESA. There are five listing factors that have to be considered before you can list a species under the ESA: (1) threat or present danger of the destruction, modification, or curtailment of habitat; (2) overuse for commercial, recreational, scientific, or educational purposes; (3) disease or predation; (4) inadequacy of existing regulatory mechanisms; and (5) other man made or natural factors that can affect their existence. Recovery plans have been developed for each listed species.

These plans describe site-specific actions necessary to reach recovery goals, objective and measurable delisting criteria, and an estimate of the time and cost to carry forth recovery actions. Although marine turtles were officially listed under the ESA in the 1970's, recovery plans were not developed until 1984 and that was a general recovery plan for every turtle species. In the early 1990's individual recovery plans were done for each of the species of sea turtles. Revisions to the Atlantic recovery plans are underway. Revised recovery plans for the loggerhead and the Kemp's Ridley have already been started, and revised recovery plan committees for the green and the leatherback are in the process of being composed.

What is anticipated for the future of the PSGNRA?

The past PSGNRA Incidental Take Permit expired at the end of 2004. In anticipation of future operation of gillnet fisheries in Pamlico Sound, NCDMF applied for an Incidental Take Permit for the operation of commercial gillnets for six years (2005-2010) in Pamlico Sound. The 2005 permit application sought levels of allowable lethal and nonlethal takes identical to previous years. Based on the best available scientific and commercial data available coupled with an analysis under Section 7 of the ESA, a Section 10 Incidental Take Permit was issued to NCDMF for the operation of gillnet fisheries for 6 years in Pamlico Sound, but with allowable take levels reduced relative to previous years. Annual internal reviews by NCDMF and NMFS of fisheries operations and interactions with sea turtles will be conducted after the end of each fishing season, to evaluate the effectiveness of the PSGNRA management plan. Future changes in the management may be implemented accordingly.

How can the public participate in the future?

Applications for ESA section 10(a)(1)(B) incidental take permits (like the PSGNRA permit) go out in the Federal Register for public comment and review. NMFS must consider relevant comments prior to issuing the permit. Draft revisions to the sea turtle recovery plans will also go out for public review and comment prior to finalizing. NCDMF and NCWRC have participated in stakeholder meetings for the revised loggerhead and Kemp's ridley recovery plans, and will be invited to attend other species revisions as well. Public participation is welcome in stakeholder meetings, and through public comment and review for documents published in the Federal Register. Relevant websites follow:

http://kempsridley.fws.gov/
http://northflorida.fws.gov/SeaTurtles/loggerhead-recovery/default-loggerhead.htm
http://www.gpoaccess.gov/fr/index.html

Atlantic Sea Turtle Strategy Overview

The Atlantic Sea Turtle Strategy is a concept that was signed into existence in June of 2001 with a general plan to address sea turtle bycatch on a gear basis instead of by specific fisheries. The goals of the Strategy are to: conserve and recover sea turtles, authorize fishery takes consistent with ESA mandates, increase effectiveness in management, and prioritize fishery interaction concerns (includes characterization of all fisheries in both state and federal (EEZ) waters). This approach was established because of the recognition that previous management strategies and mandates were not sufficient. In order to carry out the Strategy, NOAA Fisheries created new positions and assembled a team dedicated to this task. However, the Strategy is an agency-wide initiative and extends beyond the work of that team. For example, NOAA Fisheries has contracted the Atlantic States Marine Fisheries Commission to characterize the fisheries operating in state waters by gear type. The first draft characterization completed was for fisheries operating in North Carolina state waters.

A number of tasks were established for the Strategy that would provide the means for achieving the stated goals. NOAA Fisheries aims to continue and improve stock assessments for each stock/species of sea turtle in the U.S. Atlantic (including the Gulf of Mexico) to better understand the conditions, threats, and needs being faced by each species and stock. NOAA Fisheries is also working to improve and refine estimation techniques for the takes of sea turtles, including improving the estimation or categorization of sea turtle bycatch by gear type and fishery, in order to get a more accurate picture of the extent of fishery interactions. Having this information will allow them to

evaluate the significance of bycatch by gear type so that they can better identify the greatest management needs. Once these needs have been established, specialist groups will be convened to prepare plans for reduction of takes for gear types with significant levels of take. These plans will then be implemented via ESA and Magnuson-Stevens Act regulations or other means as appropriate.

North Carolina State Management Programs – NCDMF

- Shrimp Trawl Tow Times
- PSGNRA

Shrimp Trawl Tow Times

Background

A Section 10 (ESA 1973) experimental permit allowing the use of shrimp trawl tow times in place of Turtle Excluder Devices (TEDs) has been established since 1996 in an area around Brown's Inlet, North Carolina (60 FR 28741, June 2, 1995). The NCDMF applied for and received this permit due to a prevalence of thick algae concentrations in this area, which at times are so thick that it is impossible to work the area because nets quickly fill with this alga. Prior to the TED requirement, tow times were often decreased in order to work the area. With the institution of Federal Regulations requiring the use of TEDs in shrimp nets to release endangered and threatened species of sea turtles, problems quickly developed with algae clogging TEDs, rendering them useless in releasing turtles and the nets filling with algae from the TEDs forward (FR 57348, December 4, 1992). The bottom between Rich's and Brown's Inlets consists of scattered rocks and concentrations of algae.

Permit Conditions

The ITP has authorized the use of reduced tow times in place of TEDs from April 1 through November 30 of each year since 1996. The area is approximately 30 nautical miles (nm) long, between Rich's Inlet, North Carolina (34° 17.6' N. latitude), and Brown's Inlet, North Carolina (34° 35.7' N. latitude) and extends offshore 1 nm ("North Carolina restricted area"). Stipulations of the permit are established through proclamation authority granted to the Director of Marine Fisheries. These include:

- Mandatory tow time permit; Observer coverage for 5% of trips
- Fishermen log book reporting requirements; NCDMF reporting requirements
- Maximum tow time of 55 minutes from April through October
- Maximum tow time of 75 minutes from November1 through November 30
- NCDMF surveillance by land based observers, vessels, and aircraft
- Use of TEDs when algae and grasses not prevalent
- Monitoring strandings through NCWRC
- Termination of permit should related strandings exceed 10 turtles

2004 Tow Time Monitoring Summary

The Division issued 15 tow time permits in 2004; all of the permittees reported to the Division. Based on log book reports nine fishermen utilized tow times, two used TEDs during the season, two worked in South Carolina, one surrendered their permit and one fisherman's boat was destroyed by fire. These nine vessels made 135 trips and conducted 481 tows without TEDS during the tow time period based on information contained in their log books. Observers made eight trips during the period and reported no sea turtle captures in 29 observed tows. The North Carolina Sea Turtle Stranding Network provided weekly stranding reports for Onslow and Pender Counties. For the period of August 14 through November 30, 2004 seven turtles were stranded on the ocean beach. There was a loggerhead with no wounds stranded on Onslow Beach during the week of August 25. During the week of August 30 there were three loggerheads stranded, one found alive but lethargic (later died) on North Topsail Beach, one alive but lethargic (in re-hab) at Surf City and one at Topsail Beach with no wounds. A Kemp's Ridley with no wounds stranded on Onslow Beach during the week of October 26. For the week of November 15 a loggerhead stranded on North Topsail Beach with no wounds and a loggerhead with a hook and weight on a front flipper stranded at Surf City during the week of November 29. Three out of the 481 reported tows exceeded the 55-minute tow time limit by one to six minutes. Fishermen reported four sea turtle takes, two loggerheads and two Greens. All of these turtles were reported as being released alive and unharmed. Please refer to Appendix 1 for further details.

PSGNRA Management Overview (1999 – present)

Background

In November 1999, the North Carolina sea turtle stranding network noted significant increases in strandings in the southeastern portion of Pamlico Sound. Aerial surveys of eastern Pamlico Sound along Ocracoke and Hatteras Islands conducted by National Marine Fisheries Service (NMFS) and NCDMF Marine Patrol identified three active fisheries; the shrimp trawl fishery, large mesh ($\geq$ 5-inch stretched mesh) flounder gillnet fishery, and small mesh (< 5-inch stretched mesh) spotted seatrout (*Cynoscion nebulosus*) gillnet fishery (Price 2005, 2004; Gearhart 2003, 2002, 2001).

Subsequent at-sea monitoring aboard gillnet vessels conducted in 1999 by NCDMF Fisheries Management staff revealed two sea turtle takes in the flounder fishery and no takes in the spotted seatrout fishery. Considering these data, NMFS issued an emergency rule closing southeastern Pamlico Sound to gillnets larger than 5-inch stretched mesh to protect endangered and threatened sea turtles (64 FR 70,196, December 16, 1999). Since 2000, NCDMF has applied for and received Section 10 Incidental Take Permits that have allowed a limited shallow water fishery to operate requiring many stipulations.

These measures have allowed NCDMF to establish a comprehensive Habitat Conservation Plan and long term monitoring program. Stipulations of the HCP include: established sea turtle take levels, permitted entry requirements, restricted fishing areas, yardage limits, mandatory weekly logbook reporting, NCDMF weekly reporting, mandatory observer coverage, mandatory sea turtle interaction reporting, sea turtle resuscitation, handling, and tagging requirements, violation protocols, and immediate closure of the fishery should authorized sea turtle take levels be reached.

Methods

In August of each year, NCDMF issues a proclamation that establishes the PSGNRA (Figure 2). Fishermen must comply with the stipulations of the proclamation, which include permitted entry, a 2,000 yard limit for all large mesh gillnet fishing operations, 2,000 yard limit for all small mesh gillnet fishing operations, weekly logbook reporting (port, area, flounder pounds, yards of gillnet, soak time, sea turtle captures and condition of sea turtles), and observer coverage. Fishers are also mandated to use proper sea turtle handling techniques. Failure to adhere to these stipulations results in a 10-day suspension, 30-day suspension, or 6-month revocation of the PSGNRA permit.

Observers are trained to identify, measure, resuscitate, and tag sea turtles. Date, time, tag numbers, location (latitude and longitude, when possible), condition (e.g., no apparent harm, injury including a description of the nature of the injury, or mortality), species, sex (if determinable), and curved carapace length are recorded for each turtle observed. Dead sea turtles are brought to shore when feasible. All live, debilitated sea turtles are brought to shore for examination and treatment. Carcasses not brought in for post-mortem examinations are marked with external flipper tags or spray-painted before disposal overboard. Observers collect data on location, gear parameters, catch, and bycatch for each haul. All observers are debriefed within 24 hours of each trip to obtain data on flounder catch, set locations, gear parameters, and sea turtle interactions to provide estimates of sea turtle bycatch.

The total bycatch of sea turtles in the PSGNRA is estimated using the stratified ratio method. The bycatch rate (sea turtles caught per unit of fishing effort), estimated from observer data, is multiplied by the total fishing effort reported by the fishermen. Fishing effort is the product of yards and soak time (days). Total bycatch estimates are calculated weekly by adding estimates for each species within each restricted area.

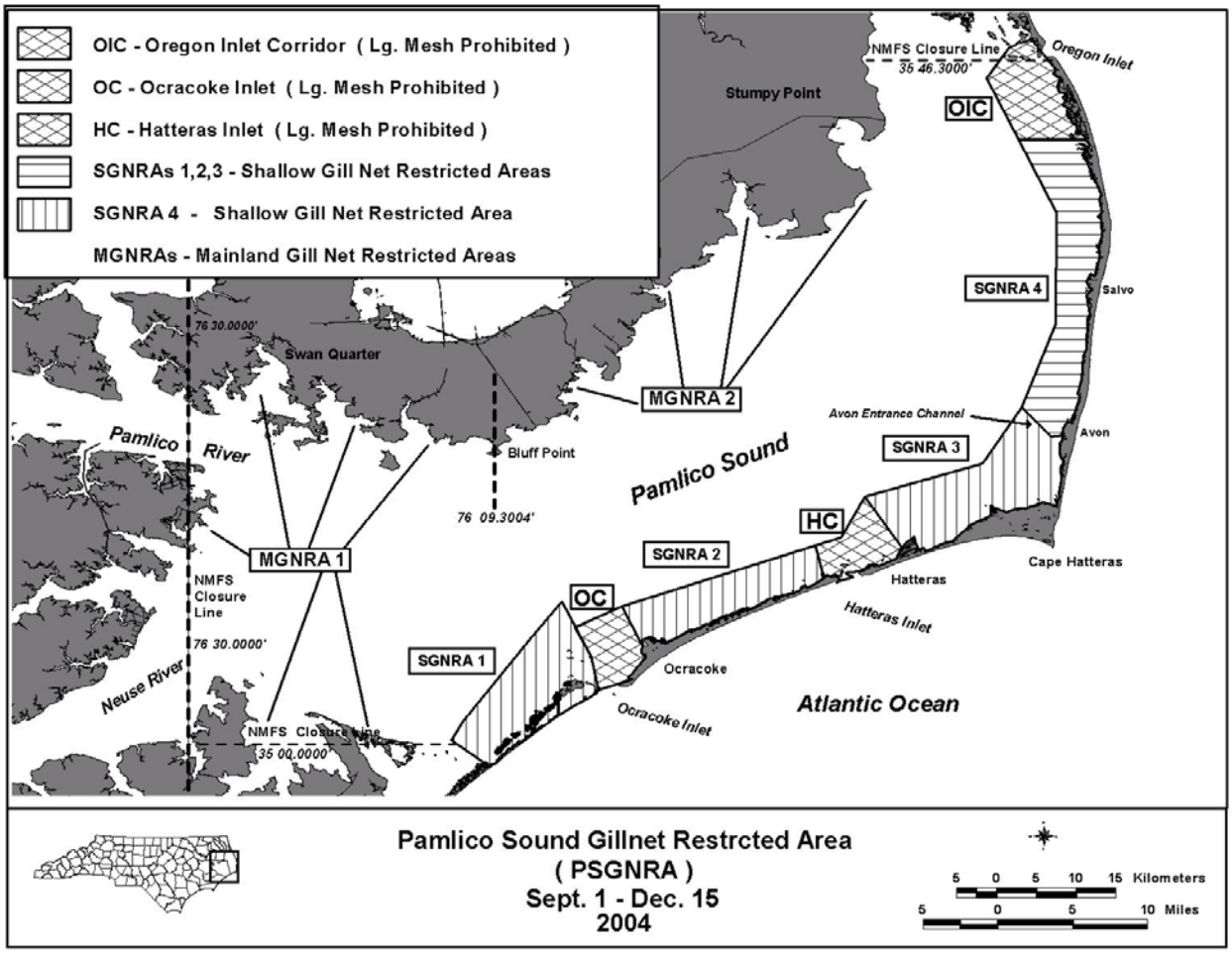

Figure 2. Map depicting the 2004 Pamlico Sound Gillnet Restricted Area (PSGNRA) from September through December.

Results Summary

From 1999 through 2004, there have been nearly 800 observations, achieving about 10% coverage of commercial gillnet fishing operations in the Pamlico Sound from September through December. In 1999 and 2000, prior to the establishment of the current restricted fishing areas (Figure 1), and prior to the permanent deep-water closure, there were 21 turtles observed from 81 observed trips. In 2000, 15 of these interactions occurred in the deep water fishing grounds of Pamlico Sound, resulting in the permanent closure of this region.

From 2001 to present there have been 6,941 reported trips and 696 observed trips throughout the PSGNRA from September through December of each year. All observed sea turtle interactions have occurred in large mesh ($\geq$ 5 in. stretch mesh) commercial gillnet operations in the shallow water from September through December of each year in the PSGNRA. The primary species observed has been the green turtle *Chelonia mydas*, which has represented 70% (n = 21) of all observed species. There have been five observations of loggerheads *Caretta caretta*, three observed Kemps Ridley's *Lepidochelys kempii*, and one observed hawksbill *Eretmochelys imbricata*. Most (70%) of the interactions have been live takes resulting in identification, sampling, tagging, and releasing the sea turtles in good condition at or near inlets along the Outer Banks.

Conclusion

Proactive and adaptive management efforts have allowed NCDMF to appropriately establish restricted fishing areas and to weight monitoring throughout the Pamlico Sound from September through December. NCDMF has been able to successfully manage the large mesh gillnet fisheries in Pamlico Sound from September – December, and observed levels of sea turtle interactions in gillnet fisheries have remained below thresholds as established by the ITPs in 2001, 2002, 2003, and 2004 (Price 2005, 2004; Gearhart 2003, 2002). Finally, sea turtle strandings have been reduced since the onset of the PSGNRA and have remained well below peaks observed in 1999.

Natural History of Sea Turtles in North Carolina

Life History

There are seven species of sea turtles worldwide. Five of these species occur in North Carolina (Figure 3): loggerhead turtles (*Caretta caretta*), green turtles (*Chelonia mydas*), Kemp's ridley turtles (*Lepidochelys kempii*), leatherback turtles (*Dermochelys coriacea*) and hawksbill turtles (*Eretmocheyls imbricata*) (Schwartz 1977, 1976). The life cycle of all marine turtles (Figure 4) starts with the incubation of eggs on tropical and subtropical sandy beaches. After emerging from their nest, hatchling turtles make their way to the ocean and swim continuously until they reach deeper water, where they spend a number of years as juveniles (Wyneken and Salmon 1992). Off the coast of North Carolina, small juveniles are thought to passively drift in gyres and eddies around the Sargasso Sea, while larger juveniles use the waters around the Azores, Madeira, the Canary Islands, and Cape Verde (Bolten 2003). At some point, the large juveniles move back from a pelagic, open-ocean existence into coastal waters (except for leatherback turtles that are thought to remain primarily pelagic). This habitat shift coincides with a switch from feeding on jelly-like organisms in the open ocean to feeding on bottom-dwelling mollusks and crustaceans (loggerheads and Kemp's ridleys) (Snover 2002) or sea grasses (greens). Large juveniles were believed to remain in coastal waters, moving between feeding zones (Witzell 2002), although new observations from North Carolina (Catherine McClellan, unpublished data) suggest that some large juvenile loggerheads move back out into pelagic regions of the Atlantic. Once they reach adulthood, sea turtles make reproductive migrations to the region where they were born, a behavior known as natal homing (Bowen and Karl 1996). Males and females mate off the nesting beaches and, starting approximately 30 days later, females begin to crawl onto the beach at night to lay up to 5 nests, each separated by a roughly 2 week period. Loggerhead females do not reproduce each year, but instead mate every 2 to 4 years (Dodd 1988).

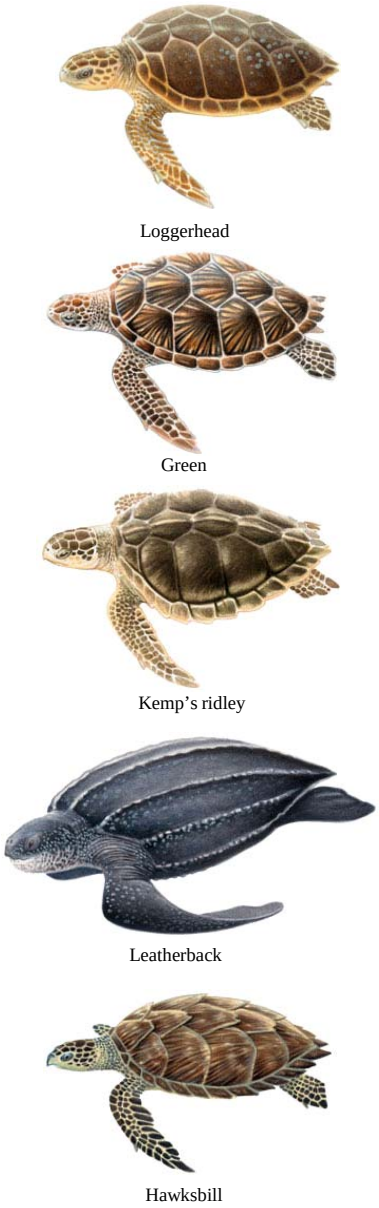

Figure 3. Sea turtles occurring in North Carolina Waters. Drawings by Garth Mix, Garth Mix Designs.

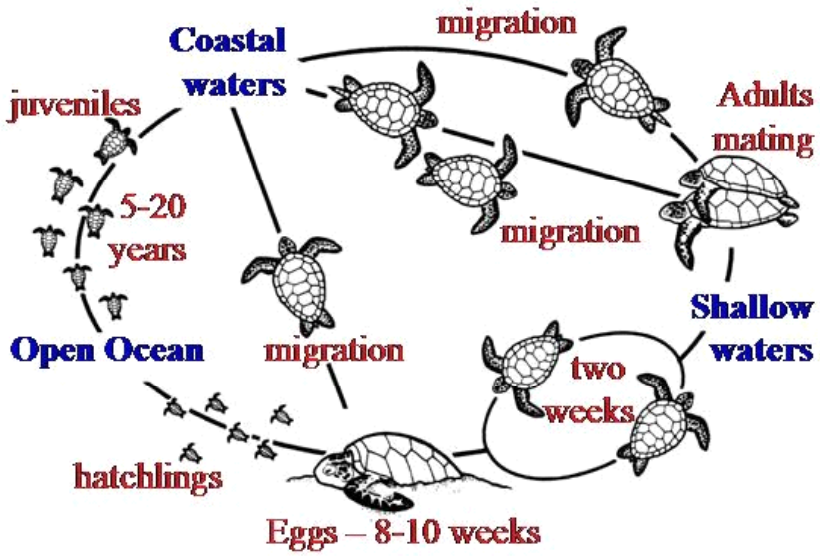

Figure 4. Diagram of generalized sea turtle life history stages and their durations adapted from Miller 1996.

Nesting

Although loggerhead, green and leatherback turtles all nest in North Carolina, on ocean-facing beaches during the summer, approximately 95% of all nests in North Carolina are made by loggerheads. Only two Kemp's ridley nests have been observed in North Carolina to date. The NC Wildlife Resources Commission, assisted by the National Parks Service, US Fish and Wildlife Service, US Department of Defense, North Carolina State Parks and Recreation and a large volunteer base, monitors sea turtle nesting. A network of volunteers and participants monitor nearly all the ocean facing beaches each day in the summer. The NC Wildlife Resources Commission has data on sea turtle nests dating from the 1970s, but only since the mid 1990s has monitoring been standardized, so that all beaches are patrolled during the nesting season. In the last decade the number of loggerhead nests laid each year in North Carolina has fluctuated from 400 to 1200. This magnitude of annual variation in the numbers of nests laid is common in sea turtle populations and is thought to reflect environmental variation and the fact that sea turtle females seldom nest in consecutive years (Hays 2000). Overall, the average number of loggerhead nests laid per year in the state is 750 (WRC, unpublished data). The number of loggerhead nests in North Carolina in total makes up about 1% of the total number of loggerhead nests laid in the southeastern United States (Ehrhart et al. 2003). Within the Atlantic basin, the southeastern U.S. loggerhead population is one of five known major nesting aggregations (Ehrhart et al. 2003).

Fewer green turtle nests are laid each year in North Carolina. The yearly total for this species ranges from 0 to 25. In the southeastern United States, Florida has the most green turtles nests: between 5000 and 9000 per year. Within the Atlantic Basin, the Florida nesting population is one of 5-10 large nesting aggregations (Hirth 1997).

Even fewer leatherback nests are laid in North Carolina, although at least one nest has been observed each year during the last five years. The southeastern United States leatherback nesting

population is one of the smaller nesting populations in the Atlantic basin; however, the number of nests laid in Florida is increasing significantly each year (Kelly Stewart, Duke Marine Lab unpublished data). Larger nesting aggregations of leatherbacks in the Atlantic include Panama/Costa Rica, Trinidad, Suriname, French Guiana, and Gabon (Troeng, Chacon and Dick 2004).

Kemp's ridley turtles nest almost exclusively in the state of Tamulipas, Mexico, and parts of Texas in the Gulf of Mexico. Only very rarely are nests observed on the coast of the southeastern United States (Marquez 1994).

Feeding

During their oceanic stage, loggerheads forage in a pelagic habitat eating organisms associated with sargassum (Bjorndal, 1997). As they become older and switch to a more coastal habitat, their diet changes too. Demersal crabs, whelks, conchs, horseshoe crabs, and other benthic organism are the primary components of their diet. Like the loggerhead, the Kemp's ridley turtle's diet changes from pelagic to benthic during the juvenile life stage, however their diet consists primarily of crabs (Bjorndal, 1997). Green turtles are more specialized and graze on sea grasses and algae. Hawksbill turtles feed on sponges and corals, which are not abundant in North Carolina waters. As leatherbacks feed on gelatinous prey, they occur almost exclusively in ocean waters. North Carolina sounds are important feeding grounds for juvenile loggerheads, Kemp's ridley, and green sea turtles (Epperly et al. 1995c).

Distribution

During the spring months, as water temperatures begin to rise, sea turtles migrate up the coast and into estuarine waters (Shoop and Kenney, 1992; Thompson and Huang, 1993; Musick et al. 1994; Witzell and Azarovitz, 1996; Braun-McNeill and Epperly, 2004). When waters begin cooling in the fall, many sea turtles migrate southward out of the temperate latitudes to warmer waters. Others move offshore to warm waters in or near the Gulf Stream (Catherine McClellan, unpublished data). This general pattern is reversed the following spring as they again migrate estuarine and northward along the coast, repopulating estuarine waters and temperate latitudes. Since 1988, researchers with the National Marine Fisheries Service (NMFS) in Beaufort have been monitoring the distribution of sea turtles in North Carolina estuarine and near-shore waters, employing three complementary methods to assess turtle distributions: aerial surveys, public sightings and mark-recapture studies. A distinct seasonal pattern of sea turtle distribution in the sounds and near-shore waters of North Carolina was discerned from this research. In April, as coastal waters begin to warm, sea turtles enter the sounds. During summer months, turtles may be found from Albemarle Sound to Cape Fear and as far west as the lower reaches of the Neuse River estuary. The greatest densities occur in Core Sound and along the eastern shore of Pamlico Sound. In the fall, turtles leave the sounds as water temperatures cool and are rarely seen inside barrier islands from January to March. Sea turtles are observed offshore throughout the year.

Although aerial surveys can cover large areas in comparatively small amounts of time, they do not allow for species identification or enumeration of turtles below the surface. Even so, surveys conducted over Pamlico and Core Sounds from 1989-1991 revealed spring immigration by turtles into these waters, a summertime dispersal, followed by fall emigration (Epperly et al. 1995a). Offshore surveys conducted during the fall/winter of 1991/1992 indicated a pattern of distribution that appeared

to be related to water temperature (Epperly et al. 1995b). Other, opportunistic aerial sightings have provided additional evidence for this pattern of dispersal. (Figure 5a-d).

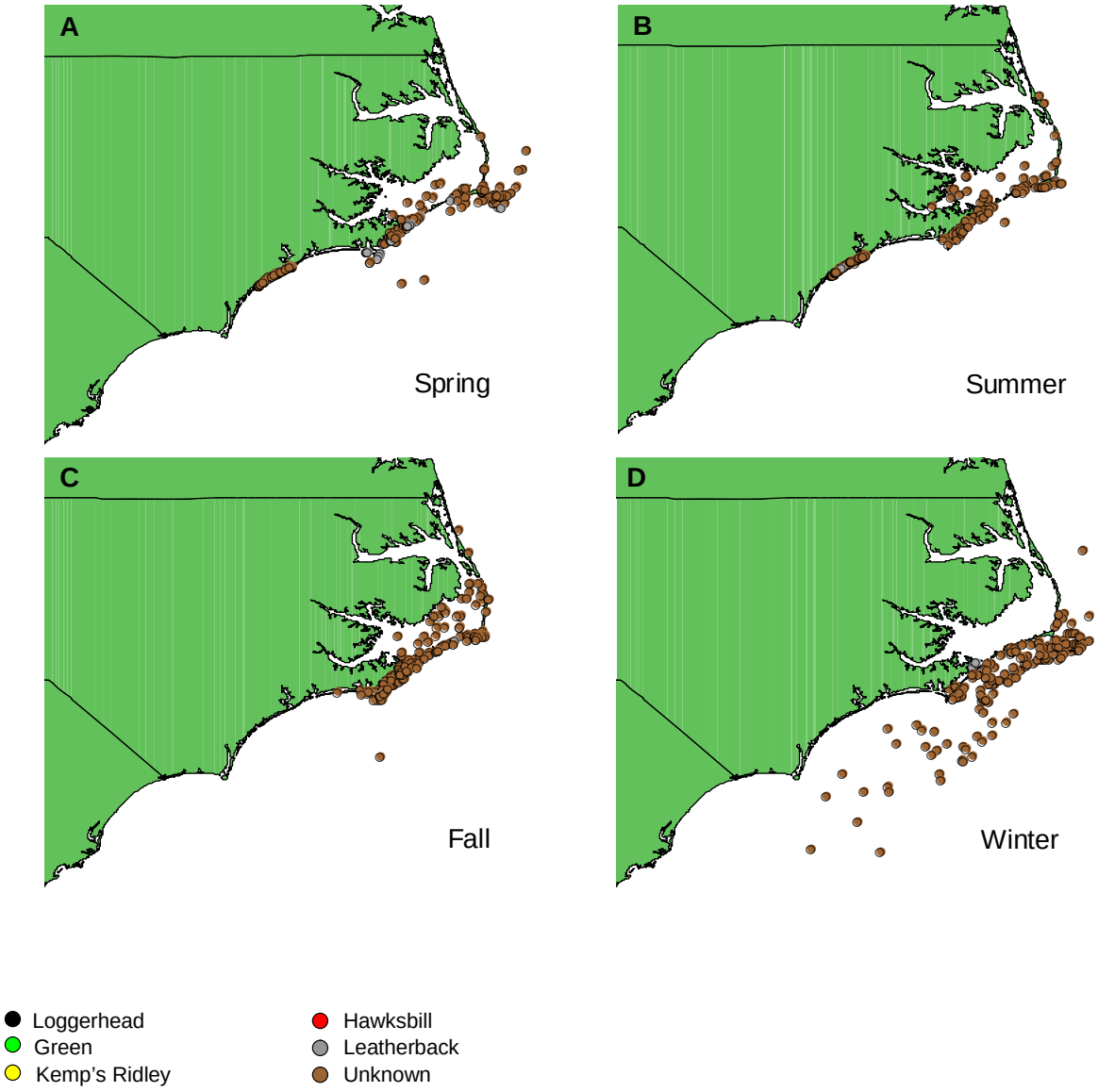

Figure 5. Sea turtle sightings from aerial surveys 1988 – 2004 during the spring (a), summer (b), fall (c), and winter (d).

The public sighting program, which has been ongoing since 1988, is facilitated by the placement of posters in prominent locations, together with postcards for individuals to document sea turtle sightings and return by mail (Figure 6). Unfortunately, this program does not provide reliable species identification or consistent effort; however, it does corroborate the seasonal distribution and relative abundance results of the aerial surveys (Figure 7a-d).

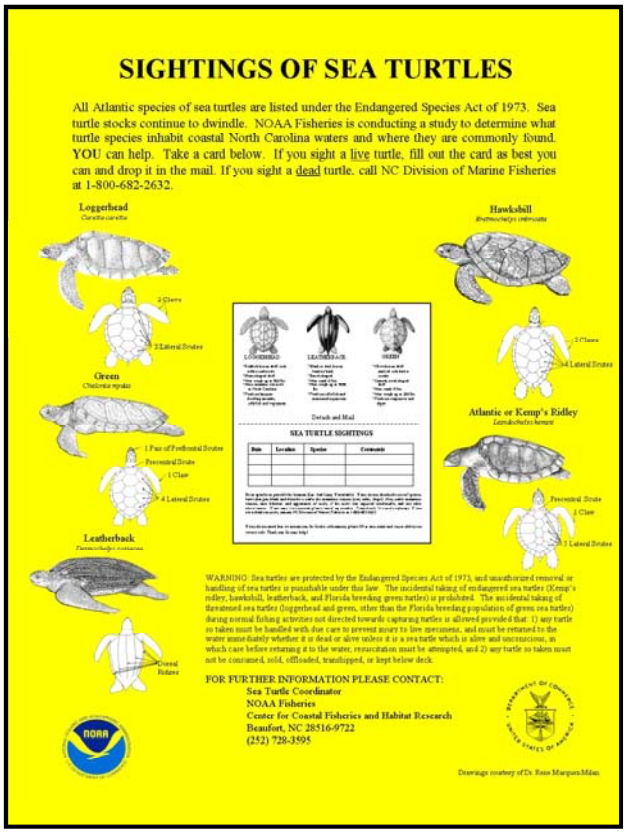

Figure 6. NMFS's public sightings program poster.

NMFS conducts an annual mark-recapture study in Core and Pamlico Sounds from June to November. Loggerhead, green, and Kemp's ridley turtles that are incidentally captured in pound nets set in Core and Pamlico Sounds are tagged with two external metal tags (one in each rear flipper) and an internal PIT (Passive Integrated Transponder) tag. Researchers measure the turtle, take blood and skin samples for sex ratio, genetic, and health analyses, and then release it. Recaptured turtles can be identified by their flipper and PIT tags, allowing researchers to estimate growth and survival rates. Recaptures occur both within and between seasons; the proportion of all turtles that have been previously captured is high (25%). From this long-term program, NMFS researchers have been able to document seasonal distribution of turtles (Figure 8a-d), determine the species composition in the sounds (80% loggerhead, 14% green, and 6% Kemp's ridley) as well as look at trends in sex ratio, growth rates, stock composition, abundance, and overall health of the population.

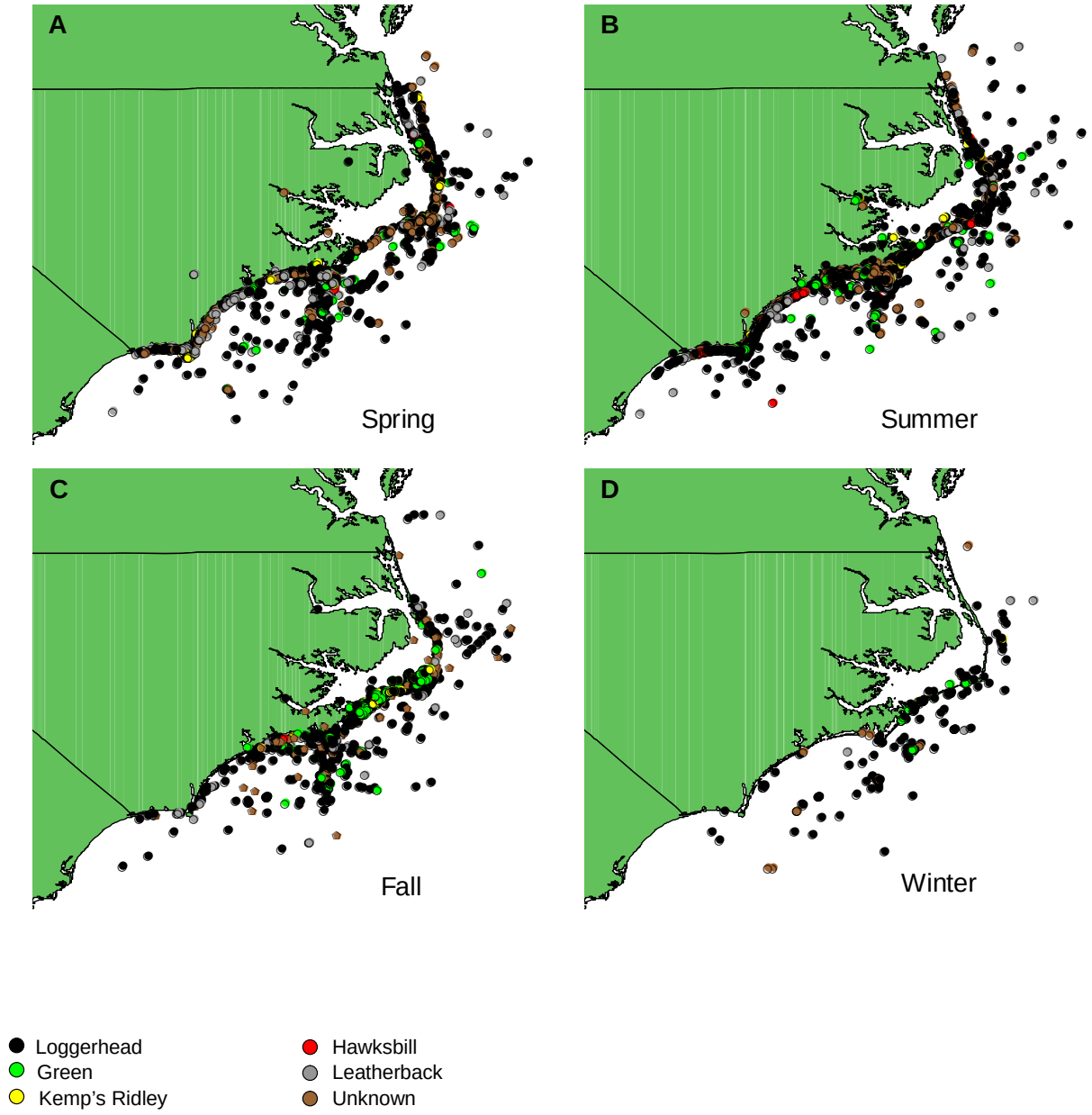

Figure 7. Sea turtle sightings from the public sightings program 1988 – 2004 during the spring (a), summer (b), fall (c), and winter (d).

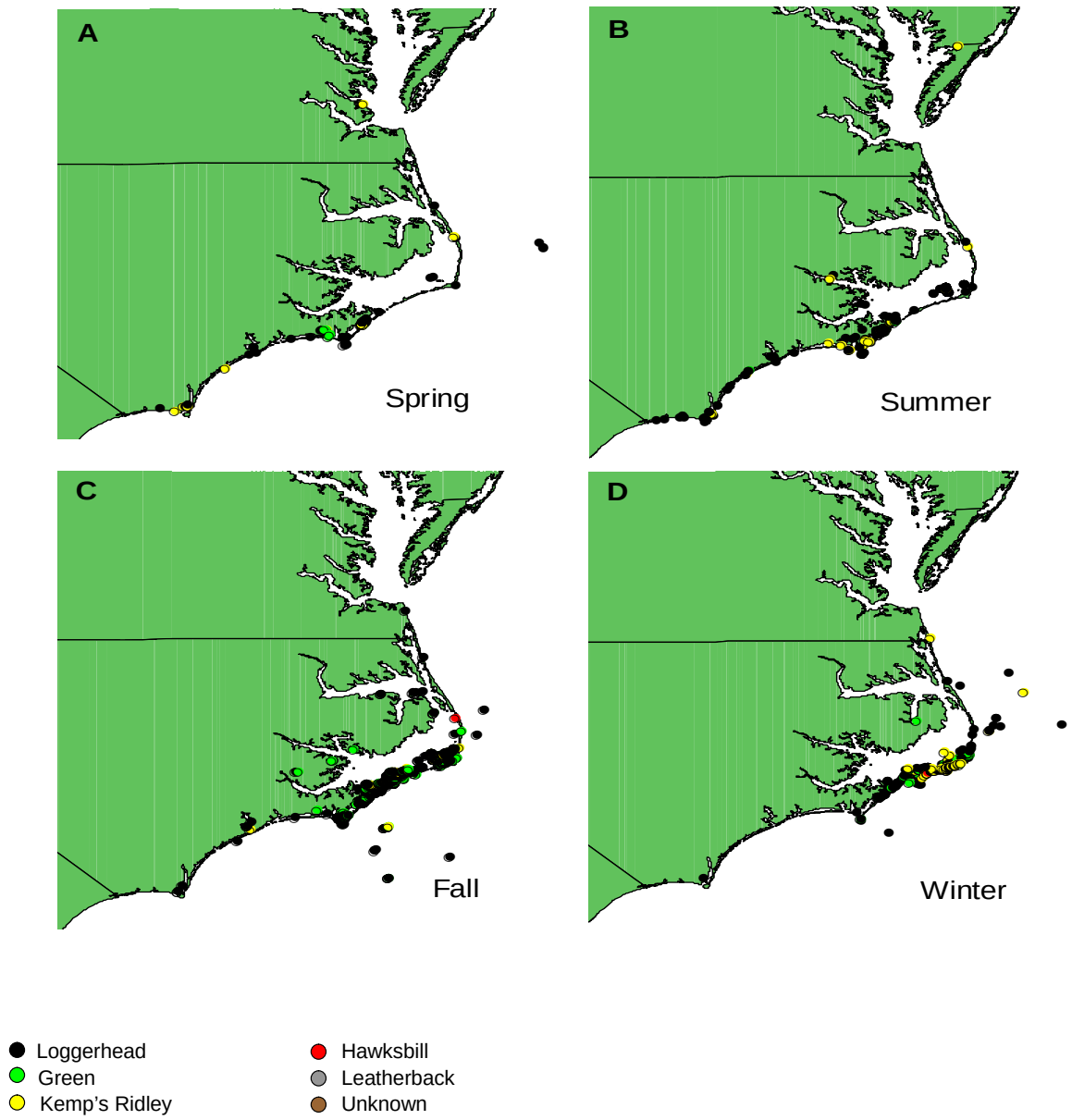

Figure 8. Sea turtle sightings from mark-recapture study 1988 – 2004 during the spring (a), summer (b), fall (c), and winter (d).

Abundance

Estimating the abundance of turtles presents a challenge to researchers as the animals are submerged and out of sight for long periods. This behavior makes it difficult to employ standard survey methods used for other marine animals, such as line transect techniques. Nevertheless, the tagging work conducted by NMFS in Core and Pamlico Sounds presents a unique opportunity to estimate abundance using mark-recapture techniques. The STAC formally inquired to NMFS about these data and were provided with the following response: "given the inherent variability in our data, our statistical power to detect a small trend in our index of population size is very low. Thus far, we (NMFS) are unable to detect a trend in the index of abundance for green and Kemp's ridleys. We

(NMFS) are seeing a very small trend (1% increase per year) for loggerheads, but the variances are quite high and the point estimate may not be significantly different from zero (e.g., no trend). Similarly, given the variability in the mark-recapture data, our estimate of population size has a huge confidence interval (95%), from zero to 45,288 animals in the Pamlico, Core, and Back sound complex. Neither ms has been through peer review yet and things could change with reviewers' comments on our (NMFS) analyses" (personal communication, Sheryan Epperly, NMFS).

Movements

While mark-recapture programs can offer researchers and conservation managers indirect evidence of the movements of sea turtles, telemetry can provide more detailed, direct data by tracking individual sea turtles. The use of telemetry to track the movements of sea turtles in North Carolina has been applied only recently. Studies of the orientation and homing behavior of loggerhead and green sea turtles in Core Sound demonstrated that juvenile sea turtles will return to their capture site after displacement within 3-5 days (Avens et al. 2003) and possess the ability to orient and navigate (Avens and Lohmann 2004). Although some of this research investigating turtle behavior took place within a laboratory setting, a few of the turtles were also equipped with radio tags to monitor their homing behavior more closely in the field.

Since 2002, satellite telemetry was employed to track the movements of loggerhead, green, and Kemp's ridley sea turtles and examine their interactions with flounder gill nets in Pamlico Sound, (Catherine McClellan, Duke Marine Lab). Forty-five turtles were tagged during the course of this study, primarily between September and November, although a few were tagged in June, 2003. Results show that turtles used the estuarine waters from Albemarle to Bogue Sound with most of the turtles found in northern Core and southern Pamlico sounds (Figure 9).

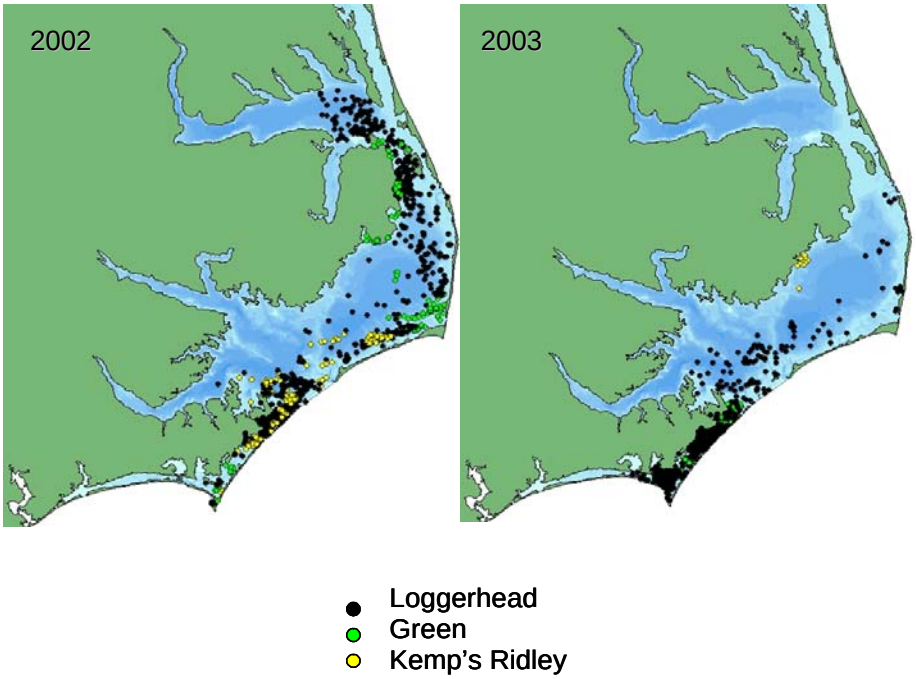

Figure 9. Estuarine locations of satellite sea turtles tracked in 2002 and 2003.

The focus of this telemetry study was to examine the habitat use of sea turtles in Pamlico Sound with respect to the distribution of fishing effort and management measures in place for the flounder large-mesh gill net fishery that operates in the fall. Tagged turtles spent most of their time (64% and 70% in 2002 and 2003, respectively) in the deepwater area closed to large-mesh gill net fishing. The areas known as southern gill net restricted area 2 and 3 (SGNRA2, SGNRA3) were also important habitat for these turtles.

The satellite-tagged turtles migrated out of the sounds between September and December with most leaving in November. The turtles used every inlet from Oregon Inlet to Beaufort Inlet, but most exited through Barden Inlet at Cape Lookout. After leaving the sounds, the turtles migrated to three general over-wintering areas: Florida, offshore North Carolina, and the North Atlantic via the Gulf Stream (Figure 10). In the year following tagging, 10 loggerheads were tracked back into North Carolina sounds, although 11 other turtles did not return to coastal waters.

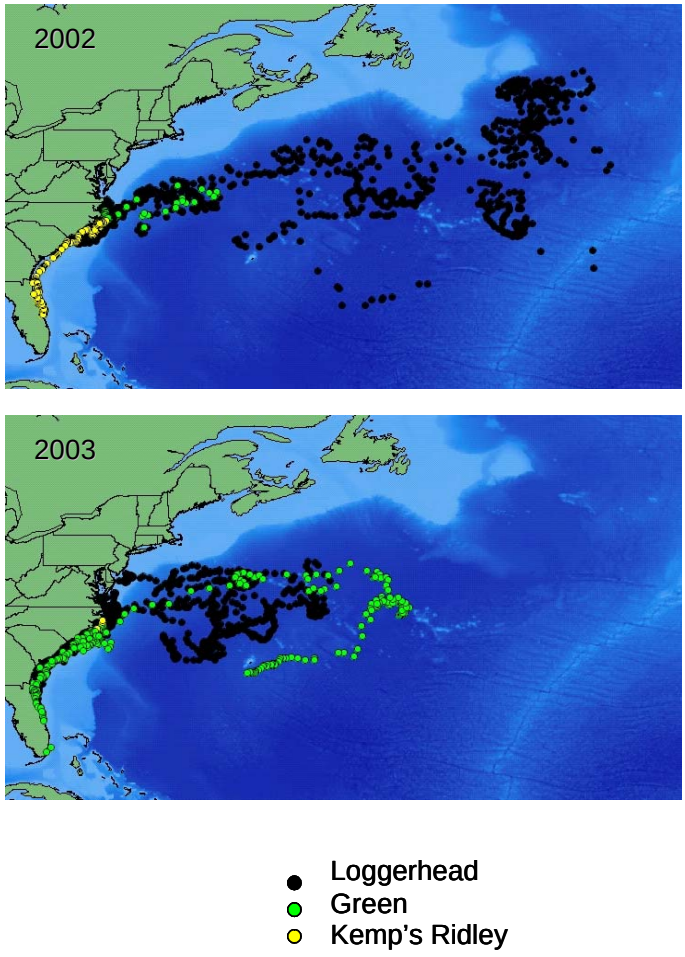

Figure 10. Migration locations of satellite sea turtles tracked in 2002 and 2003.

North Carolina Sea Turtle Strandings

A stranded sea turtle is defined as any sea turtle observed in the following conditions: dead, alive but debilitated, and injured. Stranded sea turtles can be observed on any beach, ocean or soundside, or floating in the water. Sea turtles found within or caught in set fishing gear, turtles entrained in power plant mechanisms, or turtles caught in dredges are classified as "incidental captures" and are not categorized as strandings. However, if a turtle is injured or killed during an interaction with a dredge or fishing gear and later washes ashore and is observed, that turtle will be classified as a stranded turtle.

The Sea Turtle Stranding and Salvage Network (STSSN) is a national program managed and funded by the NMFS to collect and maintain information on sea turtle strandings in the US. Since 2000 the NCWRC has had an ESA Section 6 agreement with NMFS allowing the NCWRC to run the NC STSSN. A Section 6 agreement facilitates the collaboration between federal and state agencies so that coordination of a management program for particular ESA-listed species is conducted at the state level. The NC STSSN network, coordinated by NCWRC biologists, includes US Fish and Wildlife Service staff, National Park Service (NPS) staff, NMFS biologists, US Army Corps of Engineers biologists, US Department of Defense biologists, NC Division of Parks and Recreation staff, NC Division of Marine Fisheries (NCDMF) staff, and numerous trained volunteers (over 700 individuals). The information obtained from the network is reported on a weekly basis to NMFS and NCDMF, and is used to make various management decisions, in addition to informing biologists on sea turtle mortality, abundance, and general migratory patterns.

NC STSSN participants monitor the North Carolina coastline and waterways, but coverage varies greatly depending on the area and time of year. The overall effort per year, however, has been relatively consistent since 1995. Estuarine coastlines and waters are patrolled sporadically. The most consistent effort occurs along the Cape Lookout and Cape Hatteras National Seashores on the eastern side of Core and Pamlico Sounds, where NPS personnel conduct surveys approximately once per week during certain months. There is no regular monitoring of the rest of the coastline of North Carolina estuarine waters. Opportunistic observations of stranded turtles are made by NMFS and NCDMF/Marine Patrol staff during their fieldwork, and the general public will also report stranded turtles on occasion. In contrast, all ocean facing beaches are patrolled every day during the summer (May 1 – August 31) in conjunction with the sea turtle nest monitoring program. During other months, National and State Park staff, Public works departments, law enforcement and the general public contribute to discovering and reporting sea turtle strandings on ocean-facing beaches. Overall, the monitoring effort for stranded turtles in North Carolina is heavily biased towards stranded turtles that occur on ocean-facing beaches.

When a stranded turtle is reported, trained STSSN participants will respond by going to the stranded turtle and filling out a standardized form that includes information such as species, the date and location of the stranding, the size of the animal, the condition (level of decomposition), and any wounds or abnormalities present. All of this information must be reported to NCWRC within 24 hours of observation of the stranded turtle. Photos are also taken if possible to document the condition of the turtle. Whenever possible, NCWRC biologists and other trained participants in the NC STSSN will conduct a more elaborate investigation of the stranded turtle, including opening the carcass to check on sex, general health status, and stomach contents. Samples from stranded turtles are also collected opportunistically for ongoing collaborative research projects on genetic, physiological, and ecological aspects of sea turtles frequenting North Carolina.

When a stranded turtle is observed and reported, each stranding is classified depending on its most probable cause of death. The NC STSSN will only assign a specific cause of death when there is clear evidence of a mortality factor. For instance, a longline hook lodged in the esophagus of an emaciated stranded sea turtle is strong evidence that the cause of death was incidental capture by a longline fishing boat. For the last ten years, more than 10% of all stranded sea turtles in North Carolina are classified as due to boat related injuries, specifically boat and/or propeller impacts. Cold stuns (hypothermia due to rapid decreases in water temperature) are responsible for 2.6% of all sea turtle strandings in North Carolina. Entanglement in debris or discarded fishing gear makes up less than 3% of all stranded turtles observed in North Carolina. Around 1% of observed stranded turtles are due to mutilation (e.g. severed flippers, gunshot wounds). Other occasional causes of stranded turtles include disease (1.6% of all stranded turtles observed), shark bites (0.1%), and pollution in the form of oil or tar fouling (0.1%). The majority of observed stranded turtles (81%) are classified as "unknown cause of death." This is because a specific cause of death cannot be unequivocally linked to the turtle, for instance because the carcass is too decomposed or because there are no visible wounds or signs of trauma. The likely cause(s) of mortality of the turtles in the "unknown" category are the sources previously cited (boat related injuries, entanglement in fishing gear, cold stuns, etc.), however there is no definitive evidence to link them to the specific category.

There have been cases of mass stranding events, in which dozens or even hundreds of dead stranded turtles are observed during a concentrated time period and within a defined area. For instance, in the year 2000, two mass stranding events occurred on ocean-facing beaches between Oregon Inlet and Hatteras Inlet. Between 14 and 17 April, 71 dead turtles were recorded and between 3-8 May, 209 dead turtles were observed. NMFS and NCWRC personnel were able to rule out boat strikes, disease and cold-stunning as primary causes of the mass strandings. Three co-occurring commercial fisheries were investigated as possible sources for the mass strandings: hook-and-line fishing for mackerel, bluefish gillnetting and monkfish gillnetting. No hooks were found in the carcasses, ruling out hook-and-line gear. Four of the dead turtles found in the mass strandings were still entangled in pieces of gillnet with 10-12 inch mesh size, consistent with monkfish gillnets. This information, combined with observer data collected subsequently, suggested that these two mass stranding events were a result of lethal interactions with the monkfish gillnet fishery. As a result, NMFS constrained the activity of the fishery in federal waters north of Oregon Inlet and only during months when water temperatures were cold enough that sea turtles were unlikely to be in the area, in order to reduce the likelihood of lethal interactions with sea turtles (for further details, see Braun-McNeill et al. in press).

Some stranded turtles each year are found alive and are transported to a rehabilitation facility in an effort to restore them to good health and eventual release back into the wild. In North Carolina, there are four facilities that have permits to conduct sea turtle rehabilitation and release. These are the Karen Beasley Sea Turtle Rescue and Rehabilitation Center on Topsail Island, the Network for Endangered Sea Turtles (NEST) Rehabilitation Facility at the NC Aquarium in Manteo, the NC Aquarium in Pine Knoll Shores, and the NC Aquarium in Fort Fisher. The latter two facilities are limited in space and equipment, and generally treat only a few cold stunned turtles each year. Sea turtles with more serious injuries are treated at the Topsail or Manteo facilities. Once the turtles in the rehabilitation facilities have been judged to be in good health by accredited wildlife veterinarians, the turtles are released back into the ocean. The majority of turtles are released from the beach in the summer months, although occasionally they will be released from a boat near the Gulf Stream in winter months. In the past 10 years, 143 turtles have been returned to the wild out of 285 live stranded turtles (Table 3).

The most common species of stranded sea turtle observed in North Carolina is the loggerhead, making up about 70% of all stranding observations (Figure 11). Approximately equal numbers (50-100 per year) of greens and Kemp's ridley strandings are also reported, and relatively few leatherbacks (less than 20 per year). An average of 12 stranded turtles per year are listed as unidentified as the condition of the turtle made it difficult to determine species, or the reporter of the stranding was not confident in their species ID. There have been only 6 observed hawksbill turtle strandings to date in NC (three since 2004).

The majority of strandings are found in Dare, Carteret, and Brunswick counties, although these are also the counties with the greatest amount of coastline. Approximately 64% of the strandings reported are on ocean facing beaches, with the remaining 36% in the inlets, sounds, waterways, and rivers (Figure 12). The higher number of stranded turtles observed on ocean-facing beaches likely reflects the bias in monitoring effort mentioned previously.

In the last ten years (1995-2004), the annual number of observed stranded turtles in North Carolina has fluctuated greatly from 347 in 1995 to 831 in 2000 (Figure 13). The average annual number of observed stranded sea turtles based on the last 10 years is 480, and although numbers have fluctuated greatly over this time, the past 4 years have been at or below average. Numbers of observed stranded turtles fluctuate from month to month, with average peaks in the spring (May and June) and fall (November) months (Figure 14). There is annual variation in these types of trends. For instance, 2004 had lower than average strandings in the spring and early summer months, but higher than average numbers in the fall and winter months, with the exception of October.

It should be noted that the number of observed stranded turtles is only a small percentage of the total number of turtles that have been injured or killed in North Carolina waters. In a study of sea turtle mortalities associated with the summer flounder trawl fisheries operating north of Cape Lookout in offshore waters, it was estimated that the number of stranded turtles observed on North Carolina beaches represented between 9 and 13% of the total number of turtles killed by the fishery (Epperly et al. 1996). In a study of the fate of 28 sea turtle carcasses released in Core Sound with transmitters attached, only 18% of the carcasses were subsequently observed and reported as stranded turtles, even though 21 of the 28 carcasses (75%) were tracked to shore (WRC unpublished data). Therefore, the observed number of strandings only represents a small proportion of the total number of sea turtles killed or injured in North Carolina each year: if the average annual number of observed strandings in North Carolina is 480, then the total number of sea turtles killed or injured in the state per year could be between 2667 and 5333.

The nesting beach origin of stranded turtles in North Carolina has not been fully elucidated. In terms of Kemp's ridleys, the principal nesting beaches are exclusively found in the northwestern Gulf of Mexico (Shaver et al. 2005); hence, all stranded Kemp's ridley turtles likely come from these nesting sites. Recent genetic analyses of samples taken from stranded loggerheads throughout the east coast of the USA (including North Carolina) show that stranded loggerheads in any single region come from a variety of nesting populations, including the "northern subpopulation" (beaches in Northern Florida to North Carolina), the "southern population" (Atlantic beaches in Florida south of Cape Canaveral), "gulf populations" (nesting beaches found along the Gulf coasts of Florida), and the "Mexico population" (nesting beaches in the Yucatan Peninsula) (Bowen et al. 2004). These results are concordant with genetic analyses of juvenile loggerheads passively captured in pound nets in Core Sound (Bass et al. 2004). Therefore, stranded loggerheads in North Carolina come from a variety of nesting populations in the northwest Atlantic and Caribbean. A few stranded leatherback turtles have

had tags from various nesting beaches in the West Atlantic, including Costa Rica, French Guiana, and Trinidad (Troëng et al. 2004; WRC unpublished data), but no genetic data are available for stranded leatherbacks in NORTH CAROLINA . Relatively little tag information and no genetic information are available for stranded green turtles in North Carolina, as is also the case for the six hawksbill stranded turtles in NORTH CAROLINA .

The majority of observed stranded sea turtles in North Carolina are large juvenile or subadult loggerheads: the mean straight carapace length (notch to tip) for stranded loggerhead turtles from 2000-2004 is 70.2 ± 12.9 cm SD, n= 1233 (NCWRC unpublished data). Based on population modeling and elasticity analyses of Atlantic loggerheads, a reduction in mortality of large juvenile and subadult loggerheads will have the biggest impact on the overall population (Crowder et al. 1994; Heppell et al. 2003). In other words, the ongoing mortality of juvenile loggerheads in North Carolina and elsewhere is a major impediment to the speedy recovery of the different nesting populations in the West Atlantic. Hence, the reduction to the greatest extent possible of in-water mortality of turtles in North Carolina and elsewhere is an important component of any recovery plan of loggerhead sea turtles, and is listed as Objective 22 in the Recovery Plan for the US Population of loggerhead sea turtles (US NMFS and US FWS, 1991). Similarly, in-water mortality of other species should also be reduced.

Table 3. Fate of stranded sea turtles found alive in North Carolina, 1995-2004.

Year	*Released*	*In Rehab*	*Died*	*Total*
1995	10	0	7	17
1996	14	0	18	32
1997	9	0	9	18
1998	9	0	8	17
1999	19	0	8	27
2000	23	1	11	35
2001	9	1	7	17
2002	30	3	13	46
2003	10	10	22	42
2004	10	10	24	44
Total	143	25	127	295

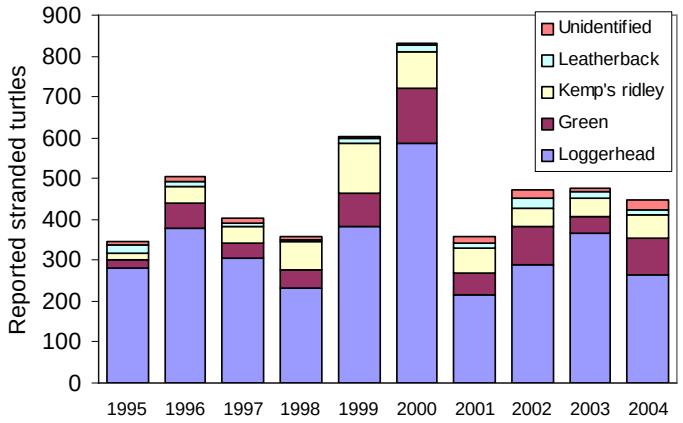

Figure 11. Species of stranded sea turtles observed in North Carolina, 1995-2004.

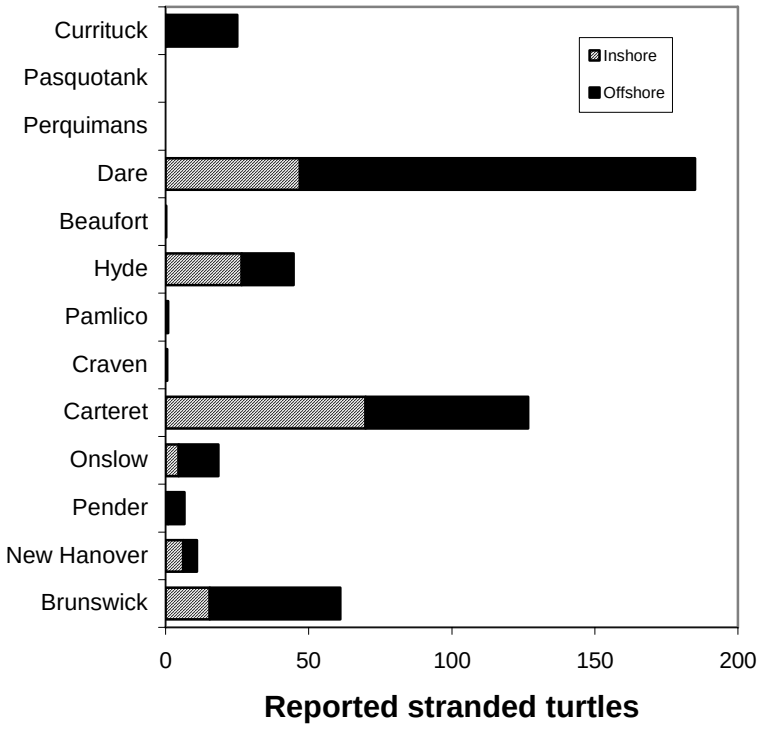

Figure 12. Annual mean number of stranded turtles observed in estuarine areas and offshore areas, per county, North Carolina between 1995-2004.

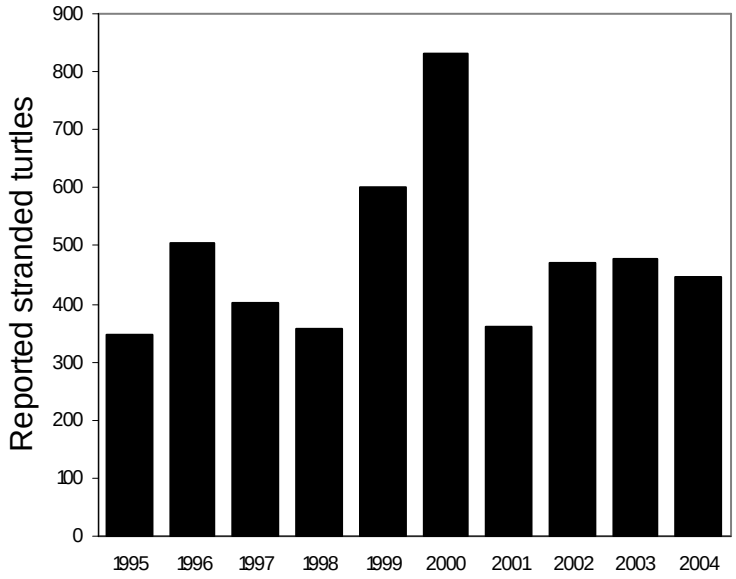

Figure 13. Total annual number of observed stranded sea turtles reported in North Carolina 1995-2004.

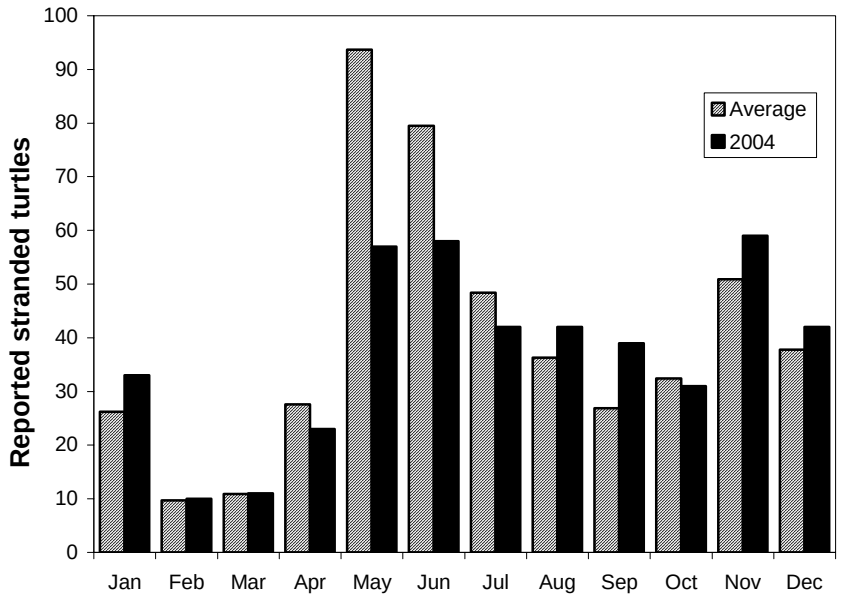

Figure 14. Mean monthly numbers of stranded turtles reported in North Carolina from 1995-2004. Data from 2004 only are presented for comparison.

North Carolina Estuarine Fisheries Descriptions

The Sea Turtle Advisory Committee (STAC) used the North Carolina Division of Marine Fisheries (NCDMF) Trip Ticket Program and the Marine Recreational Fishery Statistics Survey (MRFSS) to identify fishing gears deployed in the estuarine waters of North Carolina (Figure 15). For each gear, data are provided on the number of trips conducted, number of fishermen, number of vessels, number of dealers, ex-vessel value, number of pounds landed, and the STAC concern level (Table 4). Note in Table 4, the ex-vessel ($) and impact (project value with use of multipliers) columns refer to economic impacts. There are three kinds of economic impacts: direct, indirect, and induced. For the purpose of Table 4, direct impacts are the ex-vessel value. Indirect impacts reflect money spent to support the operation that generates the direct impacts. For commercial fishing, indirect impacts include equipment costs, fuel costs, vessel cost and maintenance, insurance, etc. Induced impacts are the result of the profits made by an industry that go back into the economy (e.g., expenditures at local stores, mortgages, etc.). All three, direct, indirect, and induced work in conjunction to determine the overall impact (Table 4).

Members of the STAC participated in a group exercise on June 21, 2005 to identify those *estuarine* fisheries most likely to incidentally catch sea turtles. It should be noted that not all STAC members were able to participate in this exercise and that the categories of threat are approximations not derived using any quantitative approach. The process was necessarily influenced by the knowledge base of fishing gear and bycatches possessed by those individuals able to participate in this process.

Given these caveats, the STAC developed the following three categories of estuarine fisheries, based on their level of threat to sea turtles: **gears of primary concern** meet at least two of the following criteria: interactions with gear are frequent; there have been fatal interactions documented by state and/or federal observers; the potential for fatal or injurious interactions is high due to gear design, seasons/locations fished, and fishing effort; or regulations regarding sea turtle interactions currently exist. **Gears of other concern** meet at least two of the following criteria: infrequent fatal and/or non-fatal interactions have been documented; current regulations for the fishery decrease or eliminate the potential for interaction, but that potential could increase with a change in those regulations; there is moderate to low effort; or more observer data are needed. The committee also identified **gears of no concern** because the way or the places in which they are deployed make sea turtle interactions unlikely and/or the effort for the fishery is extremely low.

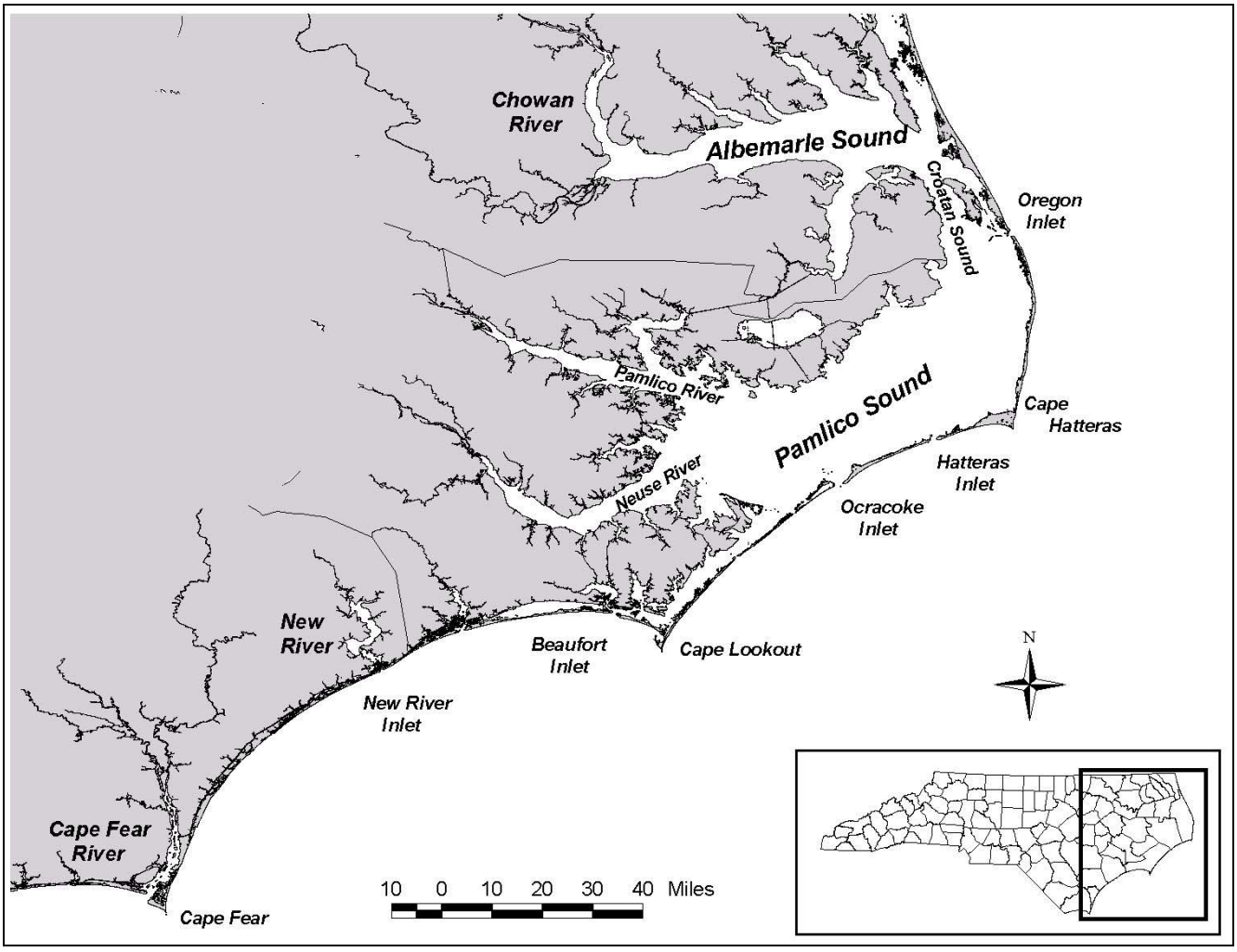

Figure 15. Map of North Carolina coastal waterbodies.

Table 4. For each gear, the number of trips conducted, number of fishermen, number of vessels, number of dealers, ex-vessel value, number of pounds landed, and the STAC concern level. Data from the North Carolina Division of Marine Fisheries Trip Ticket Program and the Marine Recreational Fishery Statistics Survey (MRFSS) (1994 –2004), and was averaged from 1994 - 2004. Note: the data from Gill Net Set (< 5 in. mesh, and ≥ 5 in. mesh) includes only 2004 data.

Gear	Pounds	Trips	Participants	Dealers	Ex-vessel	Impact	Concern*
Gill Net Set, >= 5 in. mesh	885,477	7,204	433	72	1,057,547	2,009,339	primary
Pound Net	2,681,058	3,800	190	57	3,132,333	5,951,432	primary
Shrimp Trawl	5,060,331	10,612	677	203	12,740,058	24,206,111	primary
Rod-n-Reel (Recreational)	2,494,123	1,421,708	na	na	na	na	primary
Rod-n-Reel (Commercial)	10,207	320	72	41	13,976	26,555	primary
Butterfly Net	2,285	26	6	5	6,856	13,026	other
Crab Pot	45,747,071	103,939	1,639	301	37,762,632	71,749,000	other
Crab Trawl	1,869,009	3,076	222	65	1,427,845	2,712,906	other
Gill Net Set (float)	1,821,718	13,156	971	171	1,713,333	3,255,333	other
Gill Net Set (sink)	4,411,355	26,969	1,375	238	4,427,351	8,411,966	other
Gill Net Set, < 5 in. mesh	688,434	3,557	357	85	439,704	835,437	other
Haul Seine	1,724,338	605	43	20	784,297	1,490,165	other
Skimmer Trawl	418,362	1,971	128	56	775,968	1,474,340	other
Swipe Net	33,346	42	10	6	17,295	32,860	other
Channel Net	241,628	1,930	119	47	528,537	1,004,220	other
By Hand	336,782	16,647	1,080	128	1,938,345	3,682,856	no
Cast Net	34,234	333	47	38	16,611	31,561	no
Clam Dredge	49,604	43	13	6	138,350	262,865	no
Clam Dredge (hydraulic)	61,915	577	34	13	522,294	992,359	no
Clam Trawl Kicking	84,010	934	83	17	436,357	829,078	no
Common Seine	609	8	2	2	697	1,324	no
Conch Pot	3,662	23	6	2	4,524	8,596	no
Crab Dredge	21,157	34	9	4	12,976	24,655	no
Dip Net	2,964	14	9	4	3,874	7,361	no
Eel Pot	104,414	288	53	18	205,787	390,995	no
Fish Pot	154,851	493	52	30	82,594	156,928	no
Fyke Net	272,916	414	37	14	118,870	225,853	no
Gigs	78,489	1,344	171	64	141,389	268,639	no
Gill Net (drift)	59,867	411	87	39	49,500	94,050	no
Gill Net (runaround)	1,073,682	2,598	350	100	769,536	1,462,118	no
Oyster Dredge	32,205	586	49	16	138,417	262,991	no
Peeler Pot	511,032	3,865	195	54	1,742,356	3,310,477	no
Purse Seine	1,434,912	19	2	1	157,479	299,210	no
Rakes, Bull	118,244	8,274	449	42	866,875	1,647,062	no
Rakes, Hand	221,496	16,544	1,055	78	1,501,341	2,852,547	no
Scallop Dredge (bay)	43,818	464	78	13	127,998	243,196	no
Scallop Scoop	4,416	74	27	8	16,853	32,020	no
Scallop Trawl	568	4	3	2	1,663	3,159	no
Shrimp Pound	7,080	9	2	2	2,580	4,902	no
Tongs, Hand	96,808	4,777	326	53	538,990	1,024,082	no
Tongs, Patent	218	16	6	4	1,395	2,651	no
Trolling	705	6	5	4	745	1,416	no
Trotline	48,513	254	21	7	24,193	45,967	no
Turtle Hooks	647	7	5	1	226	430	no
Turtle Pot	3,359	21	6	3	1,220	2,318	no
Total	**72,951,919**				**74,391,767**	**141,344,357**	

* The Sea Turtle Advisory Committee (STAC) identified the concern level of each gear type as: 1) primary concern, 2) other concern and 3) no concern.

Gears of Primary Concern

Gillnet Set ≥ 5 in mesh:

A stationary net consisting of monofilament or twine webbing that entraps fish in its mesh with a mesh size greater than or equal to five inches. Large mesh gill nets are fished throughout the year with peaks in landings occurring in the spring and fall. Large mesh gill netting occurs statewide in estuarine waters with the majority of landings coming from the Albemarle-Pamlico estuarine system. Species commonly harvested include southern flounder, striped bass, and American shad.

This gear was established as **primary concern** by the committee for the following reasons: 1) there are known historical interactions; 2) larger mesh and decreased twine size result in increased entanglement rate (Gearhart and Price 2003); 3) effort throughout North Carolina coincides with sea turtle distribution patterns in internal waters.

Current management: seasonal – PSGNRA; seasonal 24-hour attendance requirement in the Cape Fear River by proclamation; monitoring program; sea turtle handling, resuscitation, release protocols mandatory; statewide 3000 yard maximum limit; 2000 yard limit in PSGNRA.

Shrimp Trawl

A trawl used in the ocean, sounds, and rivers primarily to harvest shrimp. The shrimp trawl is a type of otter trawl constructed of twine webbing that becomes funnel shaped when towed through the water. Two large otter trawl doors keep the mouth of the net open during operation (Cunningham et al. 1992). Shrimp trawling is conducted year round with greatest intensity from April through November. Shrimp trawling also occurs throughout North Carolina's estuaries with the greatest amount of effort in the Pamlico Sound, Core Sound, Neuse River, New River and the Cape Fear River. Trawling is not allowed in Albemarle Sound.

This gear was established as **primary concern** by the committee due to the following reasons: 1) history of interactions resulting in mandatory Turtle Excluder Devices (TEDs); 2) TEDs are effective, but compliance may be an issue; 3) information is needed on TED compliance; 4) NCDMF cannot enforce TED compliance as it is federal regulation, not a state rule.

Current management: TED requirements; seasonal, area, and time closures; gear restrictions (mesh size limits, minimum 3/4 in bar); sea turtle release protocols.

Pound Nets

A stationary gear that directs fish into enclosures or "pounds" by means of a lead. Used primarily to harvest finfish. A pound net usually consists of an enclosure (pound) with a netting floor and a heart from the entrance to which a leader extends shoreward (Dumont and Sundstrom 1961). As many as two to six hearts, the intermediate area between the lead and the pound, guide fish through the funnel into the pound (Cunningham et al. 1992). Most pound nets are fished seasonally the year with peaks in the spring and fall. Pound nets are mainly operated in Pamlico Sound, Core Sound, Albemarle Sound and Chowan River. There are several types of pound nets with the most common being either a flounder pound net, herring pound net, or bait pound net. Southern flounder, river herring, menhaden (bait), gizzard shad (bait), harvestfish, weakfish, Atlantic spadefish, Spanish mackerel, spot, catfishes, and black drum compose the majority of the species landed from pound nets.

This gear was established as **primary concern** by the committee due to the following reasons (most notably for the flounder pound nets): 1) known interactions; 2) mortality may be a factor, but information is needed; 3) frequency of checking (i.e., storm events, water temperature declines) may be reduced at times; 4) gear may remain in water after season closes; 5) information is needed on interactions in leads of pound nets.

Current management: seasonal closures – southern flounder and river herring FMPs; escape panels for undersized fish; annual state permits required; sea turtle release protocols.

Rod-n-Reel (commercial and recreational)

Hook-and-line gear ranging from bamboo poles to sophisticated rod-and-reels using artificial lures or natural bait. Harvest from rod-n-reel gears occurs throughout the year from estuarine waters peaking in the summer and the fall. In estuarine waters, harvest from rod-n-reel gears occurs mainly from Pamlico Sound and the Cape Fear River. Southern flounder and spotted seatrout are the primary species harvested with this gear.

This gear was established as a gear of **primary concern** by the committee due to the following reasons: 1) potential for interaction; 2) very low effort commercially but high effort recreationally; 3) lost gear (line) may result in sea turtle stranding; 4) known interactions of turtles striking bait; 5) most reports of captures with this gear result in live releases, however the fate of released sea turtles is not known; 6) documented mortality.

Current management: Encourage voluntary use of circle hooks, which significantly reduce the rate of hook ingestion by loggerheads (as in the pelagic longline fishery) (Watson et al. 2005).

Gears of Other Concern

Butterfly Net

A trawl device, constructed of twine webbing, which opens in a high profile (four seam). Floats and weights are used to keep the mouth open. The majority of the landings from butterfly nets occur during the summer and early fall months. The butterfly net fishery occurs mainly in New River, Topsail Sound and the Intracoastal Waterway. Butterfly nets are almost exclusively used to harvest shrimp.

This gear was established as a gear of **other concern** by the committee due to the following reasons: 1) potential for sea turtle capture; 2) net is attended at all times, and fished frequently reducing potential for mortality; 3) relatively low effort associated with this gear throughout North Carolina; 4) effort primarily south of Morehead City in areas with relatively less sea turtles.

Current management: gear restrictions (mesh size 1 ¼ in. stretch).

Crab Pot

A wire-mesh box measuring approximately 2 by 2 feet used to harvest blue crabs. Crab pots are divided into two separate chambers. Blue crabs enter the pot through the lower chamber and then move into the upper chamber to try to reach the bait. Once inside the upper chamber blue crabs have a hard time escaping. All pots have at least two escape rings to permit the escape of undersized crabs (Cunningham et al. 1992). The crab pot fishery operates all year long peaking during the summer and fall months. Most crab potting occurs in the Albemarle-Pamlico system and supports North Carolina's

largest commercial fishery ranking first in the number of trips conducted, number of fishermen, number of vessels, number of dealers, ex-vessel value and second in the number of pounds landed.

This gear was established as a gear of **other concern** by the committee due to the following reasons: 1) size of the industry and the effort is high for this fishery; 2) limited evidence of sea turtle capture in the lines of this gear; 3) entanglement in buoy line is possible; 4) some fishermen reports of sea turtle interactions with crab pots.

Current management: Non-floating line on buoys required; required to be fished at least every 5 days.

Crab Trawl

An otter trawl used to catch crabs in the sounds and rivers. The width of the net at the mouth may range from 30 to 75 feet. The majority of vessels are double-rigged, pulling nets ranging from 28 to 32 feet in headrope length (Cunningham et al. 1992). Crab trawling occurs throughout the year with peaks in landings in spring and November. Crab trawling occurs in Pamlico Sound, Pamlico River, Croatan Sound, Pungo River, Bay River, Neuse River and Core Sound. Blue crabs account for the vast majority of the landings from this gear with southern flounder and horseshoe crabs accounting for a minority of landings.

This gear was established as a gear of **other concern** by the committee due to the following reasons: 1) potential for interaction if gear used in overlapping sea turtle distribution patterns; 2) interactions have not been observed in Pamlico or Pungo Rivers; 3) there is a peak effort associated with this fishery during the winter and early spring not coinciding with increased sea turtle presence in internal waters of North Carolina; 4) there is a relatively low effort in NORTH CAROLINA with approximately only 50 crab trawlers operating; 5) there is no TED requirement for this fishery.

Current management: gear restrictions (mesh length < 3 inch is unlawful and required 4 inch in western Pamlico Sound).

Gillnet Set (float)

A stationary net consisting of monofilament or twine webbing that entraps fish in its mesh. The top line floats on the surface of the water. Larger mesh sizes (5 in and greater) are used to harvest southern flounder, shad and striped bass, while smaller mesh sizes are used to harvest weakfish, spotted sea trout, striped mullet and other species of finfish. These types of gill nets are typically fished year round with peaks in spring and fall. These types of gill nets are also fished throughout North Carolina's estuarine water bodies with the majority of landings occurring throughout the Albemarle-Pamlico Estuarine System.

This gear was established as a gear of **other concern** by the committee due to the following reasons: 1) potential for interaction exists due to gear configuration; 2) however, relatively low effort associated with this gear type; 3) effort <u>does not generally</u> coincide with sea turtle distribution.

Current management: gear restrictions; seasonal and area restrictions.

Gillnet Set (sink)

A stationary net consisting of monofilament or twine webbing that entraps fish in its mesh. The top line is below the surface of the water. Mesh sizes generally range from 2.5 in – 6 in stretched

mesh. Larger mesh sizes (5 in and greater) are used to harvest southern flounder, shad and striped bass while smaller mesh sizes are used to harvest weakfish, spotted sea trout, striped mullet and other species of finfish. These types of gill nets are typically fished year round with peaks in spring and fall. These types of gill nets are also fished throughout North Carolina's estuarine water bodies with the majority of landings occurring throughout the Albemarle-Pamlico Estuarine System.

This gear was established as a gear of **other concern** by the committee due to the following reasons: 1) potential for interaction exists due to gear configuration; 2) the relatively low number of trips and area of use primarily in Albemarle Sound greatly reduce the potential for sea turtle interaction/mortality.

Current management: gear restrictions; seasonal and area restrictions.

Gillnet Set < 5 in. mesh

A stationary net consisting of monofilament or twine webbing with a mesh size less than five inches, that entraps fish in its mesh. Small mesh gill nets are fished throughout the year with peaks in landings occurring the spring and fall. Small mesh gill netting occurs statewide in estuarine waters with the majority of landings coming from the Albemarle-Pamlico Estuarine system. Species commonly harvested include bluefish, striped mullet, spot, Atlantic croaker, and spotted seatrout.

This gear was established as a gear of **other concern** by the committee due to the following reasons: 1) potential for interaction exists due to gear configuration; 2) NCDMF observations since 1999 have shown no observed interactions; 3) some anecdotal evidence of interactions.

Management: seasonal (May 1 – November 1) attendance requirement; gear restrictions; seasonal and area restrictions; Albemarle Sound mesh and length restrictions.

Long Haul Seine

A seine pulled by two boats for a distance of up to several miles. Fish are encircled and concentrated by pulling the net around a fixed stake. A 1,000 to 1,800 yard 6-foot deep (or deeper) net is used in the operation (Cunningham et al. 1992; Dumont and Sundstrom 1961). In long haul fishing, two 20 to 45 foot pull boats and two skiffs are required (Cunningham et al. 1992). Haul seining occurs mainly from May to October and in Core and Pamlico Sounds. This fishery targets mostly Atlantic croaker, spot, weakfish, menhaden and pinfish while pigfish, bluefish, southern kingfish, and spotted seatrout account for minor portions of the landings (Cunningham et al. 1992).

This gear was established as a gear of **other concern** by the committee. While this gear meets two of the criteria for gears of primary concern, the committee thinks that the relatively low effort establishes this gear as other concern. The concern level was further established due to the following reasons: 1) potential for interaction; 2) gear circles, herds and traps by design; 3) small mesh (typically < 4 in) makes entanglement unlikely; 4) infrequent reports of mortality; 5) very low effort (< 12 active fishermen) in North Carolina; 5) operation attended at all times by design.

Current management: culling panels required in bunt net; not allowed in Primary Nursery Areas.

Skimmer Trawl

A trawl, constructed of twine webbing, towed along side the vessel. The mouth of the trawl is held open by a rigid frame. It is normally double rigged. Skimmer trawls are commonly used during the summer and fall months with peaks in August and September. Most landings are from the Newport River, North River/Back Sound, New River, Core Sound and White Oak River. Shrimp compose the vast majority of the landings from skimmer trawls.

This gear was established as a gear of **other concern** by the committee due to the following reasons: 1) potential for interactions exists; 2) nets are pulled at frequent intervals (typically < 20 minutes) decreasing interaction/mortality potential; 3) relatively low effort in North Carolina estuarine waters.

Current management: gear restrictions and area closures (same as shrimp trawls).

Swipe Net

A seine pulled by one boat with one end secured in shallow water. The fish are encircled and concentrated by pulling the net around a stake. Swipe netting covers a small area and thus the catch is smaller than haul seine catches (Cunningham et al. 1992). Swipe netting is a smaller operation than haul seining and can be done by a three-person crew with only one pull boat and one skiff (Cunningham et al. 1992). Most swipe netting occurs during the late spring and continues through the late fall. Estuarine swipe netting occurs mostly in Bay River, Core Sound and Pamlico Sound. Swipe nets are used mainly to harvest spot, spotted seatrout, weakfish, striped mullet, menhaden and bait.

This gear was established as a gear of **other concern** by the committee due to the following reasons: 1) potential for interaction exists; 2) gear circles, herds and traps by design; 3) small mesh (typically < 4 in) makes entanglement unlikely; 4) very low effort ($\leq$10 participants) in North Carolina; 5) operation attended at all times, 6) operation conducted in shallow waters.

Current management: culling panels required in bunt net; not allowed in Primary Nursery Areas.

Channel Net

A twine net similar in design to a trawl but not pulled by a boat. It is anchored to the bottom and held open usually by upright staffs or floats. Channel nets are positioned in fairly strong tidal currents or flowing water so as to strain out floating finfish or shellfish (Dumont and Sundstrom 1961). Channel nets fish the surface and middle depths of the water column (Cunningham et al. 1992). Channel nets may be as much as 100 feet across the mouth, vary from 8 to 14 feet deep and have a cod end that extends about 40 feet behind the wings (Cunningham et al. 1992). Channel nets are mainly used from May through November with peak landings in June and July. Channel nets are mainly used in New River, Core Sound, North River/Back Sound and Topsail Sound. Channel nets are primarily used to harvest shrimp with minor landings of blue crabs.

This gear was established as a gear of **other concern** by the committee due to the following reasons: 1) stationary net set on ebb tide and fished frequently; 2) potential for interaction may exist, if the rate of checking the net every 30 – 45 minutes is not adhered to; 3) limited observer data.

Gears of No Concern

By Hand

Any harvest technique requiring only the use of ones' hands. This technique is used throughout the year to harvest primarily shellfish; hard clams, oysters and bay scallops. Most landings occur from Core Sound, Bogue Sound, Lockwood Folly River, Masonboro Sound, New River, Newport River, Shallotte River, Stump Sound, Topsail Sound, White Oak River, North River/Back Sound and the Intracoastal Waterway.

This gear was established as a gear of **no concern** by the committee due to the following reason: 1) "hands on" fishery.

Cast Net

A hand-held circular net thrown or cast on top of fish or shrimp. As the net is retrieved, the extra mesh forms pockets that trap the fish. Cast netting occurs from late spring through late fall. Most cast netting occurs in Bogue Sound, Intracoastal Waterway, Pamlico Sound, Newport River, and White Oak River. Striped mullet, minnows, menhaden bait and shrimp are the primary species harvested with this gear.

This gear was established as a gear of **no concern** by the committee due to the following reason: 1) small, thrown and retrieved immediately.

Clam Dredge

A metal rectangular shaped frame to which is attached a bag net made of iron rings or S-hooks with teeth on the lower edge used to harvest clams by dragging it along the bottom. Most clam dredging occurs during the winter months in Core Sound.

This gear was established as a gear of **no concern** by the committee due to the following reasons: 1) gear fishes less than 1 ft. water; 2) gear less than 4 ft. wide; 3) fished frequently (typically < 30 minutes); 4) cold water fishery.

Clam Dredge (Hydraulic)

A dredge that has a metal case that is pushed or pulled along by a vessel. High-pressure jets of water wash the clams out of the sediments. Clams are collected by the tooth bar of the dredge and brought on-board. The large majority of hydraulic clam dredging occurs during the winter months. The vast majority of the landings come from New River, Core Sound, and the Intracoastal Waterway.

This gear was established as a gear of **no concern** by the committee due to the following reasons: 1) water pressure washes clams off bottom onto conveyor belt; 2) chance for sea turtle interaction on belt unlikely; 3) primarily winter (December – January) fishery, cold water fishery.

Clam Trawl Kicking

A trawl made of metal and chain used to harvest clams after dislodging the clams from the bottom with propeller backwash (kicking). Trawl boards are attached directly to the trawl net, and the gear is fished 15 feet behind the tow boat (Cunningham et al. 1992). Trawl board and net size vary with the size of the kicking boat and depths of the water fished. Most clam trawl kicking occurs during the winter in Core Sound, Newport River, New River, North River/Back Sound, and Pamlico Sound.

Hard clams account for the vast majority of the landings with whelks/conchs making up a minor portion of the landings.

This gear was established as a gear of **no concern** by the committee due to the following reasons: 1) gear is constructed of "topless" net with shallow wings; 2) small trawl used in shallow water; 3) majority of effort in Core Sound, NC from December through March when sea turtles not present; 4) frequently fished (typically < 30 minutes), 5) cold water fishery.

Common Seine

A seine used to encircle finfish or shrimp, usually pulled from shore by hand. Common seines are generally set from a motor or rowboat and hauled to the shore (Dumont and Sundstrom 1961). Most landings from common seines occur during the fall peaking in September and October. The common seine fishery is mainly operated in Core Sound and Topsail Sound and harvest mostly consists of spot and southern flounder.

This gear was established as a gear of **no concern** by the committee due to the following reasons: 1) small operations done by hand; 2) very low effort; 3) attended at all times.

Conch Pot

A wire-mesh box measuring approximately 2 by 2 feet used to harvest conchs/whelks. In estuarine waters, conch pots are primarily fished in May in Core Sound. Although conchs/whelks are the targeted species minor landings of blue crabs are reported with this gear.

This gear was established as a gear of **no concern** by the committee due to the following reasons: 1) gear is an open wooden or wire box; 2) low effort in North Carolina (none reported in 2004).

Crab Dredge

A metal rectangular-shaped frame to which is attached a bag net made of iron rings of S-hooks with teeth on the lower edge used to harvest blue crabs. Crab dredging also occurs during the winter in Croatan, Pamlico and Roanoke Sounds.

This gear was established as a gear of no concern by the committee due to the following reasons: 1) limited to Stumpy Point, NC; 2) cold water fishery; 3) shallow water operation ($\leq$ 1 ft. deep).

Dip Net

A hand-held device used to scoop fish from the water. It is usually a mesh bag of webbing which is suspended from a circular, oval, or rectangular frame (Dumont and Sundstrom 1961). The majority of harvest from dip netting occurs in January from the Pamlico and Bay Rivers. The primary species of harvest is spotted seatrout. Spotted seatrout are very sensitive to sudden temperature drops in the water columns (a "big freeze"), which allow this species to be easily harvested with dip nets during the winter.

This gear was established as a gear of **no concern** by the committee due to the following reasons: 1) by hand fishery; 2) low effort in North Carolina.

Eel Pot

A cylindrical or square box usually made of small mesh used to harvest eels. Eel pots usually contain one or more conical tunnels through which eels travel to reach bait. Many pots have small openings to permit the escape of undersized catch (Cunningham et al. 1992). Eel pots are mainly used in the spring and the fall. Most eel pots are fished in Albemarle Sound, Currituck Sound and Pamlico River. American eels compose the majority of the catch with catfishes ranking second.

This gear was established as a gear of **no concern** by the committee due to the following reasons: 1) used primarily in Albemarle Sound, NC where sea turtle distribution minimal; 2) gear size prevents capture of sea turtles.

Fish Pot

A cylindrical or square box made of wire or nylon mesh used to harvest finfish, primarily sea bass (ocean) and catfish (river/sound). A catfish pot is similar to an eel pot, made up of one or more conical tunnels through which fish travel to reach the bait (Cunningham et al. 1992). Catfish pots are mainly used during the late fall and winter months. The vast majority of landings come from the Albemarle Sound and Chowan River. Fish pots are also commonly used in the Alligator River, Pasquotank River, Roanoke River, Newport River and Pamlico River.

This gear was established as a gear of no concern by the committee due to the following reasons: 1) primarily used in riverine systems away from known sea turtle distributions; 2) small conical gear.

Fyke Net

A net constructed of wooden or steel hoops covered with netting. One or more internal funnels direct fish to the inside. Fyke nets have one or two wings and/or a leader to help guide the fish into net. Fyke nets are baited and are held in place by stakes or poles (Dumont and Sundstrom 1961). Fyke nets are used year round with landings peaking during late fall and winter. Fyke nets are primarily used in the Albemarle Sound Area including the Chowan River, Perquimans River, Currituck Sound and Roanoke River. Species primarily targeted by fyke nets include catfishes, yellow perch, and white perch.

This gear was established as a gear of **no concern** by the committee due to the following reasons: 1) area of use in riverine system where sea turtles are not present; 2) small meshed gear.

Gigs

A device used to impale fish from a fixed structure, boat, or by wading. Gigs are commonly used from April through November peaking during June. Most harvest from gigs occurs from Core Sound, Masonboro Sound, Intracoastal Waterway, Bogue Sound, Cape Fear River, Topsail Sound, Newport River and New River. Southern flounder is the primary species of harvest.

This gear was established as a gear of **no concern** by the committee due to the following reason: 1) sight fishery by hand.

Gillnet (drift)

A net consisting of monofilament or twine webbing that entraps fish in its mesh. It is unanchored and allowed to drift with the current. The net is fished at the surface or at intermediate depths. It is generally set across the current and attended by a vessel (Dumont and Sundstrom 1961).

Drift gillnets are used throughout the year and peaks in the fall. Most drift netting occurs in Core Sound, Intracoastal Waterway, Masonboro Sound, Cape Fear River and Bogue Sound. Species commonly harvested with this gear include bluefish, striped mullet, American shad, and spot.

This gear was established as a gear of **no concern** by the committee due to the following reasons: 1) attended, small mesh fishery; 2) short soak times (~ 30 minutes, during peak tide cycle).

Gillnet (runaround)

A net consisting of monofilament or twine webbing that entraps fish in its mesh. It is used to encircle schools of fish. Harvest from runaround gill nets occurs year round from the estuarine waters of North Carolina but peak during the fall during the striped mullet fishery. In estuarine waters, this fishery is mainly conducted in Core Sound, Neuse River, Pamlico Sound, Intracoastal Waterway, Bogue Sound, New River and Pamlico River. This gear is mainly used to harvest striped mullet, spot, red drum, spotted seatrout, Spanish mackerel and bluefish.

This gear was established as a gear of **no concern** by the committee due to the following reasons: 1) small mesh; 2) sight fishery target schooling fish

Oyster Dredge

A metal rectangular-shaped frame to which is attached a bag net made of iron rings or S-hooks with teeth on the lower edge used to harvest oysters. An oyster dredge cannot weigh more than 100 pounds (Cunningham et al. 1992). Most oyster dredging occurs during the winter months mainly in Pamlico Sound.

This gear was established as a gear of **no concern** by the committee due to the following reasons: 1) the gear parameters (3' – 4' width); 2) total water column fished ($\leq$ 1').

Peeler Pot

A wire-mesh box measuring approximately 2 by 2 feet used to harvest peeler blue crabs and some soft blue crabs. Peeler pots are mainly used in the spring with landings peaking in the May. Similar to regular crab pots, most peeler pots are fished in the Albemarle-Pamlico system.

This gear was established as a gear of **no concern** by the committee due to the following reasons: 1) generally fished in shallow water; 2) effort primarily in spring not coinciding with sea turtle distribution in internal waters.

Purse Seine

A seine that is set from two boats, each carrying half the net. The boats separate, pay out net, encircle fish, and close the bottom of the net by hauling in the purse line, trapping the fish. The net is actually a long wall of webbing without a prominent bunt or bag. The essential feature of this net is the pursing by closing the drawstring, which is threaded through a series of rings along the bottom of the net below the lead line (Dumont and Sundstrom 1961). Most estuarine harvest occurs during the summer months from June to September. The vast majority of estuarine landings come from Core Sound and is primarily composed of menhaden.

This gear was established as a gear of **no concern** by the committee due to the following reasons: 1) this is a sight fishery; 2) gear attended at all times; 3) no soak time as schools of bait fish are sighted, encircled and gear retrieved.

Rakes, Bull

A heavy rake with teeth and a large basket to trap the catch of hard clams. Landings from bull rakes occur all year long with the majority of landings occurring during the spring and summer months. Most landings are from Core Sound, New River, Shallotte River, and the White Oak River.

This gear was established as a gear of **no concern** by the committee due to the following reasons: 1) by hand fishery; 2) area of use on shoals.

Rakes, Hand

A rake similar to a garden rake with longer and sharper teeth equipped with a small wire mesh basket or apron of webbing to hold the catch. Hand rakes are primarily used to harvest hard clams. Hand rakes are used throughout the year with a peak in landings during the spring and summer months. Harvest mainly occurs in Core Sound, Bogue Sound, Lockwood Folly River, Cape Fear River, Masonboro Sound, New River, Newport River, Shallotte River, North River/Back Sound, and the Intracoastal Waterway.

This gear was established as a gear of **no concern** by the committee due to the following reasons: 1) by hand fishery, smaller than bull rakes; 2) area of use on shoals.

Scallop Dredge (Bay)

A dredge (scallop scrap) with a metal framework to which a bag-like pocket of webbing is attached. It is towed over the bottom and has no teeth. Used exclusively in coastal waters. Bay scallop dredges are primarily used during the winter to harvest bay scallops. Core and Bogue Sounds are the primary areas of harvest.

This gear was established as a gear of **no concern** by the committee due to the following reasons: 1) fished similar to oyster dredge (3' – 4' width); 2) fishes less than 1' of water column; 3) fishing occurs during winter months when sea turtles are not present in internal waters.

Scallop Scoop

A hand-held device similar in appearance to a dip net used to harvest bay scallops. Scallop scoops are used primarily during the winter months in Core and Bogue Sounds.

This gear was established as a gear of **no concern** by the committee due to the following reasons: 1) by hand fishery; 2) small scoop ($\leq$ 6" in width); 3) primarily fished on shoals; 4) effort concentrated in winter and early spring not coinciding with sea turtle distribution in internal waters.

Shrimp Pound

A pound net used to harvest shrimp. Shrimp pounds are mainly used during the late summer and mainly in the Neuse River. Shrimp pounds are used primarily to harvest shrimp but bait landings also contribute to a significant portion of the landings from this gear.

This gear was established as a gear of **no concern** by the committee due to the following reasons: 1) very low effort (2 participants in 2004); 2) small gear operating in Neuse River only.

Tongs, hand

Two long wooden handles joined together like scissors with a rake-like basket. Used to harvest clams and oysters. Hand tongs are used throughout the year with peaks in winter and spring. Landings from hand tongs occur mainly in the Newport River, New River, Cape Fear River, and Stump Sound.

This gear was established as a gear of **no concern** by the committee due to the following reasons: 1) hand fishery; 2) deployed and retrieved instantly.

Tongs, patent

A mechanical device using hydraulic pressure to open and close a tong-like apparatus used to harvest clams and oysters. The patent tong fishery is a minor fishery with the majority of landings during the late summer. Most landings are from the Cape Fear and Shallotte Rivers.

This gear was established as a gear of **no concern** by the committee due to the following reasons: 1) very low effort (6 participants in 2004); 2) deployed and retrieved instantly hydraulically; 3) fishes less than 3 ft. sq. of sea floor.

Trolling

Using hook-and-line gear by moving it through the water. Includes lite-lining while on anchor. Troll lines are long single lines, with one or more barbed hooks at the free end of the line, baited with either a natural or an artificial lure (Dumont and Sundstrom 1961). Most landings from estuarine trolling occur during May and August from the Chowan River and Core Sound. Primary species include catfishes and king mackerel.

This gear was established as a gear of **no concern** by the committee due to the following reasons: 1) very low effort (5 participants in 2004); 2) majority of effort in riverine systems.

Trotline

A longline device used in internal coastal waters (sounds, bays, and rivers), to harvest crabs, catfish, etc. Trotlines consist of a long horizontal main line to which baits are tied (Dumont and Sundstrom 1961). In North Carolina, most trotlining occurs during the late spring and through the summer. The majority of the harvest is from the Chowan River, Pungo River, Albemarle Sound, Neuse River, Pamlico River, and Roanoke River. Catfishes and blue crabs are the primary species harvested with this gear.

This gear was established as a gear of **no concern** by the committee due to the following reasons: 1) area fished primarily riverine systems (Albemarle Sound).

Turtle hooks – Albemarle Sound Management Area (SMA)

A longline device used in internal coastal waters (sounds, bays, and rivers) to harvest snapping turtles. This is a very small fishery that occurs mainly from May to July. The large majority of landings come from the Chowan River.

This gear was established as a gear of **no concern** by the committee due to the following reasons: 1) freshwater fishery; 2) very low effort (5 participants in 2004).

Turtle pots

An elongated box containing a system of hooks wrapped with netting used to harvest snapping turtles. Landings from turtle pots peak in the early spring. The main areas of harvest include the Albemarle Sound, Roanoke Sound, Currituck Sound and Alligator River.

This gear was established as a gear of **no concern** by the committee due to the following reasons: 1) freshwater fishery; 2) very low effort (6 participants in 2004).

Recommendations for Research, Public Outreach, and Management

Introduction

As noted previously, the primary goal of the STAC is the development of solutions for the reduction of sea turtle interactions in commercial and recreational (rod and reel) fishing gear, while maintaining *economically viable* fisheries throughout the estuarine waters of North Carolina. The previous section provided basic background information and classified North Carolina fishing gears based on the degree of known or suspected harmful interactions with sea turtles. This final section of the document concludes with an evaluation of management options to reduce these interactions, and recommended research, public outreach, enforcement, and management actions that will help address the stated goal.

Management Actions

Evaluation (Options)

On December 8, 2005, January 4 and January 17, 2006 the STAC began evaluating management options for gears of primary and other concern. The STAC recognized that the management options are not the sole source for making recommendations; members also used information summarized in the fact finding document, data on fishing effort, and personal experience. The committee used the gear descriptions and current management criteria to list potential management options while weighing some of the positive and negative impacts of each action. Collectively, this and other information (e.g., gear descriptions, effort distribution, concern level prioritization, sea turtle distribution, management options) were used to make consensus recommendations to the NCMFC. The STAC also included recommendations where consensus was not reached. Following are the list of gears of primary and other concern, management options and pros and cons for each. The STAC did not list any management options or provide recommendations to gears identified as gears of no concern.

The STAC acknowledged that within the following management options there can be both positive and negative outcomes or a need for additional clarification. For example, effort may shift from one fishery to another through management options such as seasonal closures, reduced effort, and gear restrictions, potentially having both positive and negative impacts. Specifically, a reduction in effort from one fishery may result in decreased sea turtle interactions in that fishery, but concurrently result in increased sea turtle interactions in another fishery if effort shifts. The STAC would like to reiterate its limited ability to accurately quantify the socio-economic impacts to the industry and/or community that arise from the management options of seasonal/area closures, gear restrictions, reduced overall effort, and eliminating use of the gear. The STAC recognized that there are potential social and economic impacts to communities and the industry from management options that limit the number of participants, reduce effort, limit gear types, or eliminate the use of a certain gear type. These potential impacts include the following: loss of income to the industry or individual, loss of heritage for the industry, loss of markets and/or market value, and loss of diversity to the industry. However, the STAC recognizes that it lacks the expertise to evaluate the scale or scope of these impacts.

Gears of Primary Concern:

· Shrimp Trawls

Management options:

(+ potential positive impact of action)

(- potential negative impact of action)

· No Action

+ no new regulations
- no reduction in sea turtle interactions

· Seasonal/Area closures

+ decreased sea turtle interactions
+ economic gain to individual fishermen
+ decreased bycatch
- socio-economic impacts to industry and/or community
- may result in effort shift to other fisheries with potential increased interactions
- increased resources necessary to define overlaps of sea turtle distribution and commercial fishing operations
- increased enforcement (resources)

· Gear restrictions (modifications to gear parameters)

+ decreased sea turtle interactions
- socio-economic impacts to industry and/or community
- may result in effort shift to other fisheries with potential increased interactions
- increased enforcement (resources)

· Reduce overall effort (fewer boats, permits, licenses)

+ decreased sea turtle interactions
+ economic gain for participating fishermen
+ decreased bycatch
- economic loss to non-participating fishermen
- may result in effort shift to other fisheries with potential increased interactions
- socio-economic impacts to industry and/or community

· Eliminate use of gear

+ decreased sea turtle interactions
+ decreased bycatch
- socio-economic impacts to industry and/or community
- may result in effort shift to other fisheries with potential increased interactions
- loss of data

· Other options

· Improve TED compliance

+ allow for collection of data
+ decreased sea turtle interactions
- increased resources needed

- may result in effort shift to other fisheries with potential increased interactions
- inconvenience to fishing industry
- economic hardship to industry (time and shrimp loss)

· **Gillnets (≥ 5 in. stretch mesh)**

Management options:

(+ potential positive impact of action)

(- potential negative impact of action)

· No Action

+ no new regulations
- no reduction in sea turtle interactions

· Seasonal/Area closures (extend PSGNRA regulations to other areas)

+ decreased sea turtle interactions
+ economic gain to individual fishermen
+ decreased bycatch
- socio-economic impacts to industry and/or community
- may result in effort shift to other fisheries with potential increased interactions
- increased resources necessary to define overlaps of sea turtle distribution and commercial fishing operations
- increased enforcement (resources)

· Reduce overall effort (fewer boats, permits, licenses, less gear)

+ decreased sea turtle interactions
+ economic gain for participating fishermen
+ increased populations of target species (i.e., flounder, striped bass, shad)
+ decreased bycatch
+ fewer resources needed to manage fisheries
- economic loss to non-participating fishermen
- may result in effort shift to other fisheries with potential increased interactions
- socio-economic impacts to industry and/or community
- loss of data

· Gear restrictions (modifications to gear parameters)

+ decreased sea turtle interactions
- socio-economic impacts to industry and/or community
- may result in effort shift to other fisheries with potential increased interactions
- increased enforcement (resources)

· Eliminate use of gear

+ decreased sea turtle interactions
+ decreased bycatch
- socio-economic impacts to industry and/or community
- may result in effort shift to other fisheries with potential increased interactions
- loss of data

· **Pound Nets**

Management options:

(+ potential positive impact of action)
(- potential negative impact of action)

· No Action
+ no new regulations
- no reduction in sea turtle interactions

· Seasonal/Area closures
+ decreased sea turtle interactions
+ economic gain to individual fishermen
+ decreased bycatch
- socio-economic impacts to industry and/or community
- may result in effort shift to other fisheries with potential increased interactions
- increased resources necessary to define overlaps of sea turtle distribution and commercial fishing operations
- increased enforcement (resources)

· Reduce overall effort (fewer boats, permits, licenses, less gear)
+ decreased sea turtle interactions
+ economic gain for participating fishermen
+ increased populations of target species (i.e., flounder, striped bass, shad)
+ decreased bycatch
+ fewer resources needed to manage fisheries
- economic loss to non-participating fishermen
- may result in effort shift to other fisheries with potential increased interactions
- socio-economic impacts to industry and/or community

· Gear restrictions (modifications to gear parameters)
+ decreased sea turtle interactions
- socio-economic impacts to industry and/or community
- may result in effort shift to other fisheries with potential increased interactions
- increased enforcement (resources)

· Eliminate use of gear
+ decreased sea turtle interactions
+ decreased bycatch
- socio-economic impacts to industry and/or community
- may result in effort shift to other fisheries with potential increased interactions
- loss of data

· **Rod and Reel (Recreational)**

Management options:

(+ potential positive impact of action)
(- potential negative impact of action)

· No Action
  + no new regulations
  + no loss of income to recreational industry
  + maintain economic resource
  - no reduction in sea turtle interactions
  - resources needed currently

· Seasonal/Area closures
  + decreased sea turtle interactions
  + decreased bycatch
  - socio-economic impacts to industry and/or community
  - may result in effort shift to other fisheries with potential increased interactions
  - increased resources necessary to define overlaps of sea turtle distribution and recreational fishing operations
  - increased enforcement (resources)

· Reduce overall effort
  + decreased sea turtle interactions
  + increased populations of target species
  + decreased bycatch
  - socio-economic impacts to industry and/or community
  - may result in effort shift to other fisheries with potential increased interactions

· Gear restrictions (modifications to gear parameters)
  + decreased sea turtle bycatch mortality (i.e., use of circle hooks)
  + decreased finfish bycatch mortality (i.e., use of circle hooks)
  - socio-economic impacts to industry and/or community
  - increased enforcement (resources)

· Eliminate use of gear
  + decreased sea turtle interactions
  + decrease in discarded line (decreased entanglement potential)
  + decreased bycatch
  - socio-economic impacts to industry and/or community
  - loss of data
  - loss of food source for low-income individuals

Gears of Other Concern:

· **Butterfly Net, Channel Net, Skimmer Trawl**

Management options:

(+ potential positive impact of action)
(- potential negative impact of action)

· No Action
  + no new regulations
  + no loss of income to industry

+ allows flexibility in fishing effort (by gears)
- no reduction in sea turtle interactions
- resources needed currently

· Seasonal/Area closures
+ decreased sea turtle interactions
+ economic gain to individual fishermen
+ decreased bycatch
- socio-economic impacts to industry and/or community
- may result in effort shift to other fisheries with potential increased interactions
- increased resources necessary to define overlaps of sea turtle distribution and commercial fishing operations
- increased enforcement (resources)

· Reduce overall effort (fewer licenses, less gear)
+ decreased sea turtle interactions
+ economic gain for participating fishermen
+ increased populations of target species
+ decreased bycatch
- loss of income to non-participating fishermen
- socio-economic impacts to industry and/or community
- may result in effort shift to other fisheries with potential increased interactions

· Gear restrictions (modifications to gear parameters)
+ decreased sea turtle interactions
- socio-economic impacts to industry and/or community
- may result in effort shift to other fisheries with potential increased interactions
- increased enforcement (resources)

· Eliminate use of gear
+ decreased sea turtle interactions
+ decreased bycatch
- socio-economic impacts to industry and/or community
- may result in effort shift to other fisheries with potential increased interactions
- loss of data

· **Long Haul Seine, Swipe Net**

Management options:

(+ potential positive impact of action)
(- potential negative impact of action)

· No Action
+ no new regulations
+ no loss of income to industry
+ allows flexibility in fishing effort (by gears)
- no reduction in sea turtle interactions

· Seasonal/Area closures

+ decreased sea turtle interactions
+ economic gain to individual fishermen
+ decreased bycatch
- socio-economic impacts to industry and/or community
- may result in effort shift to other fisheries with potential increased interactions
- increased resources necessary to define overlaps of sea turtle distribution and commercial fishing operations
- increased enforcement (resources)

· Reduce overall effort (fewer licenses, less gear)

+ decreased sea turtle interactions
+ economic gain for participating fishermen
+ increased populations of target species
+ decreased bycatch
- loss of income to non-participating fishermen
- socio-economic impacts to industry and/or community
- may result in effort shift to other fisheries with potential increased interactions

· Eliminate use of gear

+ decreased sea turtle interactions
+ decreased bycatch
- socio-economic impacts to industry and/or community
- may result in effort shift to other fisheries with potential increased interactions
- loss of data

· **Other Gillnets (Gillnet Set (float), Gillnet Set (sink), Gillnet Set (< 5 in. stretch mesh))**

Management options:

(+ potential positive impact of action)
(- potential negative impact of action)

· No Action

+ no new regulations
+ no loss of income to industry
+ allows flexibility in fishing effort (by gears)
- no reduction in sea turtle interactions

· Seasonal/Area closures (extend PSGNRA regulations to other areas*)

* PSGNRA regulations may not apply to Gillnet Set (< 5 in. stretch mesh)

+ decreased sea turtle interactions
+ economic gain to individual fishermen
+ decreased bycatch
+ increase in target species populations
- socio-economic impacts to industry and/or community
- may result in effort shift to other fisheries with potential increased interactions
- increased resources necessary to define overlaps of sea turtle distribution and commercial fishing operations
- increased enforcement (resources)

· Reduce overall effort (fewer licenses, less gear)
+ decreased sea turtle interactions
+ economic gain for participating fishermen
+ increased populations of target species
+ decreased bycatch
- loss of income to non-participating fishermen
- socio-economic impacts to industry and/or community
- may result in effort shift to other fisheries with potential increased interactions
- loss of economic gain to state

· Eliminate use of gear

+ decreased sea turtle interactions
+ decreased bycatch
- socio-economic impacts to industry and/or community
- may result in effort shift to other fisheries with potential increased interactions
- loss of data

· **Crab Pot**

Management options:
(+ potential positive impact of action)
(- potential negative impact of action)

· No Action
+ no new regulations
+ no loss of income to industry
+ allows flexibility in fishing effort (by gears)
- no reduction in sea turtle interactions

· Seasonal/Area closures
+ decreased sea turtle interactions
+ increase economic gain to individual fishermen
+ decreased bycatch
+ increase in target species populations
- socio-economic impacts to industry and/or community
- may result in effort shift to other fisheries with potential increased interactions
- increased resources necessary to define overlaps of sea turtle distribution and commercial fishing operations
- increased enforcement (resources)

· Reduce overall effort (fewer boats, licenses, less gear)
+ decreased sea turtle interactions
+ economic gain for participating fishermen
+ increased populations of target species
+ decreased bycatch
+ reduce number of lost pots (ghost pots)
- loss of income to non-participating fishermen
- may result in effort shift to other fisheries with potential increased interactions

- socio-economic impacts to industry and/or community

· Eliminate use of gear
  + decreased sea turtle interactions
  + decreased bycatch
  + reduce number of lost pots (ghost pots)
  - socio-economic impacts to industry and/or community
  - may result in effort shift to other fisheries with potential increased interactions
  - loss of data

· **Crab Trawl**

Management options:

(+ potential positive impact of action)
(- potential negative impact of action)

· No Action
  + no new regulations
  + no loss of income to industry
  + allows flexibility in fishing effort (by gears)
  - no reduction in sea turtle interactions

· Require TEDs
  + decreased sea turtle interactions (mortality)
  - economic cost to industry
  - increased enforcement (resources)
  - loss of catch

· Seasonal/Area closures
  + decreased sea turtle interactions
  + economic gain to individual fishermen
  + decreased bycatch
  + increase in target species populations
  - socio-economic impacts to industry and/or community
  - may result in effort shift to other fisheries with potential increased interactions
  - increased resources necessary to define overlaps of sea turtle distribution and commercial fishing operations
  - increased enforcement (resources)

· Reduce overall effort (fewer boats, licenses, less gear)
  + decreased sea turtle interactions
  + economic gain for participating fishermen
  + increased populations of target species
  + decreased bycatch
  + reduce number of lost pots (ghost pots)
  - loss of income to non-participating fishermen
  - may result in effort shift to other fisheries with potential increased interactions
  - socio-economic impacts to industry and/or community

· Gear restrictions (modifications to gear parameters)
  + decreased sea turtle interactions
  - socio-economic impacts to industry and/or community
  - may result in effort shift to other fisheries with potential increased interactions
  - increased enforcement (resources)
  - initial expenditure to industry (TEDs)

· Eliminate use of gear
  + decreased sea turtle interactions
  + decreased bycatch
  - socio-economic impacts to industry and/or community
  - may result in effort shift to other fisheries with potential increased interactions
  - loss of data

Management Recommendations

Recommendations for Gears of Primary Concern

· *Gillnet Set (≥ 5 in. stretch mesh)*

Recommendation 1: Establish mandatory observer coverage of all large mesh (≥ 5 in. stretch) gillnets throughout all estuarine waters. The level of this coverage should have a minimum goal of 2% of the total effort by area. Coverage should increase (~10%) in areas when/where sea turtle interactions are occurring. Note: mandatory coverage here means if an observer contacts a fisherman that he complies with the request of a trip barring any safety, insurance or health issues.

Rationale: Real time, continuous observer coverage will better define sea turtle distribution/fishing operation overlaps. This will allow managers the ability to make informed decisions for reducing sea turtle interactions. Mandatory observer coverage will also benefit fishery management through the assessment of finfish bycatch.

Recommendation 2: Provide education on turtle resuscitation to fishermen. Support outreach programs that encourage reporting turtles and compliance with regulations.

Rationale: Knowledge of sea turtle resuscitation and other ways that fishers can protect turtles will prevent sea turtles deaths.

Recommendation 3: Implement state seasonal/area closures in identified problem areas.

Rationale: In areas where known concentrations of sea turtles and increased commercial gillnet activity have resulted in interactions, state seasonal/area closures will allow increased protection for sea turtles.

Recommendation 4: Support continued efforts for gear modification and testing with the objective of reducing sea turtle interactions.

Rationale: Modifications to existing gear, which prevent incidental capture of sea turtles, can allow fishing to continue in areas inhabited by sea turtles.

· *Shrimp Trawl*

Recommendation 1: Determine and enforce TED compliance throughout North Carolina through the NC MFC creating a rule change or authorizing proclamation authority to the director of NCDMF to provide state authority to enforce TED compliance. As this is a federal regulation, initially an estimate of current compliance needs to be obtained. Following this, the NCDMF may opt to increase effort to ensure compliance with TED regulations.

Rationale: Currently, TED compliance for the state of North Carolina is not known. As there are known interactions with protected sea turtles in this gear, the enforcement of this federal rule is a must. An initial estimate of compliance needs to be obtained, and appropriate management actions should follow.

Recommendation 2: Support turtle resuscitation education and TED education

Rationale: Knowledge of sea turtle resuscitation will potentially prevent sea turtles deaths. Knowledge of TED regulations will not only protect sea turtles, it will also protect fishers from violations due to inexperience/ignorance.

Recommendation 3: Add statewide observer coverage. The level of this coverage should have a minimum goal of 2% of the total effort by area. Coverage should increase (~10%) in areas when/where sea turtle interactions are occurring. Note: mandatory coverage as defined here requires a fisherman to comply with the request to carry an observer during a trip, barring any safety, insurance or health issues.

Rationale: Observer coverage will provide information on interactions, effectiveness of TEDs, and compliance.

· *Pound Net*

Recommendation 1: Have state apply for a section 10 agreement for all pound nets that interact with turtles.

Rationale: Fishery can operate legally as it has frequent though (debatably) non-lethal interactions, and as a proactive measure to protect the commercial pound net industry. This measure will allow the state to collect data to assess interactions.

Recommendation 2: Encourage and educate the industry about the importance of regularly checking pound net leads and pounds during normal commercial fishing operations for the presence of sea turtles.

Rationale: A potential exists for sea turtle entanglement in the leads of pound nets, as well as entanglement in the heart and pound of the gear when gear is deployed. To minimize the potential mortality, these checks will allow for disentanglement. More frequent checks of the pounds when water temperatures are low (<15° C) allows turtles to leave the sounds, preventing cold stunning and eventual death of those that remain within the pounds.

Recommendation 3: Require industry to catalogue gear time out of the water and report this to NCDMF.

Rationale: cataloging gear time out of water would encourage removal of gear when not fishing.

Recommendation 4: Encourage industry to remove all webbing during closed seasons, and establish a recovery cost for pulling lost or abandoned gear.

Rationale: A potential exists for sea turtle entanglement in the leads of pound nets, as well as entanglement in the heart of the gear when gear is deployed. To minimize the potential mortality, lead checks will allow for disentanglement. While costly to the industry, removing gear from the water during closed seasons will eliminate the potential for sea turtle entanglement and cold stunning.

Recommendation 5: Support sea turtle resuscitation education. Support educational outreach programs that emphasize importance of removing nets at end of season, checking nets regularly, mending holes or areas that may result in entanglement issues, and reporting turtles.

Rationale: Knowledge of sea turtle resuscitation and other ways that pound net fishers can protect turtles will prevent sea turtles deaths.

Recommendation 6: Evaluate existing observer coverage from NMFS. To obtain these data the NCMFC should request and routinely receive these data from NMFS.

Rationale: Currently, there have been two, three-year cycles of data collections from pound net operations in North Carolina waters. However, these data have not been available to the industry or public. Having this information about sea turtle abundance, distributions, and fishery interactions will allow managers to make informed decisions.

Recommendation 7: Support gear modifications and testing that would reduce sea turtle interactions .

Rationale: Modifications to existing gear, which prevent incidental capture of sea turtles, can allow fishing to continue in areas inhabited by sea turtles.

· *Rod and Reel (recreational)*

Recommendation 1: Conduct research on the effectiveness of circle hooks in recreational fishing operations. If considered effective, require the use of circle hooks in recreational fishing operations using bait throughout the estuarine waters of North Carolina year round.

Rationale: The use of circle hooks in recreational fishing operations may prove effective in reducing sea turtle mortality.

Recommendation 2: Support outreach programs that encourage the use of circle hooks, demonstrate dehooking and line removal techniques, encourage reporting hooked or entangled turtles, and emphasize the impact of discarded line on turtles.

Rationale: Educating the public on the harmful effects of hooking or entangling a sea turtle with fishing gear and enlisting their aid to report such incidences will serve to promote sea turtle conservation.

Recommendation 3: The MRFSS survey should include questions of whether an angler had hooked a sea turtle (they are already asked if they have seen a turtle). If problem areas are identified, exploratory observer coverage should be implemented.

Rationale: The MRFSS survey and observer coverage will provide the necessary data to determine the extent of hooking a sea turtle.

Recommendations for Gears of Other Concern

· *Butterfly Net, Channel Net, Skimmer Trawl*

Recommendation 1: Implement observer coverage. The level of this coverage should have a minimum goal of 2% of the total effort by area. Coverage should increase (~10%) in areas when/where sea turtle interactions are occurring.

Rationale: Real time, continuous observer coverage will better define sea turtle distribution/fishing operation overlaps. This will allow managers the ability to make informed decisions for reducing sea turtle interactions. Mandatory observer coverage will also benefit fishery management through the assessment of finfish bycatch.

Recommendation 2: Provide educational information on sea turtle resuscitation and reporting requirements for unharmed/injured/dead turtles.

Rationale: Knowledge of sea turtle resuscitation will help prevent sea turtle deaths. Reporting requirements will add to the observer data.

· *Long Haul Seine, Swipe Net*

Recommendation 1: Implement observer coverage. The level of this coverage should have a minimum goal of 2% of the total effort by area. Coverage should increase (~10%) in areas when/where sea turtle interactions are occurring.

Rationale: Real time, continuous observer coverage will better define sea turtle distribution/fishing operation overlaps. This will allow managers the ability to make informed decisions for reducing sea turtle interactions. Mandatory observer coverage will also benefit fishery management through the assessment of finfish bycatch.

Recommendation 2: Support gear modifications and testing that would reduce sea turtle interactions should interactions be determined a problem.

Rationale: Modifications to existing gear, which prevent incidental capture of sea turtles, can allow fishing to continue in areas inhabited by sea turtles.

Recommendation 3: Provide educational information on sea turtle resuscitation and reporting requirements for unharmed/injured/dead turtles.

Rationale: Knowledge of sea turtle resuscitation will help prevent sea turtle deaths. Reporting requirements will add to the observer data.

· Other Gillnets *(Gillnet Set (float), Gillnet Set (sink), Gillnet Set (< 5 in. stretch mesh))*

Recommendation 1: Implement observer coverage. The level of this coverage should have a minimum goal of 2% of the total effort by area. Coverage should increase (~10%) in areas when/where sea turtle interactions are occurring.

Rationale: Real time, continuous observer coverage will better define sea turtle distribution/fishing operation overlaps. This will allow managers the ability to make informed decisions for reducing sea turtle interactions. Mandatory observer coverage will also benefit fishery management through the assessment of finfish bycatch.

Recommendation 2: Support gear modifications and testing that would reduce sea turtle interactions should interactions be determined a problem.

Rationale: Modifications to existing gear, which prevent incidental capture of sea turtles, can allow fishing to continue in areas inhabited by sea turtles.

Recommendation 3: Implement state seasonal/area closures for large mesh (> 5 in stretch mesh) in identified problem areas.

Rationale: In areas where known concentrations of sea turtles and increased commercial gillnet activity have resulted in interactions, state seasonal/area closures will reduce interactions with sea turtles.

Recommendation 3: Provide educational information on sea turtle resuscitation and reporting requirements for unharmed/injured/dead turtles.

Rationale: Knowledge of sea turtle resuscitation will help prevent sea turtle deaths. Reporting requirements will add to the observer data.

· *Crab Pot*

Recommendation 1: Continue to support Marine Patrol in their efforts during the pot clean up and follow their recommendations for making the clean up more effective/efficient.

Rationale: There is little evidence of sea turtle interaction in this fishery, however effort is high and the potential for interaction in the buoy line exists. Thus, a reduced number of pots (abandoned or ghost) will decrease the potential for protected species as well as finfish bycatch.

Recommendation 2: Eliminate bait lids on crab pots when/where sea turtle interactions are occurring.

Rationale: May reduce potential for harmful sea turtle interaction by readily allowing removal of the bait within the crab pot.

· *Crab Trawl*

Recommendation 1: Implement observer coverage. The level of this coverage should have a minimum goal of 2% of the total effort by area. Coverage should increase (~10%) in areas when/where sea turtle interactions are occurring.

Rationale: Real time, continuous observer coverage will better define sea turtle distribution/fishing operation overlaps. This will allow managers the ability to make informed decisions for reducing sea turtle interactions. Mandatory observer coverage will also benefit fishery management through the assessment of finfish bycatch.

Recommendation 2: Provide educational information on sea turtle resuscitation and reporting requirements for unharmed/injured/dead turtles.

Rationale: Knowledge of sea turtle resuscitation will help prevent sea turtle deaths. Reporting requirements will add to the observer data.

Recommendation 3: Support gear modifications and testing that would reduce sea turtle interactions should interactions be determined a problem.

Rationale: Modifications to existing gear, which prevent incidental capture of sea turtles, can allow fishing to continue in areas inhabited by sea turtles.

Research Needs

During STAC discussions all members agreed that information was limited in many areas regarding the status of sea turtles and fishery interactions. To address this, the STAC recommended support and funding for analyses and dissemination of results from existing studies. In addition to funding, the following areas for research are recommended: sea turtle status, fishery interactions and gear development.

Sea turtle status

The STAC recognized the need to obtain accurate population estimates of Atlantic sea turtles, and the relative difficulty in obtaining these estimates at this time. The current way of assessing population size and/or trends is through counting nests or nesting females on beaches. However, such estimates do not include information on either adult males, non-reproductive adult females, or subadult/juvenile turtles, the latter being the most common stage class of turtles that occur in NC estuarine waters.

Information collected on stranded turtles can be useful in monitoring the presence of turtles in North Carolina waters and also for identifying potential sources of mortality. Stranded turtles are observed and reported by volunteers and participants in the NC STSSN on a case-by-case basis, and trends are assessed weekly by zone (latitude) throughout North Carolina. For logistic reasons, observer coverage for stranded turtles in NORTH CAROLINA is concentrated on the ocean facing beaches. There is less observer effort expended on sea turtle strandings that occur estuarine, largely due to the relative inaccessibility of estuarine habitats and the general reduced interest in reporting strandings.

The STAC recommended increasing public involvement in monitoring and reporting stranded turtles in estuarine waters through increasing publicity about the NC STSSN. The STAC also encouraged the NPS to conduct regular patrols of accessible estuarine coastlines in Cape Hatteras and Cape Lookout National Seashores.

Increased monitoring for strandings in estuarine waters will facilitate stratification by man-hours and by geographical location, which may be more representative of sea turtle distribution and mortality factors.

The STAC also recommended continuing in-water sea turtle tagging studies and implementing fishery independent studies (such as recurrent aerial surveys) to collect accurate spatial and temporal distribution data.

Fishery Interactions

The STAC recognized the general lack of observer coverage data throughout many of North Carolina commercial fisheries, and the importance of having accurate real time data for the management of fisheries and reduction of bycatch. Currently, the NCDMF has an estuarine observer program throughout all estuarine waters. The program was established in April 2004, and has obtained coverage (~1.5% of total trips - 11% of fall fishery in PSGNRA) throughout the estuarine large and small mesh gillnet fisheries. The NCDMF observer program is now beginning to expand into the Shrimp Trawl, Pound Net, and Crab Trawl fisheries. Funding for this program exists through September 2006 with allocated funds, and is under a grant agreement, which may re-allocate funds through September 2007.

The NMFS observer program in North Carolina is primarily tasked with obtaining trips in commercial trawler and gillnet fisheries (Category I and Category II) as allocated on the Northeast Fishery Observer Program (NEFOP) sea day schedule by month and county. Categories I and II fisheries are classified by NOAA Fisheries based on the level of serious injury and mortality of marine mammals occurring incidentally in each fishery. The majority of days that are tasked in North Carolina are for Dare County, North Carolina in the commercial ocean gillnet fishery. However, the NEFOP does occasionally obtain estuarine gillnet trips in Pamlico Sound, NC.

The STAC recommended that state exploratory observer coverage with a minimum goal of 2% coverage of the total fishing effort (by fishery) be expanded to all gears of primary and other concern fisheries, and that NCDMF search for long-term funding for this program. The STAC further recommended that observer coverage be administered fairly to all fishermen. Finally, the STAC recommended that alternative methods for obtaining sea turtle interaction information from recreational fisheries be explored.

The STAC also recognized other specific research needs. There was considerable discussion regarding the ultimate fate of sea turtles following post-capture release and multiple captures in commercial fishing gears. **Although beyond the scope of the original mandate, the STAC recommended funding for studies directed at post-capture mortality. Similarly, the STAC recommended expanding independent socio-economic studies relating to sea turtle management.**

Gear Development

The STAC recognized the need to continue gear development programs throughout North Carolina fisheries for the purpose of developing commercial fishing gears that maintain target catches while reducing bycatch. Currently, the North Carolina Sea Grant Fishery Resource Grant Program, the Blue Crab Program (hurricane funding), and the NCDMF gear development programs are tasked with this goal. **The STAC recommended continued support and funding for these programs. The STAC also recommended directed research to identify fishing gear that reduces if not eliminates sea turtle interactions, for example:**

- **Gillnet fishery – large mesh low-profile gillnet design expansion studies**
- **Shrimp Trawl fishery – continued TED design studies**
- **Pound Net fishery – escape panel and turtle deflector grid studies**
- **Rod and Reel (Recreational) – circle hook studies**
- **Crab Pot fishery – research directed to identify sea turtle impacts to crab pot gear**

Other Considerations

Public Outreach

Better agency coordination and expanded educational outreach will increase the effectiveness of existing rules and programs protecting sea turtle populations.

Agency Coordination

The STAC recognized the potential benefit of continuing and improving agency, and other stakeholder coordination throughout the state of North Carolina concerning the need to reduce sea turtle interactions, and maintain commercial and recreational fisheries. Improved state and federal agency coordination on these issues would also be beneficial. **The STAC recommended that the framework for a network group be established to exchange information, ideas, and discuss problems on a biannual basis.**

Educational Outreach

The STAC recommended expanded outreach programs be implemented to inform state agencies, the public, and the commercial and recreational fishing industries about issues relating to sea turtles and fishery management. These may include, but are not limited to: convening public meetings to inform the fishing industry about ESA regulations; conducting regular fish house visits to speak with fishermen about ESA regulations; providing sea turtle release and resuscitation flyers and establishing training programs; and informing the public about current issues relating to sea turtle interactions in North Carolina fisheries.

Enforcement

The STAC recommended the need to evaluate (and improve if necessary) the level of compliance with current regulations pertaining to sea turtles in internal North Carolina waters. For example, it would be beneficial to know how well regulations are being followed. For example:

- **Habitat destruction – e.g. from estuarine dredging**
- **Pollution – e.g. from sewage outfall**
- **Development – both commercial and coastal**
- **Fishery compliance – e.g. TED compliance, deep water large mesh gillnet Pamlico Sound closure, etc.**

Other Threats

While the STAC is focused on estuarine fishing gear interactions, it is important to note that factors other than estuarine fishing operations have an impact on the recovery of the Atlantic sea turtle populations. Table 5 provides a list of these common threats to sea turtles.

Table 5. Threats and impacts to Atlantic sea turtle populations as compiled from the STAC and the NOAA Biennial Report to Congress on the Recovery of Threatened and Endangered Species October 1, 2002 – September 30, 2004.

Threats and Impacts to Atlantic Sea Turtle Populations Outside the Scope of the STAC*
Ocean commercial and recreational fisheries
Global climate change
Coastal development
Entanglement in marine debris
Pollution
Boating activities/propeller strikes
Power plant entrapment
Acoustic disturbance
Pesticides, heavy metals, PCBs
Dredging
Oil and gas production
Habitat destruction
Parasites and disease

*As discussed by STAC and outlined in the NOAA Biennial Report to Congress on the Recovery of Threatened and Endangered Species October 1, 2002 - September 30, 2004.

Table 5 provides a general list (not in ranked order) of threats to sea turtle populations other than estuarine commercial and recreational fishing gear interactions. Each of these are known or suspected to have caused injuries or mortalities to sea turtles. For example, pollution in estuaries, which are commonly used as feeding grounds for sea turtles, presents the potential problem of ingestion of harmful substances or debris by turtles. Likewise, with an increasing coastal human population, the number of boaters presents an increased potential for strikes and mortality. Similarly, large industry operations such as power plants and oil and gas production pose the threat of capture, injury or mortality.

One issue discussed by the STAC was the importance of maintaining estuarine and near shore habitat. Many finfish and sea turtles rely on estuaries as nursery areas. The degradation or loss of these habitats may severely affect important stages of their life cycles and life history. Through the Coastal Habitat Protection Plan (CHPP), fish habitats (e.g., submerged aquatic vegetation (or SAVs), shell bottom, and hard bottoms) have been identified. There are numerous goals and implementation steps to protect these habitats. The three North Carolina commissions (Environmental Management Commission (EMC), Coastal Resources Commission (CRC), and the MFC) involved in the development and adoption of the CHPP have committed to these implementations steps (e.g., beach and inlet management plan), and are actively working toward these (Street et al. 2005).

Jurisdictional authority

In order to understand the mechanisms that could be used to implement specific management actions from the recommendations, the following description of North Carolina's jurisdictional and management authority is provided.

General authority for stewardship of the marine and estuarine resources by the North Carolina Department of Environment and Natural Resources (DENR) is provided in General Statute (G.S.) 113-131. The North Carolina Division of Marine Fisheries (NCDMF) is the arm of the Department that carries out this responsibility. Authority for DMF enforcement officers is provided by G.S. 113-136. The Marine Fisheries Commission is charged "to manage, restore, develop, cultivate, conserve, protect and regulate the marine and estuarine resources of the State of North Carolina" (G.S. 143B-289.51). Marine and estuarine resources are "defined as all fish; all marine mammals; all shellfish; all crustaceans; and all other fishes, except inland game fish, found in the Atlantic Ocean and in coastal fishing waters; all fisheries based upon such fish; all uncultivated or undomesticated plant and animal life other than wildlife resources, inhabiting or dependent upon coastal fishing waters; and the entire ecology supporting such fish, fisheries and plant and animal life" (G.S. 113-129). The MFC can regulate fishing times, areas, gear, seasons, size limits and quantities harvested or possessed (G.S. 143B-289.52). The statutes also allow the MFC to delegate authority to implement its regulations for fisheries "which may be affected by variable conditions" to the Director of DMF by issuing public notices called "proclamations", as provided in G.S. 113-221 (e). Thus, North Carolina has a powerful and flexible legal basis for coastal fisheries management.

While the MFC manages commercial and recreational fishing practices in coastal waters through rules implemented by the NCDMF, several other agencies directly and indirectly affect coastal fisheries and habitats. The Environmental Management Commission (EMC) has wide-ranging authority over activities affecting water quality statewide. Rules adopted by the EMC govern point and nonpoint discharges, wastewater management, alteration of non-coastal wetlands, and stormwater management. The EMC is unique because its rules are implemented by several different DENR agencies, including the Division of Water Quality (DWQ), Division of Air Quality (DAQ), Division of Water Resources (DWR), and the Division of Land Resources (DLR). The Coastal Resources Commission (CRC) enacts rules to manage development and land disturbing activities along estuarine and ocean shorelines, shoreline stabilization, alteration of submerged bottoms and coastal wetlands, and marina construction. The Division of Coastal Management (DCM) implements rules adopted by the CRC. The N.C. Wildlife Resources Commission (WRC) is the state agency charged with management of inland fisheries, hunting, and management of terrestrial wildlife, birds, and protected species, including sea turtles on land. The National Marine Fisheries Service, by contrast has predominant jurisdictional authority over sea turtles in the water.

Literature Cited

Avens, L., J. Braun-McNeill, S.P. Epperly, and K.J. Lohmann. 2003. Site fidelity and homing behavior in juvenile loggerhead sea turtles (*Caretta caretta*). Marine Biology 143: 211-220.

Avens, L. and K.J. Lohmann. 2004. Navigation and seasonal migratory orientation in juvenile sea turtles. The Journal of Experimental Biology 207: 1771-1778.

Bass, A.L., Epperly, S.P. and Braun-McNeill, J. 2004. Multi-year analysis of stock composition of a loggerhead turtle (Caretta caretta) foraging habitat using maximum likelihood and Bayesian methods. Conservation Genetics 5: 783 – 796.

Bjorndal, K.A. 1997. Foraging ecology and nutrition of sea turtles. *In* P.L. Lutz and J.A. Musick (eds.), The Biology of Sea Turtles, pp. 199-231. CRC Press, Boca Raton, Florida.

Bolten, A.B. 2003. Active swimmers – passive drifters: the oceanic juvenile stage of loggerheads in the Atlantic system. *In* A.B. Bolten and B.E. Witherington (eds.) Loggerhead Sea Turtles, pp. 63-78. Smithsonian Books, Washington, DC.

Bowen, B. W. and Karl, S. A. 1996. Population genetics, phylogeography, and molecular evolution. *In* Lutz, P. L. and Musick, J. A. (eds.), The biology of sea turtles. CRC Press, pp. 29-50.

Bowen, B.W., Bass, A.L., Chow, S.-M., Bostron, M., Bjorndal, K.A., Bolten, A.B., Okuyama, T., Bolker, B.M., Epperly, S., Lacasella, E., Shaver, D., Dodd, M., Hopkins-Murphy, S.R., Musick, J.A., Swingle, M., Rankin Baransky, K., Teas, W. and Dutton, P.H. 2004. Natal homing in juvenile loggerhead turtles (Caretta caretta). Molecular Ecology 13: 3797-3808.

Braun-McNeill, J., Sasso, C., Epperly, S.P. and Rivero, C. In press. The use of sea surface temperature imagery and the management of sea turtle interactions in the Mid Atlantic Bight. Proceedings of the 23rd Annual Symposium on Sea Turtle Biology and Conservation, 17-21 March 2003, Kuala Lumpur, Malaysia.

Braun-McNeill, J. and S. P. Epperly. 2004. Spatial and temporal distribution of sea turtles in the western North Atlantic and the U.S. Gulf of Mexico from Marine Recreational Fishery Statistics Survey (MRFSS). Mar. Fish. Review. 64(4):50-56.

Crowder, L. B., Crouse, D. T., Heppell, S. S. and Martin, T. H. 1994. Predicting the impact of turtle excluder devices on loggerhead sea turtle populations. Ecological Applications 4: 437-445.

Cunningham, P. A., R. J. Curry, R. W. Pratt, S. J. Stichter, K. West, L. Mercer, P. Phalen, S. Sherman, B. Burns, and S. Winslow. 1992. Watershed Planning in the Albemarle-Pamlico Estuarine System, Report 5-Fishing Practices Mapping. Research Triangle Institute, Research Triangle Park, NC. 227 pp.

Dodd, C. K. Jr. 1988. Synopsis of the Biological Data on the Loggerhead Sea Turtle Caretta caretta (Linnaeus 1758). Biological Report. - USFWS, p. 110.

Dumont, W. H. and G. T. Sundstrom. 1961. Commercial Fishing Gear of the United States. United States Department of the Interior, Fish and Wildlife Service, Bureau of Commercial Fisheries, Washington, D.C. 61 pp.

Ehrhart, L. M., Bagley, D. A. and Redfoot, W. E. 2003. Loggerhead turtles in the Atlantic Ocean: geographic distribution, abundance and population status. *In* Bolten, A. B. and Witherington, B. E. (eds.), Loggerhead Sea Turtles. Smithsonian Press, pp. 157-174.

Epperly, S. P., J. Braun, and A. J. Chester. 1995a. Aerial surveys for sea turtles in North Carolina estuarine waters. Fish. Bull. 93(2):254-261**.**

Epperly, S.P., J. Braun, A.J. Chester, F. A Cross, J.V. Merriner, and P.A. Tester. 1995b. Winter distribution of sea turtles in the vicinity of Cape Hatteras and their interactions with the summer flounder trawl fishery. Bull. Mar. Sci. 56:547-568.

Epperly, S. P., Braun, J. and Veishlow, A. 1995. Sea turtles in North Carolina waters. Cons. Biol. 9: 384-394.

Epperly, S.P., Braun, J., Chester, A.J., Cross, F.A., Merriner, J.V., Tester, P.A. and Churchill, J.H. 1996. Beach stranding as an indicator of at-sea mortality of sea turtles. Bulletin of Marine Science 59: 289-297.

Gearhart J. 2001. Sea turtle bycatch monitoring of the 2000 fall flounder gillnet fishery of southeastern Pamlico Sound, North Carolina. Completion Report for ITP 1259. North Carolina Department of Environment and Natural Resources, Division of Marine Fisheries. 26pp.

Gearhart J. 2002. Sea turtle bycatch monitoring of the 2001 fall flounder gillnet fishery of southeastern Pamlico Sound, North Carolina. Completion Report for ITP 1348. North Carolina Department of Environment and Natural Resources, Division of Marine Fisheries. 44pp.

Gearhart J. 2003. Sea turtle bycatch monitoring of the 2002 fall flounder gillnet fishery of southeastern Pamlico Sound, North Carolina. Completion Report for ITP 1398. North Carolina Department of Environment and Natural Resources, Division of Marine Fisheries. 39pp.

Gearhart J. and B. Price. 2003. Evaluation of modified flounder gillnets in southeastern Pamlico Sound, NC. Completion report for NOAA award no. NA 16FG1220 segment 1. North Carolina Department of Environment and Natural Resources, Division of Marine Fisheries.

Hays, G. C. 2000. The implications of variable remigration intervals for the assessment of population size in marine turtles. J. Theor. Biol. 206: 221-227.

Heppell, S.S., Crowder, L.B., Crouse, D.T., Epperly, S.P. and Frazer, N.B. 2003. Population models for Atlantic loggerheads: past, present and future. In: Bolten, A.B. and Witherington, B.E. (eds.), Loggerhead Sea Turtles. Washington, D.C.: Smithsonian Books, pp. 255-273.

Hirth, H. F. 1997. Synopsis of biological data on the green turtle Chelonia mydas (Linnaeus, 1758). - U.S. Dept. of the Interior, Fish and Wildlife Service, p. 120.

Marquez, M. R. 1994. Synopsis of biological data on the Kemp's ridley turtle, *Lepidochelys kempi* (Garman, 1880). - NOAA Tech Mem. NMFS-SEFC-343.

Miller, J. D. 1996. Reproduction in sea turtles. *In* P.L. Lutz and Musick, J. A. (eds.), The biology of sea turtles. CRC Press, pp. 51-81.

Musick, J. A., D. E. Barnard, and J. A. Keinath. 1994. Aerial estimates of seasonal distribution and abundance of sea turtles near the Cape Hatteras faunal barrier. *In* B.A. Schroeder and B. E. Witherington (eds.), Proceedings of the Thirteenth Annual Symposium on Sea Turtle Biology and Conservation, p. 121-123. NOAA Tech. Memo. NMFS-SEFSC-341. National Marine Fisheries Service, Miami, Florida.

Price B. 2004. Sea turtle bycatch monitoring of the 2003 fall flounder gillnet fishery of southeastern Pamlico Sound, North Carolina. Completion Report for ITP 1398. North Carolina Department of Environment and Natural Resources, Division of Marine Fisheries. 26pp.

Price B. 2005. Sea turtle bycatch monitoring of the 2003 fall flounder gillnet fishery of southeastern Pamlico Sound, North Carolina. Completion Report for ITP 1398. North Carolina Department of Environment and Natural Resources, Division of Marine Fisheries. 27pp.

Shaver, D., Amos, A.F., Higgins, B. and Mays, J. 2005. Record 42 Kemp's ridley nests found in Texas in 2004. Marine Turtle Newsletter 108: 1-3.

Schwartz, F. J. 1977. Species accounts. Reptiles: Testudines; Chelonidae. *In* Cooper, J. E., S. S. Robinson, and J. B. Funderburg (eds.), Endangered and Threatened Plants and Animals of North Carolina, p. 303-308. North Carolina Museum of Natural History, Raleigh, North Carolina.

Schwartz, F. J. 1976. Status of sea turtles, Chelonidae and Dermochelidae, in North Carolina. J. Elisha Mitchell Sci. Soc. 92:76-77.

Shoop, C. R., and R. D. Kenney. 1992. Seasonal distributions and abundances of loggerhead and leatherback sea turtles in waters of the northeastern United States. Herpetolog. Monogr. 6:43-67.

Snover, M. L. 2002. Growth and ontogeny of sea turtles using skeletochronology: methods, validation and application to conservation. PhD Thesis, Duke University, p. 144.

Street, M.W., A.S. Deaton, W.S. Chappell, and P.D. Mooreside. 2005. North Carolina Coastal Habitat Protection Plan. NC Division of Marine Fisheries, Morehead City, NC. 608 p.

Thompson, N. B., and H. Huang. 1993. Leatherback turtles in southeast U.S. waters. NOAA Tech. Memo. NMFS-SEFSC-318. National Marine Fisheries Service, Miami, Florida.

Troeng, S., Chacon, D. and Dick, B. 2004. Possible decline in leatherback turtle *Dermochelys coriacea* nesting along the coast of Caribbean Central America. Oryx 38: 395-403.

US National Marine Fisheries Service and US Fish and Wildlife Service (US NMFS and US FWS). 1991. Recovery Plan for U.S. Population of Loggerhead Turtle. National Marine Fisheries Service, Washington, D.C., 64pp.

Watson, J.W., S.P. Epperly, A. K. Shah, and D.G.Foster. 2005. Fishing methods to reduce sea turtle mortality associated with pelagic longlines. Canadian Journal of Fisheries and Aquatic Sciences. 62: 965-981.

Witzell, W. N., and T. Azarovitz. 1996. Relative abundance and thermal and geographic distribution of sea turtles off the U.S. Atlantic Coast based on aerial surveys (1963-1969). NOAA Tech. Memo. NMFS-SEFSC-381. National Marine Fisheries Service, Miami, Florida.

Witzell, W. N. 2002. Immature Atlantic loggerhead turtles (Caretta caretta): suggested changes to the life history model. Herpetological Review 33: 266-269.

Wyneken, J. and Salmon, M. 1992. Frenzy and postfrenzy swimming activity in loggerhead, green, and leatherback hatchling sea turtles. Copeia 2:478-484.