Policy Recommendations for the Reduction of Sea Turtle Bycatch in North Carolina's Inshore Gill Net Fisheries

by

Jenna Wallis

Stephen E. Roady, J.D., Advisor

May 2010

Masters project submitted in partial fulfillment of the

requirements for the Master of Environmental Management degree in

the Nicholas School of the Environment of

Duke University

2010

Abstract

North Carolina's 2.5 million acres of coastal waters provide habitat for five species of sea turtles. The North Carolina Division of Marine Fisheries (NCDMF) is charged with managing state fisheries and is responsible for ensuring that sea turtle bycatch is both limited and in compliance with the Endangered Species Act (ESA). In 2005, NCDMF applied for and obtained an Incidental Take Permit (ITP) under section 10 of the ESA. The Karen Beasley Sea Turtle Rescue and Rehabilitation Center, represented by the Duke Environmental Law and Policy Clinic, filed suit against NCDMF and the North Carolina Marine Fisheries Commission on February 23, 2010 for violations of that ITP and of section 9 of the ESA. In light of that lawsuit, this project examines potential methods for reducing sea turtle bycatch in North Carolina's gill net fisheries.

The goal of this master's project was to find potential areas of agreement between recreational and commercial interests pertaining to sea turtle bycatch in the Pamlico Sound area. This goal included the explicit aim to create management recommendations for reductions in sea turtle / gill net bycatch based upon input from fishers. Commercial and recreational fishers were interviewed using an informal, semi-structured interview process. Participants were chosen using a referral system.

The results of the interviews were analyzed using the NVivo software program. Commonalities between and within groups were coded and used to create management recommendations. The data suggest that newly imposed regulations will need to be strictly monitored in order to help ensure an effective outcome, given a long history of

distrust between commercial and recreational fishers. Specific policy recommendations include gear modifications, increased gill net attendance requirements, increased fisher education on sea turtle entanglement in gill nets, increased penalties for lack of self reporting sea turtle interactions, and increased spatial and temporal restrictions on gill net usage.

Introduction

North Carolina state waters provide habitat for 5 species of sea turtle, consisting of the green (*Chelonia mydas*), the loggerhead (*Caretta caretta*), the hawksbill (*Eretmochelys imbricate*), the Kemp's ridley (*Lepidochelys kempii*), and the leatherback (*Dermochelys coriacea*). (Epperly S, Braun J, Veishlow A. 1995) All of these species are protected under the Endangered Species Act of 1973 and therefore require federal and state protection. (U.S. Fish and Wildlife Service. 2010; 16 U.S.C. Section 1538(a)(1)(B) (2006)) Highly migratory animals, sea turtles migrate through and forage in North Carolina inshore waters, and nest on ocean-facing beaches. (Epperly S, Braun J, Veishlow A. 1995) While in North Carolina waters, sea turtles are under the jurisdiction of the North Carolina Division of Marine Fisheries, which manages for the protection and incidental capture of sea turtles in state fisheries. With complex life histories that cross ocean basins, sea turtles are especially vulnerable to high sub-adult and adult mortality rates.

The most common species of sea turtle in North Carolina coastal waters are loggerheads and greens. Listed as threatened and endangered under the Endangered

Species Act, respectively, these turtles have become the center of many discussions on fisheries bycatch issues. Both loggerheads and greens extensively use the shallow sounds and estuarine river mouths, allowing for multiple fisheries and boat strike interactions to occur. North Carolina is host to the northern sub-population of loggerheads, which has been labeled as genetically different from the main population. "Because of its small and therefore vulnerable size, the northern subpopulation has been of special concern." (Hawkes L, Broderick A, Godfrey M, Godley B. 2005)

Pamlico and Core Sounds, specifically, provide important habitat for the North West Atlantic loggerhead population. (Loggerhead Biological Review Team. 2009) These sounds also provide important nursery habitat for neritic juvenile greens. Studies on bycatch and seasonal distributions found that loggerheads are located in NC inshore waters year-round. (Murray K. 2009; Shoop R, Kenney R. 1992) Most of these turtles were caught as bycatch in shallow waters with temperatures ranging from 8.6 to 27.8 degrees Celsius. (Epperly S, Braun J, Veishlow A. 1995) Similarly, greens were caught from March through the end of December, in shallow waters with temperatures ranging from 12.2 to 26.9 degrees Celsius. (Epperly S, Braun J, Veishlow A. 1995) "Sea turtles caught on the NC foraging grounds represent many age classes of both transient and resident animals and reflect both recruitment into the neritic foraging population and permanent emigration from it." (Epperly S, Braun-McNeill J, Richards P. 2007)

Existing Regulations

As stated above, all sea turtles found in North Carolina waters are protected by the Endangered Species Act. (U.S. Fish and Wildlife Service. 2010) Currently, there is an incidental take permit (ITP) issued under §10 of the Endangered Species Act that allows for the 'taking' (harm or death) of dozens of sea turtles annually from large mesh gill net fishing efforts in the Pamlico Sound Gill Net Restricted Area. (National Marine Fisheries Service. 2005) (See Figure 1 for PSGNRA map.) The Pamlico Sound Gill Net Restricted Area (PSGNRA) was established in 2000, and operates under ITP #1528. Incidental Take Permit #1528 allows for the use of large mesh gill nets in shallow coastal waters inside the PSGNRA from September 15th thru December 15th. The PSGNRA is permanently closed to large mesh gill nets outside of the temporal and spatial restrictions set forth in ITP 1528. (Price B. 2009) Under this incidental take permit, authorized takes of turtles for 2008 were as follows: (Gillman E, et al. 2009)

Authorized takes for the fall 2008 large mesh gill net fishery in the PSGNRA

	Maximum Estimated Lethal	Maximum Estimated Live	Total Authorized Take
Kemp's Ridley	14	27	41
Green	48	120	168
Loggerhead	3	38	41
Hawksbill/Leatherback	Any combination of lethal or live - 2 observed takes	Any combination of lethal or live - 2 observed takes	2

There has been much controversy over the issuance of this ITP, as it is the only permit of its kind for the entire NC coast, although gill net fisheries exist in areas outside of the PSGNRA. Authorized take levels are established using extrapolation models, and the fishery is closed once authorized levels have been reached or exceeded. It is important to note that the fall southern flounder fishery in the PSGNRA was closed due to estimated live green takes in both November of 2007 and October of 2009. (Price B. 2008; North Carolina Division of Marine Fisheries. 2009)

The Duke Environmental Law and Policy Clinic filed suit in federal court on behalf of the Karen Beasley Sea Turtle Rescue and Rehabilitation Center on February 23, 2010. (The Karen Beasley Sea Turtle Rescue and Rehabilitation Center v. N.C. Division of Marine Fisheries, et al., (E.D.N.C. 7:10-CV-32-BO)) The plaintiff argues that the defendants, NCDMF and NC Marine Fisheries Commission, were in violation of § 9 of the ESA, as well as of ITP #1528. The 60-day notice of intent to sue, a requirement under the citizen suit of the Endangered Species Act, states that defendants violated § 9 of the ESA by "authorizing and issuing licenses allowing the use of gill nets, which have resulted in significant take of multiple species of endangered and threatened turtles", and that defendants violated ITP #1528 by failing to have fishermen report all incidental takes and for inadequate observer coverage of large mesh gill net fisheries within the Pamlico Sound Gill Net Restricted Area. (Duke Environmental Law and Policy Clinic. 2009) Both parties have entered into settlement negotiations, and the plaintiff has been advised of the results of this research.

The Threat of Gill Nets

Gillnets are a largely indiscriminate type of fishing gear that are constructed of extremely strong monofilament mesh. (See Figure 2 for illustration of a typical gill net.) In North Carolina "during late fall and early winter, the narrowness of the continental shelf and influence of the Gulf Stream concentrate turtles, making them, more susceptible to fishery interactions" (Murray K. 2009). During the period of time during that the United States had an active turtling industry, gillnets were one of the most common gear choices. (Witzell W.N. 1994) Gill netting was used for both direct and indirect fishing efforts. Indirect turtle captures made up the largest percentage of captures, with passive fishing (setting nets for long periods of time) being a popular method. (Witzell W.N. 1994)

North Carolina's inshore gill net fisheries are divided into large mesh and small mesh fisheries. Small mesh fisheries use a mesh that is smaller than 5 inches in stretch, while large mesh fisheries use mesh that is 5 inches or greater in stretch. Murray's gillnet bycatch study found that "mesh size explained the largest amount (20%) of variation in bycatch rates." (Murray K. 2009) Project Global has stated that gill nets are "considered one of the greatest threats to the survival" of sea turtles. (Project Global. 2009) Additionally, Murray has suggested that, "the largest bycatch reduction could potentially be achieved in the southern mid-Atlantic below 38 degrees N [from Virginia south through North Carolina], in large (>17.8 cm) and medium (14 to 17.8 cm) mesh gillnets." (Murray K. 2009)

Bycatch mortality rates count dead animals that are found entangled in nets. They do not count the numerous animals that die as a result of the stresses from forced submersion or infections from lacerations caused by the nets. Recent research by Snoody et al. states that the biological stress that turtles endure from forced submersion can result in post-release deaths. (Snoody J, Landon M, Blanvillain G, Southwood A. 2009) Continual forced submersion events further exacerbate the likelihood of a post-release death. Given these findings and the underreporting of sea turtle bycatch, true sea turtle mortality rates are uncertain. An increase in observer coverage could reduce this uncertainty, and help construct more accurate levels of gill net-induced mortalities. (Wallace B, Heppell S, Lewison R, Kelez S, Crowder L. 2008).

Methods

Data Collection:

This project was conducted as a case study, as it was bound both temporally and spatially. (O'Leary Z. 2008) Research was conducted between September 2009 and February 2010, and participants were chosen from the Pamlico Sound region of North Carolina. Data was collected using informal, un-structured interviews.

Interviews were conducted with commercial and recreational fishers who work in North Carolina state waters. Interviews were based upon themes rather than definitive questions to allow for the interview to be conducted at the comfort levels of the participants. (O'Leary Z. 2008) Furthering the effort to gain the trust and comfort of the participants, interview settings were not limited to a formal office setting, and were often

conducted dockside. All interviews were conducted face-to-face, with several conducted in groups. The flexibility within my data collection methods encouraged fishers to communicate their ideas and concerns openly on a very controversial topic. (O'Leary Z. 2008) Interview sessions were recorded with permission. Participants were selected from a referral system, beginning with one contact from the recreational fishing community and one contact from the commercial fishing community. All personal identification information remained confidential.

Information was collected from these two user groups to provide insights into the two, often clashing, forms of the fishery. Equal attempts were made to collect substantively similar interviews from each fishing community, but the results show that this goal produced a less than ideal sample size. Seven commercial fishermen and seven recreational fishermen were interviewed. Although this sample size is small, the data appear to be representative as they are supported by scientific and media publications.

Data Analysis:

Interviews were analyzed using the NVivo qualitative data analysis software program. The NVivo software program allows for simultaneous qualitative analysis of visual, audio, and written material. The program provides an array of tools that can be used for in-depth analysis. The most common of these tools is the method of coding. Coding consists of digitally highlighting points of interest within the data. (QSR International. 2010)

Interview results were entered into the NVivo program, and were coded for similarities, differences, and unique management suggestions. Nodes (categories) were created for each identified management suggestion, as well as fisher concerns regarding the fishery. Twelve different nodes were created, and consisted of the following:

- Sea turtle populations appear to be increasing
- There is no need to protect sea turtles
- Concerns should be about people's livelihoods, not animals
- Tensions between recreational and commercial fishers
- Economic concerns that commercial fishers rely on gill nets
- Economic concerns that recreational fishers bring in more money to the state than commercial fishers
- A reduction in total gill net yardage
- Increased temporal and spatial restrictions
- Restricted gill net use based on gill net heritage or economic dependence
- Gear modifications
- Increased net attendance requirements
- Other bycatch issues.

Results

Collected data suggests that in fact, hundreds of sea turtles are 'taken' each year in North Carolina gill net fisheries, and that commercial and recreational fishing

communities may have difficulties in working together towards bycatch reduction. Each community of fishers seems to view the other as a competitor for the resource, and is unwilling to collaborate with 'the other side'. Several interviews support this inference with name calling and accusations of depleting the resource from one side to the other. Data within groups were very similar, and so will be discussed as recreational or commercial. Recreational fishers' attitudes towards commercial fishers appeared to stem from a competition for the fish that are caught as commercial bycatch; specifically the bycatch of red drum was of particular concern. A participant commented on this competition for the fish by saying, "We counted 23 red fish and 1 flounder and 1 cormorant in the nets we saw that day. My time and my vested interest and time on the water is greatly impacted by an event like that." Recognition of these existing biases is important when considering the true interest of these groups in reducing sea turtle bycatch.

As a whole, the data suggest that both groups are concerned with sea turtle protection, but that economic factors create a divide between the actions of commercial and recreational fishers. Recreational fishers derive most of their income from charter tours, which are negatively impacted when excessive gill nets or dead/struggling turtles are seen. Commercial fishers on the other hand, rely on heavy gill net setting for increased catch success. Sea turtle bycatch is an unintended and unwanted result of this gear choice, and is seen as an economic disincentive since high sea turtle bycatch levels can result in a fishery closure. Net tending, the act of staying with set nets, greatly reduces dangerous sea turtle/gill net interactions, but is difficult to practice when nets are set overnight. The fear of a fisheries closure seems to cause commercial fishermen to

under-report turtle interactions, which in turn creates difficulties in effective management of the fishery. The threat of a sea turtle bycatch induced fishery closure appeared to alter the quantity and quality of data obtained from commercial fishermen.

This negative incentive to report sea turtle/ gill net interactions creates a weak knowledge base for management plans, and thus needs to be overcome. This could be done through increased observer coverage, increased penalties for lack of reporting, or increased rewards for accurate reporting. Based upon the obtained data, I suggest several management recommendations to help reduce sea turtle bycatch in North Carolina's inshore gill net fisheries.

Management Recommendations

- *Reduce total yardage per vessel* – This suggestion was made by all recreational fishers, and is supported by several NCDMF proclamations that have been set in place to increase sea turtle protection. Recreational fishers support that gill net yardage, which is currently set at 3,000 yards per operator, be reduced to 1,000 yards per vessel. (North Carolina Division of Marine Fisheries. 2009) In addition to a reduction in total yardage, net shot length (the yardage of each individual gill net) should be limited to 100 yards, with a minimum of 25 yard intervals. A restriction on shot length was suggested by a commercial fisher who had been practicing this restriction on his own, and had found reduced rates of sea turtle bycatch to be associated with the practice. This restriction will decrease the overall net weight, allowing for increased movement of entangled turtles. This in turn, should enable entangled turtles to surface for air before being disentangled

when the fish retrieves the net. A reduction in total yardage, as well as a minimum of 25 yards of open water between shots should allow for increased amounts of net-free waters within Pamlico Sound, which will reduce the likelihood of sea turtle entanglement.

- *Increase temporal and spatial restrictions* – Restrictions to large mesh gill nets should be applied statewide and year round to reflect the presence of sea turtles in these waters. All recreational fishers supported this idea, while commercial fishers were concerned that this would severely limit their ability to secure enough fish to adequately provide for their families. Although this is a viable concern, any take of a sea turtle in an amount greater that the number allowed by the ITP or located in an area that is not covered by an incidental take permit is a direct violation of section 9 of the endangered species act. (16 U.S.C. Section 1538(a)(1)(B) (2006)). The North Carolina Division of Marine Fisheries should apply for a state-wide Incidental Take Permit under section 10 of the ESA to account for all sea turtle takings in North Carolina inshore fisheries. This ITP would allow for strict control over sea turtle/fishery interactions, and should include strict requirements for fisheries closures once sea turtle interactions have amounted to a level that could potentially harm the sea turtle populations found in NC waters.

- *Gear modifications* – All recreational fishers and two commercial fishers suggested gear modifications to reduce sea turtle entanglement in large mesh gill nets. These modifications include a switch to low profile large mesh gill nets. These nets have been tested by NCDMF, and have demonstrated drastic reductions in sea turtle entanglements compared to traditional nets. Low profile nets should have a maximum net height of 15 meshes (half of a traditional net), and should be void of tie downs and non-essential floats, as these have been associated with increased sea turtle interaction rates. (Price B, Van Salisbury C. 2007; Gearhart J. 2002) A gear modification from traditional to low profile nets would require minimum financial investment by fishers, and would have little affect on the effectiveness of the gear for target species. (Price B, Van Salisbury C. 2007)

- *Increase penalties for lack of self reporting* – Although not one of the fishers interviewed recommended it, an increase in penalties for lack of self reporting sea turtle interactions would help to increase the strength of sea turtle/fishery interaction data, and would consequently increase the effectiveness of management decisions. Penalties should be substantial enough to overcome the negative incentive to self report. Although any violation of the ITP within the PSGNRA would be considered a violation of the Endangered Species Act, which could hold a violation cost of $25,000 per violation per day, this penalty has yet to be assigned to remedy violations. (16 USC § 1540) Revenues obtained through

state managed penalty payments should be used to further sea turtle protection measures in North Carolina waters.

- *Increase fisher education* – Interview results showed a large information gap pertaining to the status of sea turtles in North Carolina waters and what measures should be taken when a sea turtle is found entangled in a net. One participant stated that, "DMF would consider a recreational fisherman helping a lethargic turtle outside of a net in Pamlico Sound, if I take it out and I try to resuscitate it, they would consider it a take." This statement is incorrect because the law allows for individuals to assist entangled, injured, and lethargic sea turtles found in the water, and to report and transport them to the correct authorities. This lack of understanding of existing rules and regulations could easily be corrected with the implementation of an educational program. The educational program should include information on the following:

    - The importance of sea turtle protection measures, emphasizing the endangered and threatened status of each species.
    - That aiding an entangled, injured, or lethargic sea turtle is legally permitted.
    - Descriptions of sea turtle resuscitation methods
    - Where to bring lethargic, injured, or healthy sea turtles in the event of an interaction.
    - Who to call in the event of an interaction.

The Division of Marine Fisheries should be responsible for implementing a multi-faceted education plan. As a provision of the gill net permit, a short educational seminar could be provided via video followed by a brief question and answer period by a NCDMF staff member. Production of a video would be an efficient way to convey information, and would require minimal funding. These seminars would be only a minor inconvenience to both NCDMF staff members and the fishers themselves. In a supplement to this educational seminar, pamphlets and stickers should be provided to fishers upon obtaining their recreational or commercial fishing license. Stickers could be provided to fishers to be placed on their boats or simply kept nearby, and to be used as a quick reference guide to important phone numbers for reporting sea turtle interactions.

A combination of the above management recommendations should reduce sea turtle entanglements with gill nets, increase accurate data collection on fisheries and sea turtle interactions, and increase fisher awareness of sea turtle protection measures.

Acknowledgements

I would like to thank my client, the Karen Beasley Sea Turtle Rescue and Rehabilitation Center for all of its sea turtle conservation efforts. I would also like to recognize the Karen Beasley Center's legal counsel, with whom I have worked closely throughout this project. And finally, I would like to send a special thank you to my advisor, Steve Roady, and to my supervising attorney, Michelle Nowlin, both of whom have been invaluable to me throughout this past year.

References Cited

Duke Environmental Law and Policy Clinic. 2009. 60-Day Notice of Intent to Sue: Violations of the Endangered Species Act Related to the North Carolina Inshore Gillnet Fishery.

Endangered Species Act of 1973. 16 U.S.C. Section 1538(a)(1)(B) (2006).

Endangered Species Act of 1973. 16 U.S.C. Section 1540.

Epperly S, Braun J, Veishlow A. 1995. Sea Turtles in North Carolina Waters. Conservation Biology, Vol. 9, No. 2, pp. 384-394

Epperly S, Braun-McNeill J, Richards P. 2007. Trends in Catch Rates of Sea Turtles in North Carolina, USA. U.S. Department of Commerce. National Oceanic and Atmospheric Administration. National Marine Fisheries Service, Northeast Fisheries Science Center. Endangered Species Research, Vol. 3, pp. 283-293

Gearhart J. 2002. Sea Turtle Bycatch Monitoring of the 2001 Fall Gillnet Fisheries in Southeastern Pamlico Sound, NC; North Carolina Division of Marine Fisheries Completion Report for Incidental Take Permit 1348. North Carolina Department of Environment and Natural Resources, Division of Marine Fisheries. Morehead City, NC, USA.

Gilman E, et al. 2009. Mitigating Bycatch in Coastal Passive Net Fisheries. Fish and Fisheries. Vol. 11, No. 1, pp. 57-88

Hawkes L, Broderick A, Godfrey M, Godley B. 2005. Status of Nesting Loggerhead Turtles *Caretta caretta* at Bald Head Island (North Carolina, USA) After 24 Years of Intensive Monitoring and Conservation. Oryx Vol. 39, No. 1, pp. 65-72

Loggerhead Biological Review Team. 2009. Loggerhead Sea Turtle (*Caretta caretta*) 2009 Status Review Under the U.S. Endangered Species Act. National Oceanic and Atmospheric Administration. National Marine Fisheries Service.

Michigan Sea Grant. 2009. You're your Nets; View of a Gill Net. Avail from: http://www.miseagrant.umich.edu/nets/images/gillnetlg.gif

Murray K. 2009. Characteristics and Magnitude of Sea Turtle Bycatch in US Mid-Atlantic Gillnet Gear. U.S. Department of Commerce. National Oceanic and Atmospheric Administration. National Marine Fisheries Service, Northeast Fisheries Science Center. Endangered Species Research, Vol. 8, pp. 211-224

National Marine Fisheries Service. 2005. Permit to Incidentally Take Endangered/Threatened Species, Permit No. 1528. U.S. Department of Commerce. National Oceanic and Atmospheric Administration.

North Carolina Division of Marine Fisheries. 2009. Proclamation M-19-2009; Re: Commercial Large Mesh Gill Nets. North Carolina Department of Environment and Natural Resources, Division of Marine Fisheries. Morehead City, NC, USA. Avail from: http://www.ncfisheries.net/procs/procs2k9/M-19-2009.html

North Carolina Division of Marine Fisheries. 2009. Proclamation M-24-2009; Re: Commercial Gill Nets – Pamlico Sound Gill Net Restricted Area (PSGNRA). North Carolina Department of Environment and Natural Resources, Division of Marine Fisheries. Morehead City, NC, USA. Avail from: http://www.ncfisheries.net/procs/procs2k9/M-24-2009.html

O'Leary Z. 2008. Researching Real-World Problems; A guide to Methods of Inquiry. Los Angeles: Sage; 300p.

Pate P. 2005. Application for an Individual Incidental Take Permit under the Endangered Species Act of 1973 for Atlantic Sea Turtle Populations of Loggerhead (*Caretta caretta*), Green (*Chelonia mydas*), Kemp's ridley (*Lepidochelys kempii*), Leatherback (*Dermochelys coriacea*), and Hawksbill (*Eretmochelys imbricate*). North Carolina Department of Environment and Natural Resources, Division of Marine Fisheries. Morehead City, NC, USA.

Price B. 2008. Sea Turtle Bycatch Monitoring of the 2007 Fall Gillnet Fisheries in Southeastern Pamlico Sound, North Carolina: Completion Report for Activities under Endangered Species Act Section 10 Incidental Take Permit #1528. North Carolina Department of Environment and Natural Resources, Division of Marine Fisheries. Morehead City, NC, USA.

Price B. 2009. Sea Turtle Bycatch Monitoring of the 2008 Fall Gillnet Fisheries in Southeastern Pamlico Sound, North Carolina: Completion Report for Activities under Endangered Species Act Section 10 Incidental Take Permit #1528. North Carolina Department of Environment and Natural Resources, Division of Marine Fisheries. Morehead City, NC, USA.

Price B, Van Salisbury C. 2007. Low Profile Gillnet Testing in the Deep Water Region of Pamlico Sound, NC. North Carolina Department of Environment and Natural Resources, Division of Marine Fisheries. Morehead City, NC, USA.

Project Global – Global Bycatch Assessment of Long-Lived Species. 2009. Fishing Gear - Gillnets. Avail from: http://bycatch.env.duke.edu/gear/gillnets

QSR International. 2010. NVIVO 8; Features and Benefits. Avail from: http://www.qsrinternational.com/products_nvivo_features-and-benefits.aspx

Shoop R, Kenney R. 1992. Seasonal Distributions and Abundances of Loggerhead and Leatherback Sea Turtles in Waters of the Northeastern United States. Herpetological Monographs, Vol. 6, pp. 43-67

Snoody J, Landon M, Blanvillain G, Southwood A. 2009. Blood Biochemistry of Sea Turtles Captured in Gillnets in the Lower Cape Fear River, North Carolina, USA. Journal of Wildlife Management, Vol. 73, No. 8, pp. 1394-1401

The Karen Beasley Sea Turtle Rescue and Rehabilitation Center v. N.C. Division of Marine Fisheries, et al., (E.D.N.C. 7:10-CV-32-BO)

U.S. Fish and Wildlife Service. 2010. Species Profile. Avail from: http://ecos.fws.gov/tess_public/SpeciesReport.do

Wallace B, Heppell S, Lewison R, Kelez S, Crowder L. 2008. Impacts of Fisheries Bycatch on Loggerhead Turtles Worldwide Inferred From Reproductive Value Analyses. Journal of Applied Ecology, Vol. 45, pp.1076-1085

Witzell W.N. 1994. The Origin, Evolution, and Demise of the U.S. Sea Turtle Fisheries. U.S. Department of Commerce. National Oceanic and Atmospheric Administration. National Marine Fisheries Service. Marine Fisheries Review, pp. 8-23

Figure 1. Map of the Pamlico Sound Gill Net Restricted Area. (Pate P. 2005)

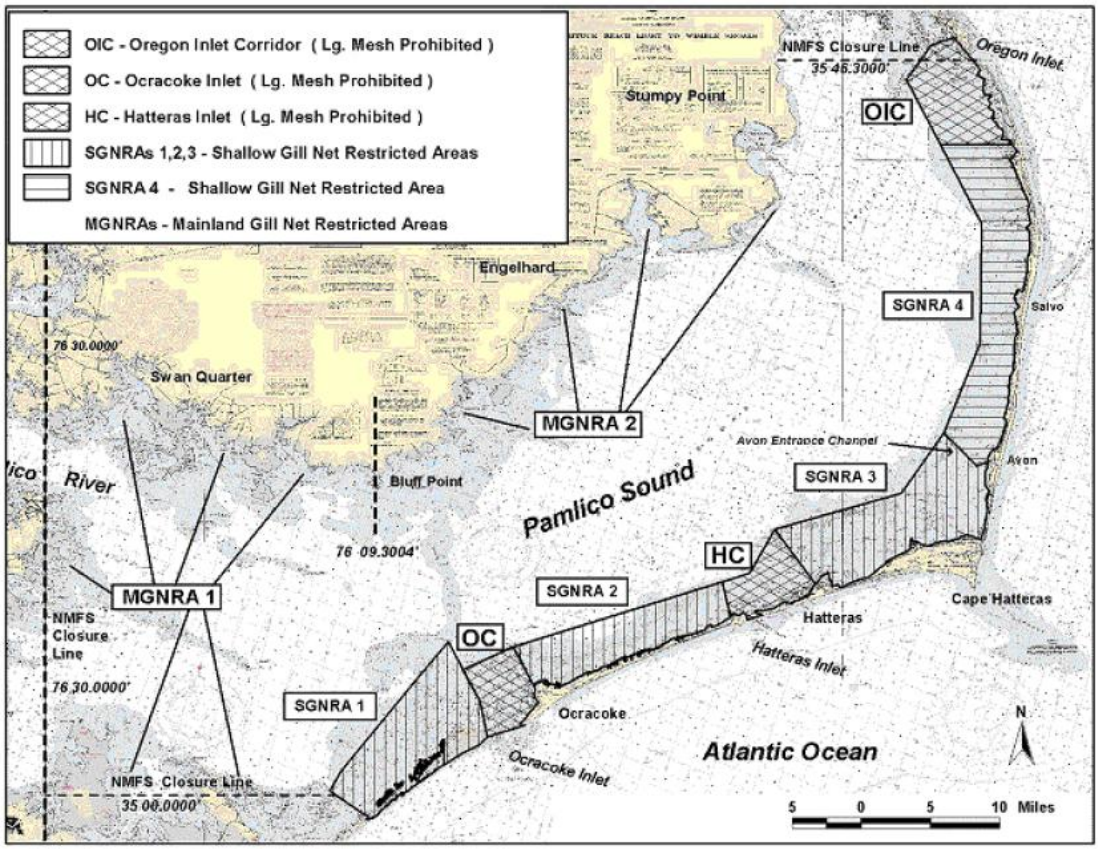

Figure 2. Picture of a Typical Gill Net. (Michigan Sea Grant. 2009)