



NCDMF Completion Report for Incidental Take Permit 1398

Sea Turtle Bycatch Monitoring of the 2003 Fall Gillnet Fisheries in Southeastern Pamlico Sound, North Carolina

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TABLE OF CONTENTS

TABLE OF CONTENTS.....	ii
LIST OF TABLES	iii
LIST OF FIGURES	v
BACKGROUND	7
METHODS	9
ITP Conservation Plan	12
<i>Logbook Reporting</i>	13
<i>Sea Sampling</i>	13
<i>Authorized Incidental Take Levels</i>	14
PROJECT LIMITATIONS.....	16
RESULTS	16
Permit Reporting	16
<i>Fishing Activity</i>	16
Sea Sampling	18
<i>Gear Parameters</i>	18
<i>Finfish and Sea Bird Bycatch</i>	20
<i>Sea Turtle Bycatch</i>	25
<i>Sea Turtle Bycatch Estimates</i>	26
<i>Core Sound Monitoring</i>	27
DISCUSSION.....	30
CONCLUSIONS AND RECOMMENDATIONS	32
LITERATURE CITED	33

LIST OF TABLES

Table 1. Sea turtle strandings by species from Sep. 15 to Dec. 15, 1999 in southeastern Pamlico Sound. Maximum authorized strandings, estimated lethal takes, and live takes for the same period and area during the 2000 fishing season.....	14
Table 2. Maximum authorized lethal and live takes by species from September 15 through December 15 for the PSGNRA during the 2001 fishing season.....	15
Table 3. Maximum authorized lethal takes and live takes by species from September 1 through December 15 for the PSGNRA during the 2003 fishing season.....	15
Table 4. Observed trips, effort and sea turtle interactions in the small mesh gillnet fishery throughout the PSGNRA for the 2003 fishing season.....	23
Table 5. Summary statistics for gear parameters observed in the large and small mesh set gillnet fisheries and small mesh runaround gillnet fishery during the 2003 season.	23
Table 6. Tabulation by species of relative biomass (kgs) and number of individuals sampled in the large mesh gillnet fishery in the PSGNRA from September 1 – December 15, 2003.	24
Table 7. Tabulation by species of relative biomass (kgs) and number of individuals sampled in the small mesh set gillnet fishery in the PSGNRA from September 1 – December 15, 2003.	25
Table 8. Observed large mesh gillnet sea turtle interactions by species, condition, and location observed in the PSGNRA during the 2003 fishing season.....	26
Table 9. Observed large mesh gillnet sea turtle interactions, fishing effort (yards x soak days), flounder landings (lbs), and sea turtle bycatch rates based on effort and landings by week and area in the PSGNRA during the 2003 fishing season.....	26
Table 10. Reported large mesh gillnet sea turtle interactions, fishing effort (yards x soak days), flounder landings (lbs), and sea turtle bycatch estimates based on effort and landings in the PSGNRA during the 2003 fishing season. Estimates calculated with rates from Table 9.....	27
Table 11. Allowable take thresholds and effort and landings estimates by lethal and live takes in the PSGNRA from September 1 – December 15, 2003.....	27
Table 12. Sea turtle take observed in the large mesh flounder gillnet fishery in Core Sound during the 2003 fishing season.	27

Table 13. Tabulation by species of relative biomass (kgs) and number of individuals sampled in Core Sound from September 1 – December 15, 2003.	29
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LIST OF FIGURES

Figure 1. Map of southeastern Pamlico Sound and the 2000 Pamlico Sound Gillnet Restricted Area (PSGNRA).....	8
Figure 2. North Carolina estuarine flounder gillnet fishing grounds in southeastern Pamlico Sound.	8
Figure 3. NCDMF 2001 Pamlico Sound Gillnet Restricted Area (PSGNRA) and NMFS closed area. S1=Shallow Water Gillnet Restricted Area 1; S2=Shallow Water Gillnet Restricted Area 2; S3=Shallow Water Gillnet Restricted Area 3; OC=Ocracoke Inlet Corridor; HC=Hatteras Inlet Corridor.	9
Figure 4. NCDMF 2002 Pamlico Sound Gillnet Restricted Area (PSGNRA) and NMFS closed area. SGNRA1=Shallow Water Gillnet Restricted Area 1; SGNRA2=Shallow Water Gillnet Restricted Area 2; SGNRA3=Shallow Water Gillnet Restricted Area 3; MGNRA1=Mainland Gillnet Restricted Area 1; MGNRA2=Mainland Gillnet Restricted Area 2; OIC=Oregon Inlet Corridor; OC=Ocracoke Inlet Corridor; HC=Hatteras Inlet Corridor.....	11
Figure 5. NCDMF 2003 Pamlico Sound Gillnet Restricted Area (PSGNRA) and NMFS closed area. SGNRA1=Shallow Water Gillnet Restricted Area 1; SGNRA2=Shallow Water Gillnet Restricted Area 2; SGNRA3=Shallow Water Gillnet Restricted Area 3; SGNRA 4=Shallow Water Gillnet Restricted Area 4; MGNRA1=Mainland Gillnet Restricted Area 1; MGNRA2=Mainland Gillnet Restricted Area 2; OIC=Oregon Inlet Corridor; OC=Ocracoke Inlet Corridor; HC=Hatteras Inlet Corridor.....	12
Figure 6. Number of valid and active PSGNRA permits by week for the 2003 season.	17
Figure 7. Number of PSGNRA large mesh gillnet trips and flounder landings by week for the 2003 fishing season.	17
Figure 8. Total amount of large mesh gillnet effort (yards*soak days), and total pounds of flounder landed by week in the Outer Banks PSGNRA restricted areas for 2003.	19
Figure 9. Total amount of large mesh gillnet effort (yards*soak days), and total pounds of flounder landed by week in the mainland PSGNRA restricted areas for 2003.	20

Figure 10. Large mesh trips, fishing effort (yards x soak days), and flounder landings (lbs) observed and reported by week for the 2002 fishing season.....	21
Figure 11. Mean CPUEs (lbs of flounder\1000 yards\day) and effort (yards x soak days) for logbook reports and observed large mesh gillnet trips by week for the 2002 fishing season.	22
Figure 13. Coefficients of variation (CVs) by week for two measures of large mesh fishing effort (lbs of flounder landed vs. yards of gillnet fished) observed during the 2002 fishing season.....	23
Figure 13. Observed large mesh gillnet sets and sea turtle interactions in the Pamlico Sound Gillnet Restricted Area from September 1 – December 15, 2003.	28
Figure 14. Observed small mesh gillnet sets and sea turtle interactions in the Pamlico Sound Gillnet Restricted Area from September 1 – December 15, 2003.	29
Figure 15. Observed gillnet sets and sea turtle interactions in Core Sound from September 1 – December 15, 2003.	29
Figure 16. Total and Kemp’s ridleys sea turtle strandings observed by the North Carolina Stranding Network from 1994 through 2003 throughout Pamlico Sound. Source: Matthew Godfrey, NCWRC.....	32

BACKGROUND

Since 2001, the commercial gillnet fisheries operating in Pamlico Sound, NC have had management measures imposed that restrict areas, seasons, and allowable sea turtle interactions. This area is now referred to as the Pamlico Sound Gillnet Restricted Area (PSGNRA) (Figure 1). The PSGNRA was established based upon increased sea turtle strandings sighted in 1999 in the southeastern portion of Pamlico Sound. Investigation of the fisheries operating in the area at that time, identified large (\geq 5-inch stretched mesh – flounder) and small ($<$ 5-inch stretched mesh - spotted seatrout *Cynoscion nebulosus*) mesh gillnet fisheries as a potential source of fishery interaction with sea turtles.

Observations of gillnet fisheries indicated a shallow water large mesh fishery along the Outer Banks, a deep water large mesh fishery further from shore, and a shallow water small mesh gillnet fishery operating throughout Pamlico Sound. The large mesh fisheries both targeted southern flounder (*Paralichthys lethostigma*) (Figure 2). The deep water fishery operated in depths ranging from 10 to 20 feet from September – December. The shallow water large mesh fishery operates in depths ranging from 6 to 11 feet in areas next to the barrier islands (Figure 2). The small mesh gillnet fisheries are composed of the runaround and set net fisheries and target species in these fisheries generally include spotted seatrout, weakfish (*Cynoscion regalis*), and bluefish (*Pomatomus saltatrix*), (Gearhart 2003).

Initial monitoring of these fisheries in 1999 identified the large mesh gillnet fishery as a source of sea turtle interactions in Pamlico Sound during the months of September through December. With this information, the National Marine Fisheries Service (NMFS) initially issued an emergency rule closing this area to large mesh gillnet fishing operations to protect endangered and threatened sea turtles (Gearhart 2003).

To maintain this economically vital flounder fishery, in 2000 NCDMF applied for and received an Incidental Take Permit (ITP) under Section 10 of the Endangered Species Act (ESA). The ITP contained a comprehensive conservation plan, which was designed to reduce sea turtle interactions by establishing restricted areas and intensive monitoring, while allowing fisheries to propagate. Observations in 2000 under the ITP identified the deep water region of Pamlico Sound as the primary source for sea turtle interactions. Considering this, NMFS established a permanent rule for the 2001 fishing season to close all potential fishing grounds utilized by the deep water large mesh gillnet fisheries (Gearhart 2003). In 2001, NCDMF again consulted with NMFS and prepared an application for and received an ITP under Section 10 of the ESA (Gearhart 2003). Restricted areas were established throughout the PSGNRA where fishermen could continue operations as stipulated in the ITP (Figure 3).

From 2001 to present, NCDMF has been able to successfully manage the large mesh gillnet fisheries in Pamlico Sound from September – December. Observed levels of sea turtle interactions in gillnet fisheries remained below thresholds as established by the ITP in 2001 and 2002 (Gearhart 2003, 2002).



Figure 1. Map of southeastern Pamlico Sound and the 2000 Pamlico Sound Gillnet Restricted Area (PSGNRA).

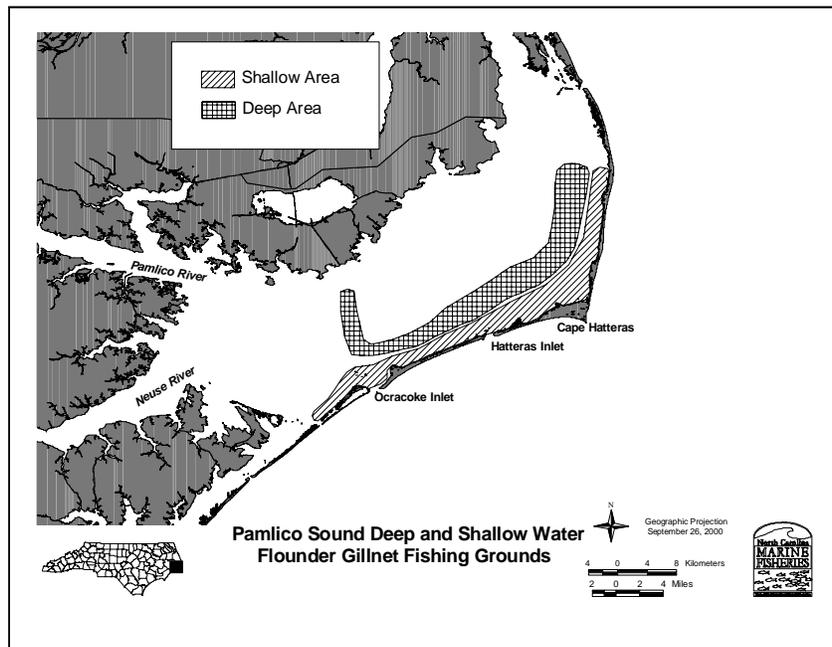


Figure 2. North Carolina estuarine flounder gillnet fishing grounds in southeastern Pamlico Sound.

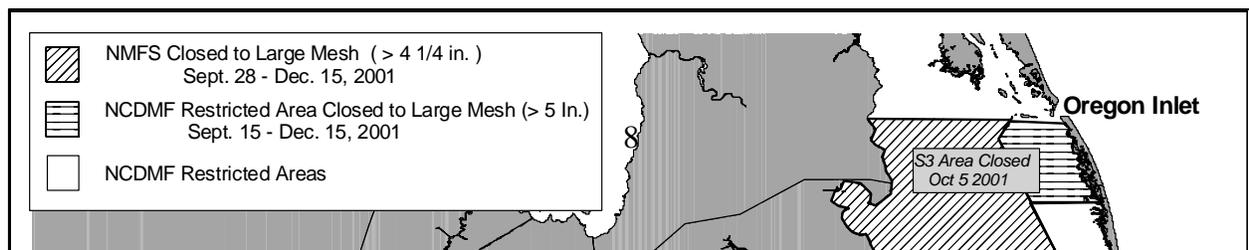


Figure 3. NCDMF 2001 Pamlico Sound Gillnet Restricted Area (PSGNRA) and NMFS closed area. S1=Shallow Water Gillnet Restricted Area 1; S2=Shallow Water Gillnet Restricted Area 2; S3=Shallow Water Gillnet Restricted Area 3; OC=Ocracoke Inlet Corridor; HC=Hatteras Inlet Corridor.

METHODS

During 2002, NMFS reviewed NCDMF monitoring data and chose to issue a final rule that would implement the Pamlico Sound large mesh (> 4 ¼ inch) gillnet closure each year from September 1 through December 15 (Figure 5, 67 FR 56,931, September 6, 2002). Corresponding to the development of the NMFS final rule, NCDMF again prepared an application for an ITP under Section 10 of the ESA (67 FR 49,009, July 29, 2002). After reviewing the 2000 and 2001 monitoring data, several changes were made to the 2002 application.

Changes to the 2002 application included the implementation of a three-year (2002 – 2004) ITP, designation of the PSGNRA from September 1 through December 15 each year, addition of Mainland Gillnet Restricted Areas (MGNRAs) to the PSGNRA, creation of the Oregon Inlet Corridor (OIC), and removal of small mesh gillnets from the PSGNRA permitting requirements (Figure 4), (Gearhart 2003). These measures allow NCDMF to establish a comprehensive conservation plan and a long term monitoring program.

On November 4, 2002, NMFS issued ITP #1398 to NCDMF (67 FR 67,150, November 4, 2002). A key component of the permit was a comprehensive conservation plan. The primary goal of this plan was to reduce sea turtle takes in Pamlico Sound from September 1 through December 15 for the 2002-2004 fishing seasons.

For the 2003 fishing season, there was only one change to the sampling protocols from the 2002 fishing season. Specifically, the designated restricted area SGNRA3 was divided into two regions: SGNRA3, and SGNRA4 (Figure 5). This was done to more accurately weight necessary observer coverage. The shallow water gillnet restricted area, SGNRA4 extends from the Avon Channel from Avon, NC north to the southern edge of the OIC. The designation of this restricted area did not create additional fishing grounds.

As with previous years of monitoring, the issued ITP entailed a comprehensive conservation plan. Stipulations of the conservation plan include: weekly logbook reporting, mandatory observer coverage, and immediate closure of the fishery should authorized sea turtle take levels be reached.

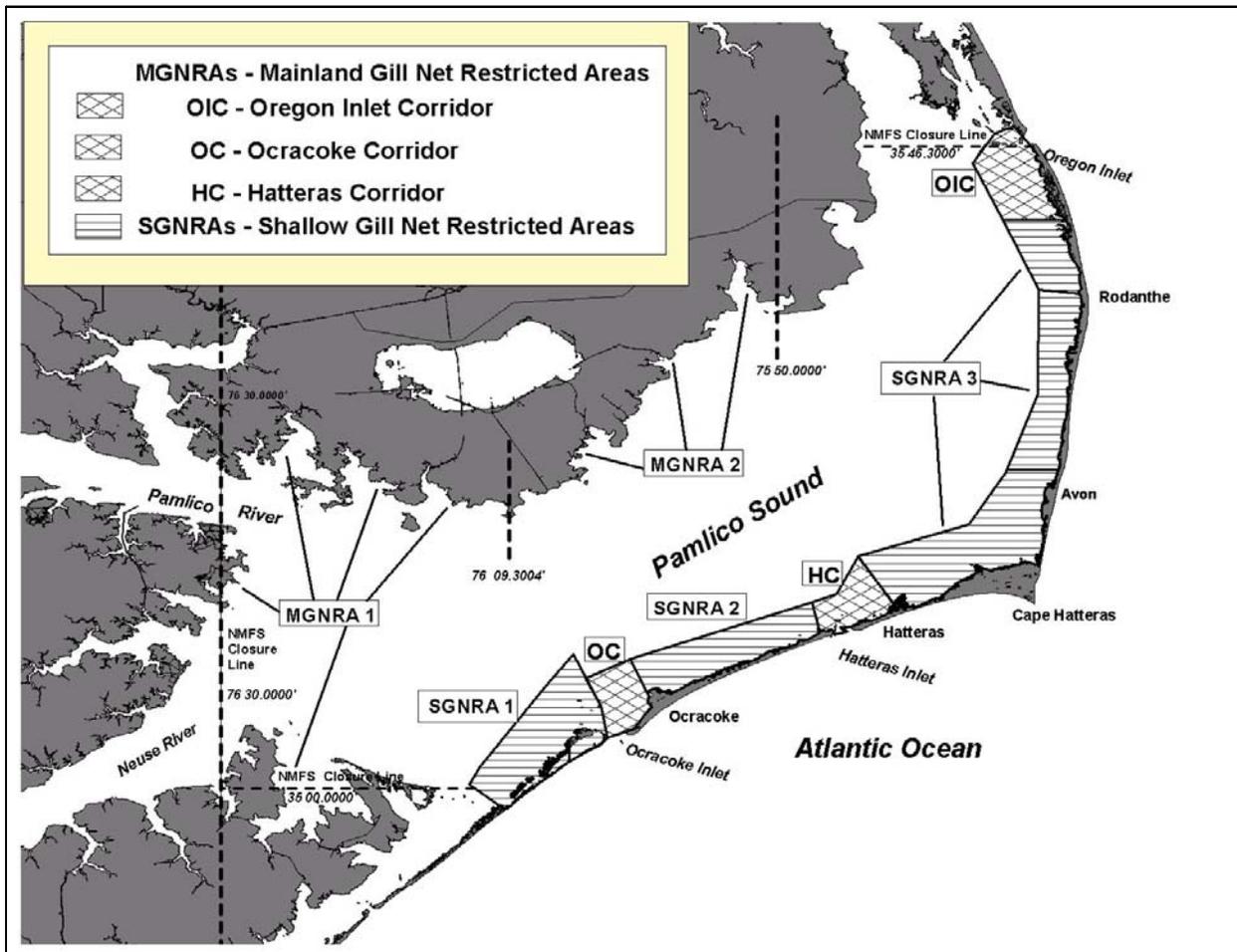


Figure 4. NCDMF 2002 Pamlico Sound Gillnet Restricted Area (PSGNRA) and NMFS closed area. SGNRA1=Shallow Water Gillnet Restricted Area 1; SGNRA2=Shallow Water Gillnet Restricted Area 2; SGNRA3=Shallow Water Gillnet Restricted Area 3; MGNRA1=Mainland Gillnet Restricted Area 1; MGNRA2=Mainland Gillnet Restricted Area 2; OIC=Oregon Inlet Corridor; OC=Ocracoke Inlet Corridor; HC=Hatteras Inlet Corridor.

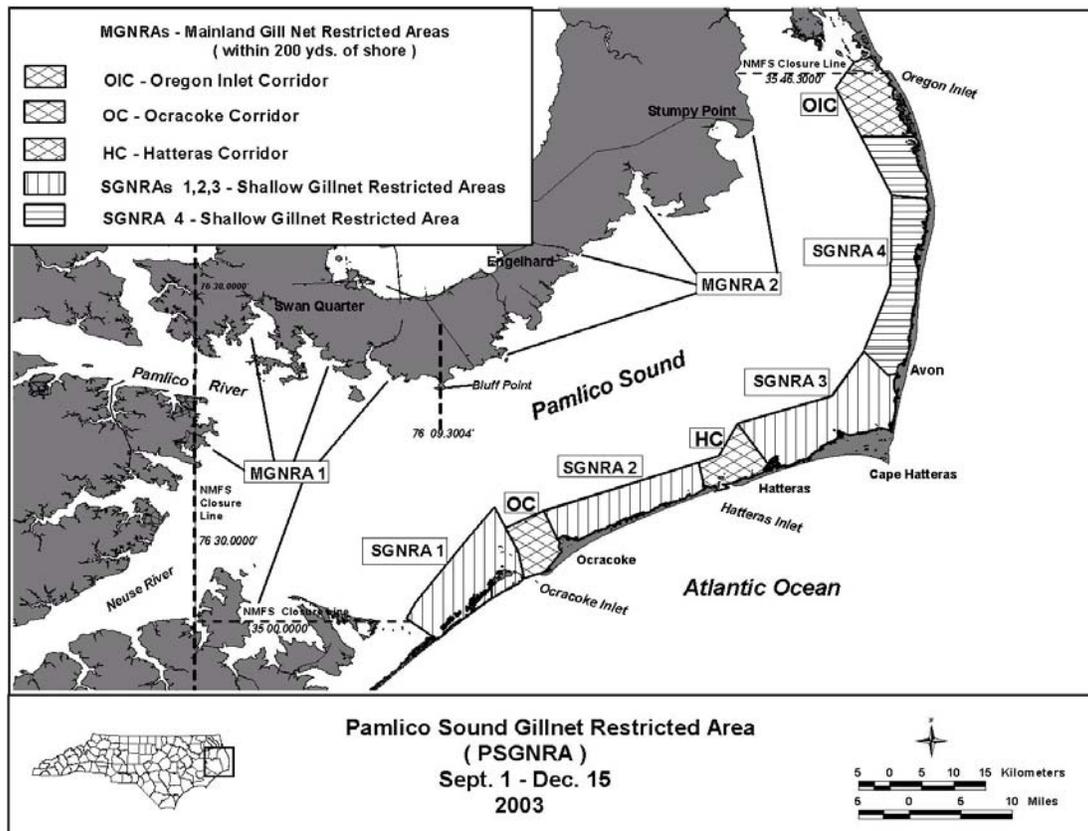


Figure 5. NCDMF 2003 Pamlico Sound Gillnet Restricted Area (PSGNRA) and NMFS closed area. SGNRA1=Shallow Water Gillnet Restricted Area 1; SGNRA2=Shallow Water Gillnet Restricted Area 2; SGNRA3=Shallow Water Gillnet Restricted Area 3; SGNRA 4=Shallow Water Gillnet Restricted Area 4; MGNRA1=Mainland Gillnet Restricted Area 1; MGNRA2=Mainland Gillnet Restricted Area 2; OIC=Oregon Inlet Corridor; OC=Ocracoke Inlet Corridor; HC=Hatteras Inlet Corridor.

ITP Conservation Plan

In August 2003, NCDMF issued proclamation M-10-2003, which established the PSGNRA including three inlet corridors. The Oregon Inlet (OIC), Ocracoke Inlet (OC) and Hatteras Inlet Corridors (HC) were established and large mesh gillnets were prohibited in these zones for the entire fishing season (Figures 4,5). The proclamation also set a 2,000 yard limit for all gillnet fishing operations and required attendance of small mesh gillnets until November 1. Sea turtle interaction reporting was required and all fishermen utilizing large mesh (\geq 5-inch mesh) gillnets were required to obtain a PSGNRA permit from NCDMF. Provisions of the permit established mandatory logbooks, weekly reports, and observer coverage.

Logbook Reporting

As with the 2002 fishing season, permitted fishermen were required to provide weekly reports to NCDMF. The following information was provided by each fisherman for each large mesh gillnet fishing trip conducted within the PSGNRA between September 1 and December 15, 2003.

- Port of landing
- Restricted area fished
- Flounder landings (lbs)
- Yards of gillnet fished
- Soak time in days
- Number of sea turtles caught
- Condition of sea turtles caught

Reports were submitted to NCDMF by 6:00 p.m. on Sunday during each week of the fishing season. Failure to comply with these reporting requirements or providing false information resulted in permit suspension. In addition, fishermen were required to report all sea turtle interactions to NCDMF within 24 hours. Penalties for non-reporting were:

- First offense non-reporting 10 day suspension
- Second offense non-reporting 30 day suspension
- Third offense non-reporting 6 month revocation

Penalties for late reporting were:

- First offense late reporting Courtesy call
- Second offense late reporting 10 day suspension
- Third offense late reporting 30 day suspension
- Fourth offense late reporting 6 month revocation

Sea Sampling

The PSGNRA permit established mandatory observer coverage for the large mesh gillnet fishery. Permit holders were required to allow NCDMF fishery observers aboard their vessels to monitor catches. Failure to comply with this permit provision resulted in permit suspension. A list of permit holders was utilized to randomly assign observers to vessels by area (Outer Banks or Mainland) and port. Outer Banks ports included Rodanthe, Avon, Buxton, Hatteras, Ocracoke, and Cedar Island. Mainland ports included Stumpy Point, Engelhard, Gull Rock, Swan Quarter, Rose Bay, Germantown, and Hobuken. Outer Banks observer coverage was proportionally allocated based on the 2001 PSGNRA trip distribution among ports. Mainland observer coverage was proportionally allocated based on the 2000 trip distribution of flounder gillnet trips among ports derived from trip tickets.

The goal of the observer program was to provide 10% coverage of both the large and small mesh gillnet fisheries from September 1 through December 15, 2003. Funding for the program was provided by NMFS. Each observer was 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 were recorded for each turtle observed. Dead sea turtles were brought to shore when feasible. All live, debilitated sea turtles were brought to shore for examination and treatment. Carcasses not brought in for post-mortem examinations were marked with external flipper tags or spray-painted before disposal overboard. Observers collected data on location, gear parameters, catch, and bycatch for each haul. The landed catch was sampled throughout each trip and total flounder weights were obtained. Data were coded on NCDMF data sheets, double keyed, visually proofed, and uploaded to NCDMF Biological Database for analysis. All observers were 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 was estimated using the stratified ratio method. The bycatch rate (sea turtles caught per unit of fishing effort), estimated from observer data, was multiplied by the total fishing effort reported by the fishermen for each fishery. Strata consisted of the restricted areas MGNRA1, MGNRA2, SGNRA1, SGNRA2, SGNRA3, SGNRA4, OIC, OC, and HC. Fishing effort was the product of yards and soak time (days). Total bycatch estimates were calculated weekly by adding estimates for each fishery within each restricted area.

Authorized Incidental Take Levels

During the 2000 fishing season, a multilevel management approach was devised to achieve the goal of 50% reduction of sea turtle strandings relative to the 1999 season. Maximum stranding levels were set by species and reflected 50% reductions for each, while maximum lethal take levels were calculated based on the assumption that one in four turtles captured at sea would strand. Maximum live takes were established assuming 50% discard mortality (Table 1).

Table 1. Sea turtle strandings by species from Sep. 15 to Dec. 15, 1999 in southeastern Pamlico Sound. Maximum authorized strandings, estimated lethal takes, and live takes for the same period and area during the 2000 fishing season.

Species	1999 Strandings	2000 Max. Authorized Strandings	2000 Max. Authorized Lethal Takes	2000 Max. Authorized Live Takes
Kemp's Ridley (<i>Lepidochelys kempii</i>)	46	24	96	192
Green (<i>Chelonia mydas</i>)	20	9	36	72
Loggerhead (<i>Caretta caretta</i>)	31	14	56	112
Species Aggregate	97	45	175	350

During the 2000 fishing season, the estimated lethal take level for green turtles was reached six weeks into the fishing season requiring NCDMF to close the PSGNRA to large mesh gillnets (Gearhart 2001). Strandings during this period were variable with many suspected cold

stun mortalities occurring. For this reason, strandings were not used as a measure of management success during the 2001 fishing season. Instead, a more conservative single level management approach was chosen, which utilized observer data and logbooks to estimate live and lethal takes in the PSGNRA. The 2001 allowable take levels were based on 2000 levels, but required many assumptions.

For 2001, new management measures had to be considered, which included: the elimination of the deep water flounder gillnet fishery; expansion of the shallow water area covered by the ITP; and addition of the small mesh gillnet fishery. It was assumed that these modifications would not change the amount of gear covered by the ITP, but the removal of the deep water fishery was expected to significantly reduce mortality. New take levels were set for the 2001 season based on these management changes and assumptions (Table 2). Maximum allowable take levels remained nearly constant, while allowable lethal takes were reduced significantly.

Table 2. Maximum authorized lethal and live takes by species from September 15 through December 15 for the PSGNRA during the 2001 fishing season.

Species	2001 Max. Authorized Lethal Takes	2001 Max. Authorized Live Takes
Kemp's Ridley	24	164
Green	24	164
Loggerhead	24	164
Species Aggregate	72	492

Live and lethal takes for all species remained below allowable levels during the 2001 fishing season, indicating that the management measures imposed were successful in reducing sea turtle takes, while allowing gillnet fisheries to operate (Gearhart 2002). Based on 2001 observations, authorized live and lethal take levels were established for each species for 2002 (Table 3). In addition to the take levels established for the three most common species encountered, two observed takes of both leatherback (*Dermochelys coriacea*) and hawksbill turtles (*Eretmochelys imbricata*) were also allowed under the 2002 ITP. The take levels established from these multi-year observations remained in place for the 2003 fishing season (Table 3). As with previous fishing seasons, if take levels were reached during the season, the incidental take authorization would end and require NCDMF to close the PSGNRA to all gillnets for the remainder of the season.

Table 3. Maximum authorized lethal takes and live takes by species from September 1 through December 15 for the PSGNRA during the 2003 fishing season.

Species	2002 Max. Authorized Lethal Takes	2002 Max. Authorized Live Takes
Kemp's Ridley	25	80
Green	50	160
Loggerhead	25	80
Species Aggregate	100	320

PROJECT LIMITATIONS

Hurricane Isabel struck the North Carolina coast on September 18, 2003 during the third week of sampling in the PSGNRA. Due to this adverse weather event, fishing effort, catches, and sampling days were somewhat reduced from week three (September 13 – September 19) through the remainder of the fishing season compared to previous years. This was due to many factors including lost gear, increased turbidity and debris throughout the water column, extensive cleanup, and lack of accessibility to normal fishing grounds. Isabel created two new channels north of Hatteras, NC, which rendered this area inaccessible to mainlanders, local fishermen and NCDMF observers. While fishing operations continued in this area (northern portion of SGNRA3), scientific observations were unavailable for this area until late November. These factors may have influenced the trends observed in the catch and effort data for the PSGNRA in the 2003 fishing season.

RESULTS

Gillnet fishery monitoring began September 1, 2003 and ended December 15, 2003. Monitoring consisted of assigning permits, collecting logbook reports, and deploying observers in the large and small mesh gillnet fisheries. All reporting and observer deployment and debriefing were done weekly to provide timely estimates of sea turtle bycatch.

Permit Reporting

Compared to the previous years, there was an increased compliance with reporting requirements during the 2003 PSGNRA fishing season. There were no notice of violations (NOVs) issued for non-reporting, and only three NOVs issued for late reporters during the 16-week season.

There were 160 PSGNRA permits issued during the 16-week season with an average of 32 participants reporting fishing activity weekly (Figure 6). The number of active fishermen peaked in late September – early October and steadily declined throughout the remainder of the season.

Fishing Activity

As with previous years, inactive permits outnumbered active permits throughout the season (Figure 6). This is due to fishermen fearing a limited entry management approach and obtaining a permit, but never fishing within the PSGNRA.

Flounder fishing effort and flounder landings peaked during late September – early October with over 70 permitted fishermen conducting over 280 trips in the PSGNRA (Figures 6 and 7). During the second and third weeks of October, fishing effort remained relatively high, but flounder landings dropped significantly and remained low for the remainder of the season (Figure 7).

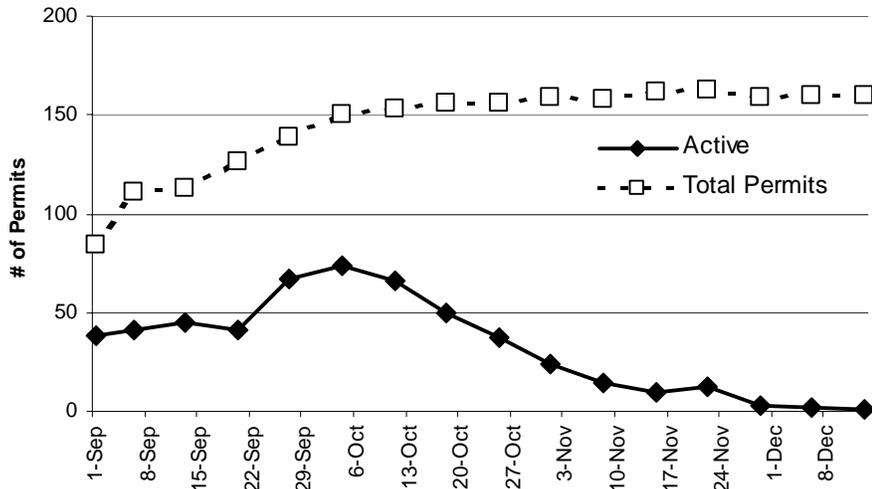


Figure 6. Number of valid and active PSGNRA permits by week for the 2003 season.

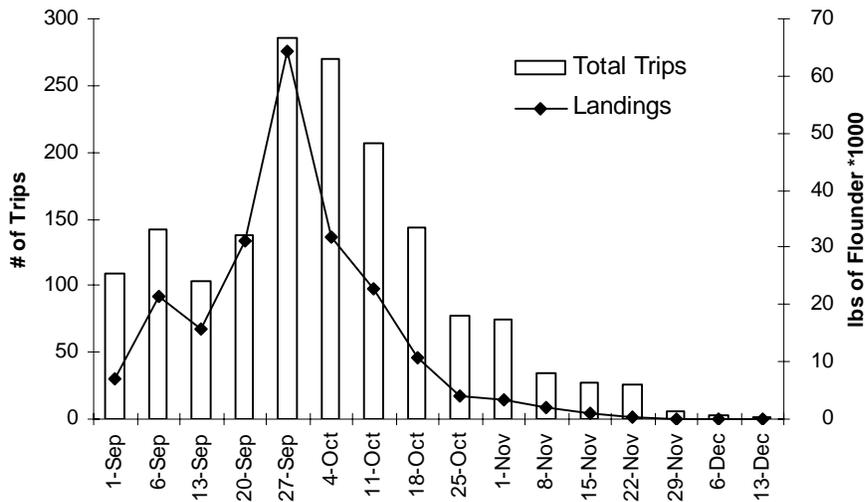


Figure 7. Number of PSGNRA large mesh gillnet trips and flounder landings by week for the 2003 fishing season.

The majority of fishing effort (47%) and landings (46%) occurred in SGNRA3 (Figure 8). There were 171,050 yards (yards x soak days), and 32,289 lbs of flounder reported from this area during the fifth sampling week. Restricted area SGNRA4 had relatively high effort and landings representing 30% of the total. Effort and landings in SGNRA2 represented 15% and 19% of the total, respectively (Figure 8). There was minimal effort and landings derived from SGNRA1 throughout the 2003 fishing season.

Similar trends exist for restricted areas SGNRA2, SGNRA3, and SGNRA4, where effort and landings peaked between late September – early October (Figure 8). For SGNRA1, effort and landings peaked during the second week of the season, and remained decreased throughout the remainder (Figure 8). There were steady declines in effort and landings in all areas from early October through December resulting in very minimal activity by December 1, 2003 (Figure 8).

On the mainland side of Pamlico Sound, total effort and catches were significantly less than along the Outer Banks (Figure 9). Collectively, areas MGNRA1 and MGNRA2 accounted for 6% of the total effort throughout the PSGNRA for 2003. Likewise, only 4% of the total pounds of flounder landed were obtained in these areas. There was significantly higher catches and effort in area MGNRA1 throughout the month of September. Following this timeframe, both areas exhibited similar trends of precipitously declining effort and catches (Figure 9).

Sea Sampling

There were a total of 125 observer trips in the PSGNRA during the 2003 fishing season, including 105 large mesh trips. Fishermen reported 1,646 large mesh gillnet trips in the PSGNRA applying 1,828,211 yards/soak day of fishing effort resulting in 215,715 pounds of flounder landed.

Observers were present on 105 large mesh fishing trips achieving 6.4 % coverage (Figure 10). Coverage of fishing effort was similar with observers sampling over 129,630 yards/soak day resulting in 6.2 % coverage (Figure 10). Observers covered 9,736 lbs of the total flounder landed representing 4.5 % coverage. Coverage of the fishery appeared to be adequate with observed effort and CPUEs tracking closely with those reported by fishermen (Figure 11). These results also indicate that fishermen logbook reports were reliable with observed effort and CPUEs verifying the reports.

Yards of gillnet fished was a less variable measure of fishing effort when compared to total flounder landings (Figure 12). Weekly coefficients of variation (CVs) for yards of gillnet fished remained below 50% for most weeks and averaged 33% while landings CVs exceeded 50% for 15 of the 16 weeks averaging greater than 60% (Figure 12).

There were 20 trips and a total of 13,858 yards of small mesh gillnet observed during the 2003 PSGNRA fishing season (Table 4). There were very few flounder observed in these nets, and there were no turtle interactions. Small mesh gillnet fishermen were not required to obtain a PSGNRA permit, and therefore not required to submit weekly logbook reports.

Gear Parameters

Mesh sizes observed in the large mesh fishery ranged from 5 to 6.73 inch stretched mesh with most fishermen using approximately 6 inch (Table 5). Small mesh set nets ranged from 3.0

to 4.75 inch and averaged 3.94 inch (Table 5). Twine sizes for both fisheries averaged approximately 0.50 mm. The mean water depth of net deployments was 0.95 m for the large mesh gillnet fishery, and 1.54 m for the small mesh set gillnet fishery (Table 5). Soak times from 12 hr to 48 hr throughout the 2003 fishing season with an average of 21.33 hr sets in the large mesh, and 22.25 hr in the small mesh set gillnet fishery. Yards per trip ranged from 100 yards to 2000 yards with a mean of 1,034 yards in the large mesh gillnet fishery, and a mean of 768 yards in the small mesh set gillnet fishery.

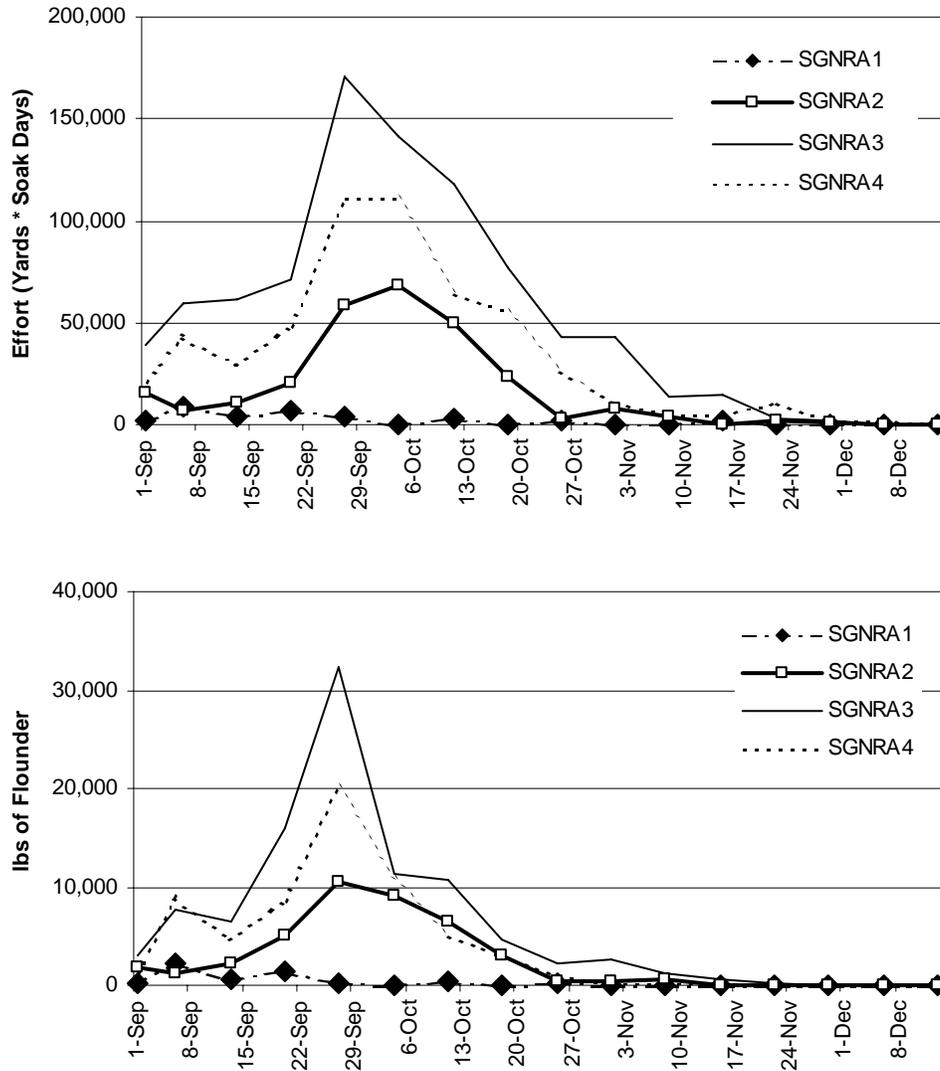


Figure 8. Total amount of large mesh gillnet effort (yards*soak days), and total pounds of flounder landed by week in the Outer Banks PSGNRA restricted areas for 2003.

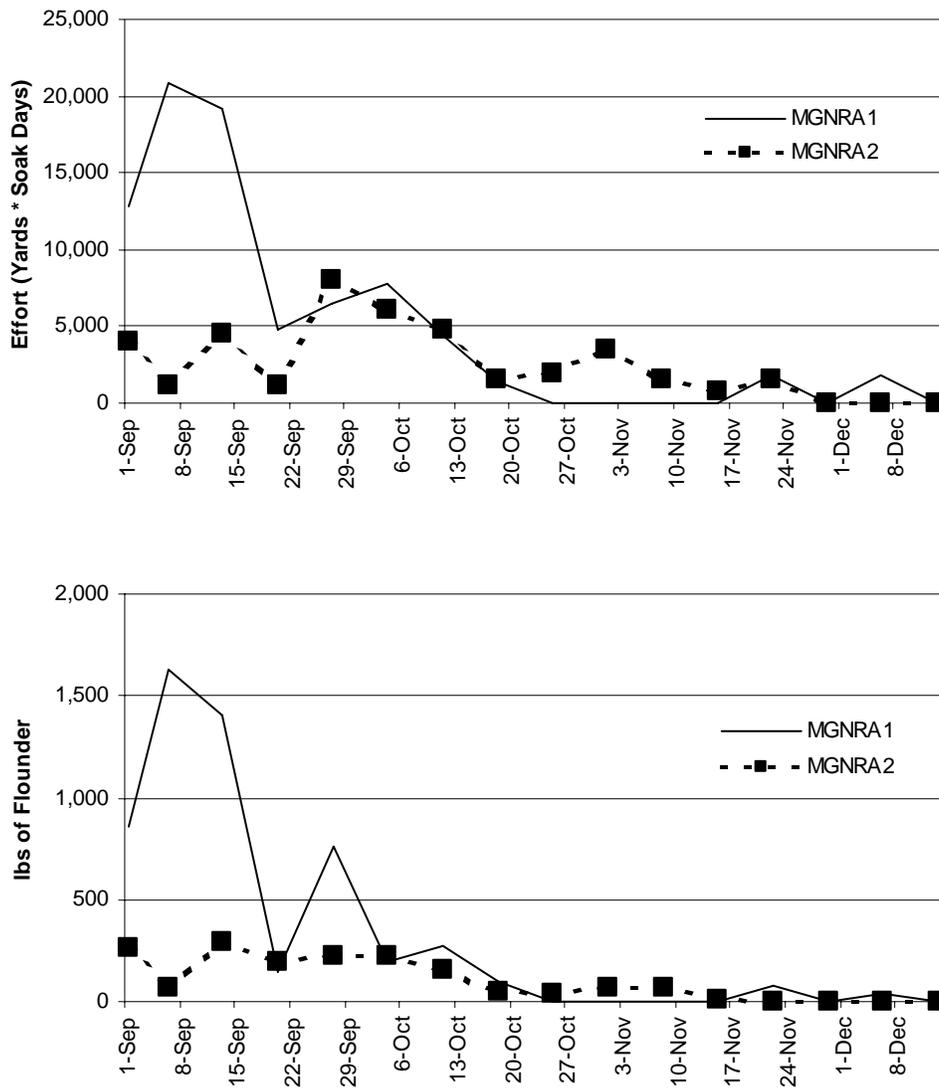


Figure 9. Total amount of large mesh gillnet effort (yards*soak days), and total pounds of flounder landed by week in the mainland PSGNRA restricted areas for 2003.

Finfish and Sea Bird Bycatch

In the large mesh fishery, catches were dominated by Paralichthid flounders, which represented 73% of the catch by weight, and 64% of the catch by number (Table 6). The next five most common species observed in large mesh gillnets were red drum, Atlantic menhaden, black drum, bluefish, and sheepshead (Table 6). Red drum were ranked second, but only 105 individuals (7% of total) were observed. There were only two striped bass, and one Atlantic sturgeon observed large mesh gillnet observations in 2003 (Table 6). Sea bird bycatch observed in the large mesh fishery included 22 double-crested cormorants, and 1 common loon (Table 6).

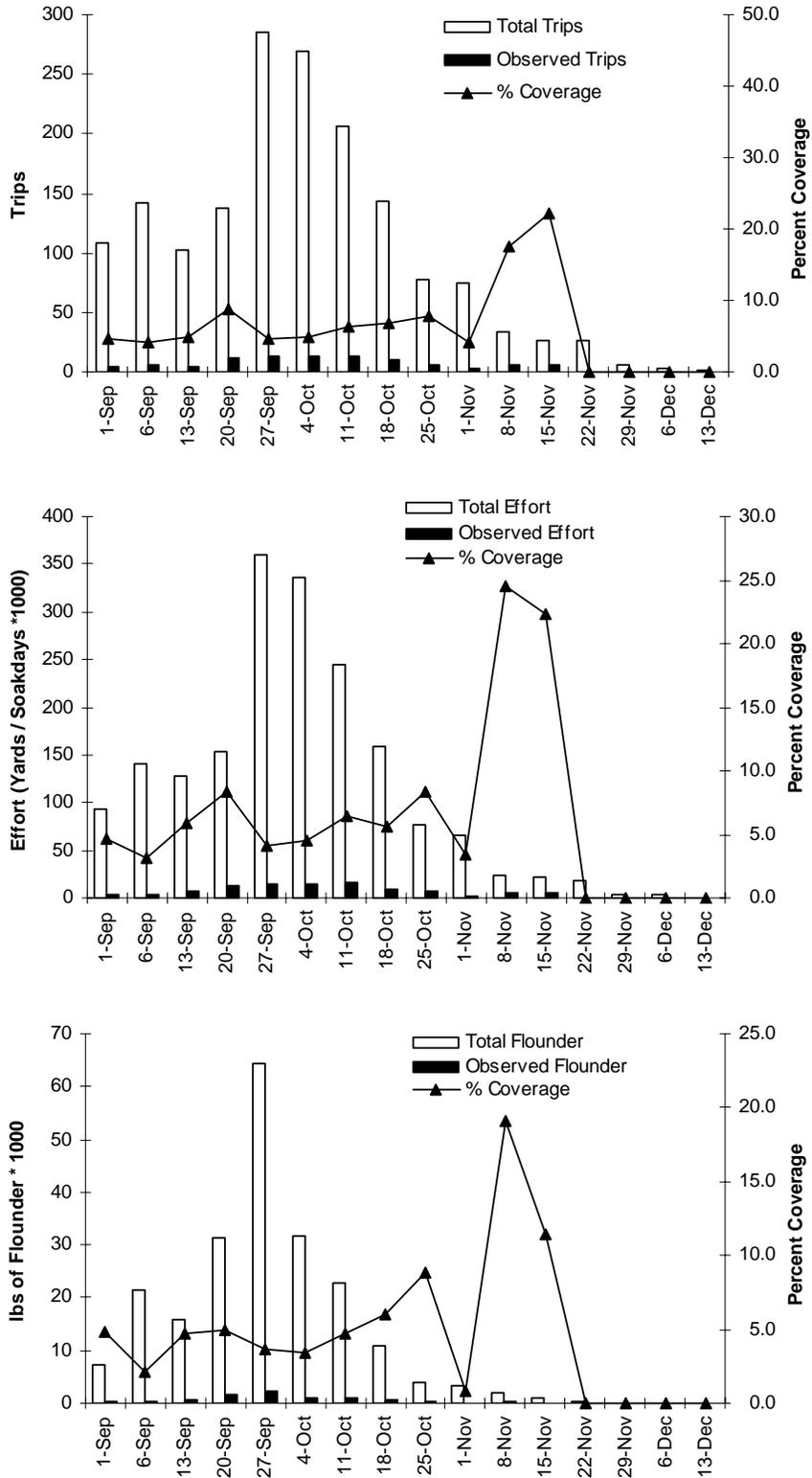


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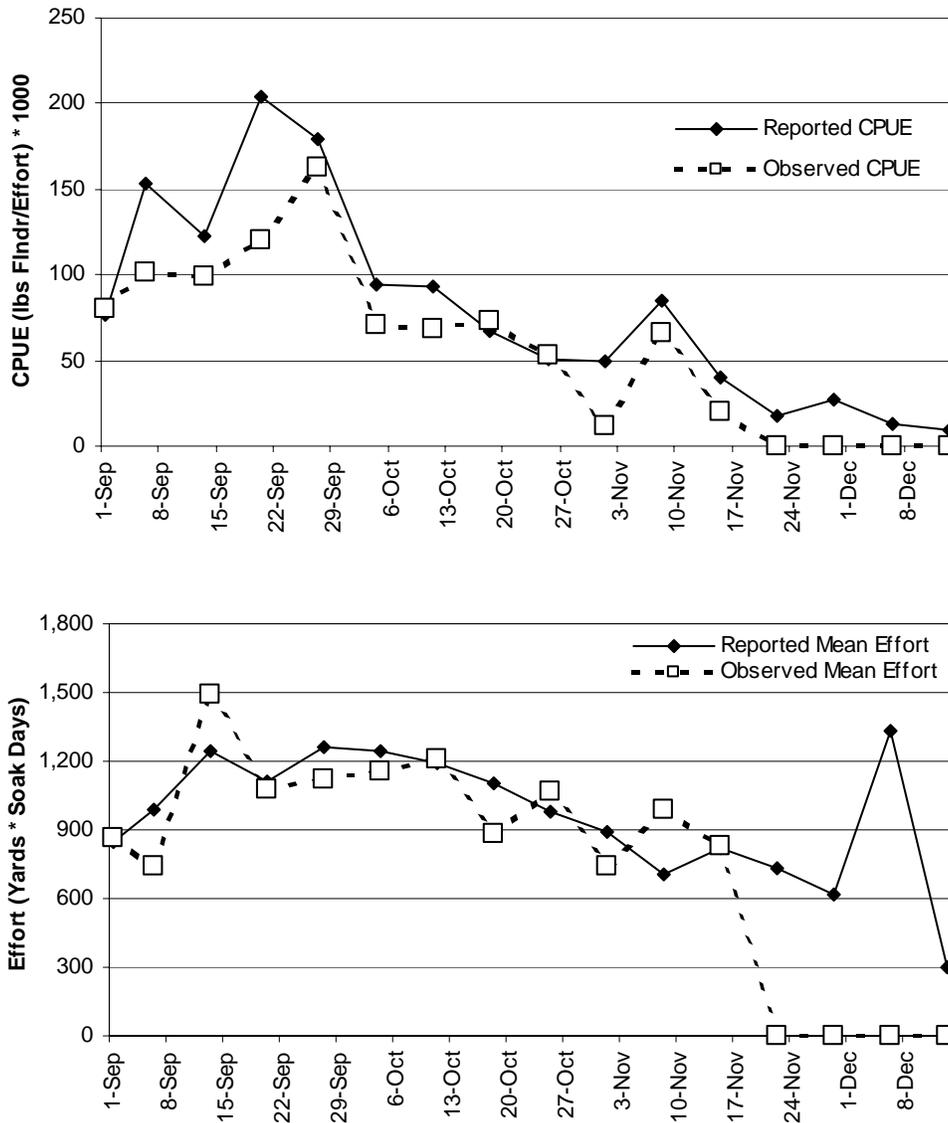


Figure 11. Mean CPUEs (lbs of flounder\1000 yards\day) and effort (yards x soak days) for logbook reports and observed large mesh gillnet trips by week for the 2002 fishing season.

In the small mesh gillnet fishery, Atlantic menhaden were the most common species encountered representing 59% of the total catch by weight, and 81% of the total catch by number (Table 7). Spotted seatrout, striped mullet, small flounder, spot, and weakfish were the next most common species caught in small mesh set gillnets throughout Pamlico Sound during the 2003 fishing season. There were two striped bass, and 17 spiny dogfish observed. There was one double-crested cormorant observed in small mesh set gillnets during the 2003 fishing season (Table 7).

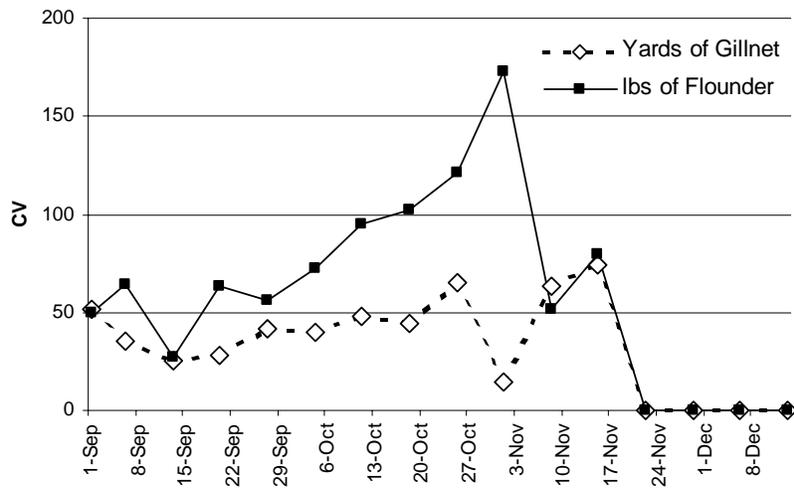


Figure 2. Coefficients of variation (CVs) by week for two measures of large mesh fishing effort (lbs of flounder landed vs. yards of gillnet fished) observed during the 2002 fishing season.

Table 4. Observed trips, effort and sea turtle interactions in the small mesh gillnet fishery throughout the PSGNRA for the 2003 fishing season.

WeekEnding	Observed Trips	Observed Effort	Sea Turtle Interactions
1-Nov	6	2,800	0
8-Nov	0	0	0
15-Nov	6	2,525	0
22-Nov	1	1,000	0
29-Nov	3	2,300	0
6-Dec	3	3,260	0
13-Dec	1	1,700	0
Totals	20	13,585	0

Table 5. Summary statistics for gear parameters observed in the large and small mesh set gillnet fisheries and small mesh runaround gillnet fishery during the 2003 season.

Mesh Size	Net Type	Gear Parameter	N	Min	Mean	Max
Large Mesh	Set Net	Mesh Size (in)	139	5.00	5.94	6.73
		Twine Size (mm)	139	0.45	0.50	0.62
		Net Set Depth (m)	139	0.20	0.95	2.70
		Soak Time (hr)	139	12.00	21.33	48.00
		Yards/Trip	94	100	1,034	2,000
Small Mesh	Set Net	Mesh Size (in)	41	3.00	3.94	4.75
		Twine Size (mm)	41	0.40	0.49	0.57
		Net Set Depth (m)	41	0.50	1.54	2.50
		Soak Time (hr)	41	15.00	22.25	24.00
		Yards/Trip	19	100	768	1,700

Table 6. Tabulation by species of relative biomass (kgs) and number of individuals sampled in the large mesh gillnet fishery in the PSGNRA from September 1 – December 15, 2003.

Scientific Name	Common Name	% Biomass	% Number	Total Number	Total Weight
Paralichthys spp.	Paralichthid flounders	73.00	63.99	3,165	2,868.20
Sciaenops ocellatus	red drum	7.44	2.12	105	292.42
Brevoortia tyrannus	Atlantic menhaden	5.22	15.63	773	205.02
Pogonias cromis	black drum	4.13	2.00	99	162.12
Pomatomus saltatrix	bluefish	3.74	3.48	172	147.10
Archosargus probatocephalus	sheepshead	2.10	1.44	71	82.58
Mugil cephalus	striped mullet	0.70	0.28	14	27.60
Cynoscion nebulosus	spotted seatrout	0.70	0.32	16	27.47
Limulus polyphemus	horseshoe crab	0.65	0.24	12	25.50
Callinectes sapidus	blue crab	0.64	3.13	155	25.24
Cynoscion regalis	weakfish	0.64	1.11	55	25.15
Leiostomus xanthurus	spot	0.44	1.29	64	17.32
Micropogonias undulatus	Atlantic croaker	0.14	0.28	14	5.60
Lagodon rhomboides	pinfish	0.10	0.55	27	4.02
Chaetodipterus faber	Atlantic spadefish	0.10	0.24	12	3.90
Orthopristis chrysoptera	pigfish	0.07	0.20	10	2.80
Menticirrhus spp.	kingfishes	0.06	0.18	9	2.55
Scomberomorus maculatus	Spanish mackerel	0.05	0.02	1	2.00
Sela. Lamni. Scyliorhinoidei	cat sharks	0.04	0.02	1	1.70
Paralichthys oblongus	fourspot flounder	0.02	0.06	3	0.70
Prionotus spp.	Prionotus searobins	0.01	0.02	1	0.30
Rajiformes	rays	.	0.99	49	.
Dasyatidae	stingrays	.	0.87	43	.
Dasyatis americana	southern stingray	.	0.18	9	.
Dasyatis sabina	Atlantic stingray	.	0.02	1	.
Rhinoptera bonasus	cownose ray	.	0.14	7	.
Acipenser oxyrhynchus	Atlantic sturgeon	.	0.02	1	.
Cyprinus carpio	common carp	.	0.24	12	.
Opsanus tau	oyster toadfish	.	0.02	1	.
Morone saxatilis	striped bass	.	0.04	2	.
Trachinotus carolinus	Florida pompano	.	0.02	1	.
Menticirrhus saxatilis	northern kingfish	.	0.02	1	.
Astroscopus spp.	Astroscopus stargazers	.	0.04	2	.
Scophthalmus aquosus	windowpane	.	0.02	1	.
Malaclemys terrapin	diamondback turtle	.	0.16	8	.
Chelonia Mydas	green Turtle	.	0.08	5	.
Gavia Immer	common loon	.	0.02	1	.
Phalacrocorax Auritus	double-crested cormorant	.	0.44	22	.
Lutra Canadensis	river otter	.	0.02	1	.

Table 7. Tabulation by species of relative biomass (kgs) and number of individuals sampled in the small mesh set gillnet fishery in the PSGNRA from September 1 – December 15, 2003.

Scientific Name	Common Name	% Biomass	% Number	Total Number	Total Weight
Brevoortia tyrannus	Atlantic menhaden	58.51	80.92	1,323	273.23
Cynoscion nebulosus	spotted seatrout	19.76	4.95	81	92.29
Mugil cephalus	striped mullet	6.43	3.49	57	30.03
Paralichthys spp.	Paralichthid flounders	5.26	2.39	39	24.56
Leiostomus xanthurus	spot	3.04	2.39	39	14.20
Cynoscion regalis	weakfish	2.46	0.98	16	11.50
Pomatomus saltatrix	bluefish	1.61	0.73	12	7.53
Sciaenops ocellatus	red drum	1.03	0.12	2	4.80
Menticirrhus spp.	kingfishes	0.56	0.43	7	2.60
Lagodon rhomboides	pinfish	0.49	0.43	7	2.30
Alosa sapidissima	American shad	0.41	0.12	2	1.90
Pogonias cromis	black drum	0.37	0.49	8	1.71
Orthopristis chrysoptera	pigfish	0.06	0.06	1	0.30
Callinectes sapidus	blue crab		0.80	13	
Squalus acanthias	spiny dogfish		1.04	17	
Dasyatis americana	southern stingray		0.12	2	
Morone americana	white perch		0.31	5	
Morone saxatilis	striped bass		0.12	2	
Archosargus probatocephalus	sheepshead		0.06	1	
Phalacrocorax Auritus	double-crested cormorant		0.06	1	

Sea Turtle Bycatch

Four sea turtles were observed in the large mesh gillnet fishery in the PSGNRA during the 2003 fishing season (Table 8). All four were green turtles. There was one observed dead in area SGNRA2 during the fifth week (September 27 – October 3), one observed live in area SGNRA3 during the ninth week (October 25 – October 31), and two (one live and one dead) observed in the eleventh week (November 8 – November 14) of the PSGNRA 2003 fishing season (Table 8, Figure 15). Two of the three turtles in SGNRA3 were observed on the edge of the restricted area where water depth begins to increase, while the other one was observed just adjacent to Hatteras Inlet. The turtle in SGNRA2 was observed nearshore approximately in the middle of Ocracoke Island. All four turtles were small with carapace lengths ranging from 245 mm to 368 mm. The two live turtles were too small to apply inconel tags, but were both pit tagged and released outside of the area in good condition (Table 8). No turtles were observed on the mainland side of the PSGNRA during 2003. No turtles were observed in small mesh gillnets throughout the 2003 PSGNRA fishing season (Figure 16).

Sea Turtle Bycatch Estimates

Sea turtle bycatch was estimated using the stratified ratio method where the bycatch rate was calculated from the number of sea turtles observed per unit of fishing effort. Fishing effort was measured by either effort (yards x soak days) or pounds of target species landed. The bycatch rate was then multiplied by the total fishing effort (effort or pounds landed) reported by the fishermen for each fishery. The strata were spatially defined by restricted areas SGNRA1, SGNRA2, SGNRA3, SGNRA4, MGNRA1, and MGNRA2. Due to the variability associated with landings, NMFS and NCDMF agreed on using gear effort as the primary measure of effort for bycatch estimates. Total bycatch estimates were calculated weekly by adding estimates for each fishery and restricted area. Bycatch rates were calculated for comparison with both observed effort and landings by area and species (Tables 9 and 10). Total lethal and live take estimates were calculated by adding weekly take estimates by species and area. Total take estimates are 19 live green turtles, and 15 dead green turtles (Table 10). Landings based estimates yielded somewhat higher live takes estimates, but nearly identical lethal take estimates (Table 10).

Table 8. Observed large mesh gillnet sea turtle interactions by species, condition, and location observed in the PSGNRA during the 2003 fishing season.

Date	Species	Condition	Carapace Length	Restricted Area	Location	Inconel Tag 1	Inconel Tag 2	Pit Tag
2-Oct-03	Green	Dead	368 mm	S2	N 35 09.339 W 75 53.890	NA	NA	NA
25-Oct-03	Green	Alive	270 mm	S3	N 35 20.277 W 75 35.402	NA	NA	432F776008
8-Nov-03	Green	Dead	245 mm	S3	N 35 22 376 W 75 33.338	NA	NA	NA
12-Nov-03	Green	Alive	310 mm	S3	N 35 14 225 W 75 41.465	NA	NA	4337296F5E

Table 9. Observed large mesh gillnet sea turtle interactions, fishing effort (yards x soak days), flounder landings (lbs), and sea turtle bycatch rates based on effort and landings by week and area in the PSGNRA during the 2003 fishing season.

Week	Area	Observed Turtles	Species	Observed Effort (yards *soak days)	Observed Flounder lbs.	Effort Bycatch Rate	Landings Bycatch Rate
5	S2	1	Green *	4,525	868	0.221	0.115
9	S3	1	Green	2,510	83	0.398	1.205
11	S3	1	Green *	5,920	391	0.169	0.256
11	S3	1	Green	5,920	391	0.169	0.256

* sea turtle observed dead

Table 10. Reported large mesh gillnet sea turtle interactions, fishing effort (yards x soak days), flounder landings (lbs), and sea turtle bycatch estimates based on effort and landings in the PSGNRA during the 2003 fishing season. Estimates calculated with rates from Table 9.

Week	Area	Observed Turtles	Species	Reported Effort (yards *soak days)	Reported Flounder lbs.	Effort Bycatch Estimate	Landings Bycatch Estimate
5	S2	1	Green *	58,300	10,518	12.9	12.1
9	S3	1	Green	42,850	2,222	17.1	26.8
11	S3	1	Green *	13,400	1,281	2.3	3.3
11	S3	1	Green	13,400	1,281	2.3	3.3

* sea turtle observed dead

Table 11. Allowable take thresholds and effort and landings estimates by lethal and live takes in the PSGNRA from September 1 – December 15, 2003.

Species	Allowable Threshold Live Takes	Effort Estimated Live Takes	Landings Estimated Live Takes	Allowable Threshold Lethal Takes	Effort Estimated Lethal Takes	Landings Estimated Lethal Takes
Green	160	19	29	50	15	15

Core Sound Monitoring

There were 13, 750 yards of gillnet observed in Core Sound through the twelfth week of the 2003 PSGNRA fishing season. Observers sampled approximately 600 lbs of flounder. The predominant species observed in small mesh gillnets were flounder representing 69% of the total number of fish observed. There was one observed dead green turtle observed in the Core Sound large mesh gillnet fishery during the first week of sampling during the 2003 fishing season (Table 12). Other common species observed in Core Sound included Atlantic menhaden, weakfish, bluefish, spot and croaker (Table 13). There were 2 double-crested cormorants observed during Core Sound sampling.

Table 12. Sea turtle take observed in the large mesh flounder gillnet fishery in Core Sound during the 2003 fishing season.

Date	Species	Condition	Carapace Length	Location	Inconel Tag	Pit Tag
9/4/2003	Green	Dead	330	N 34 44.563 W 76 27.799	NA	NA

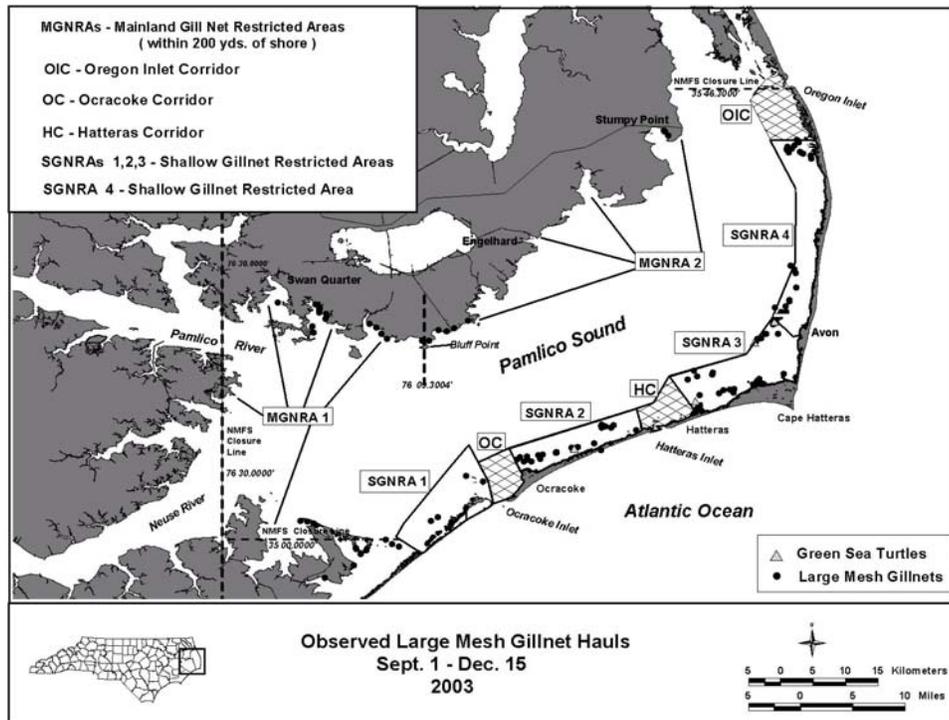


Figure 13. Observed large mesh gillnet sets and sea turtle interactions in the Pamlico Sound Gillnet Restricted Area from September 1 – December 15, 2003.

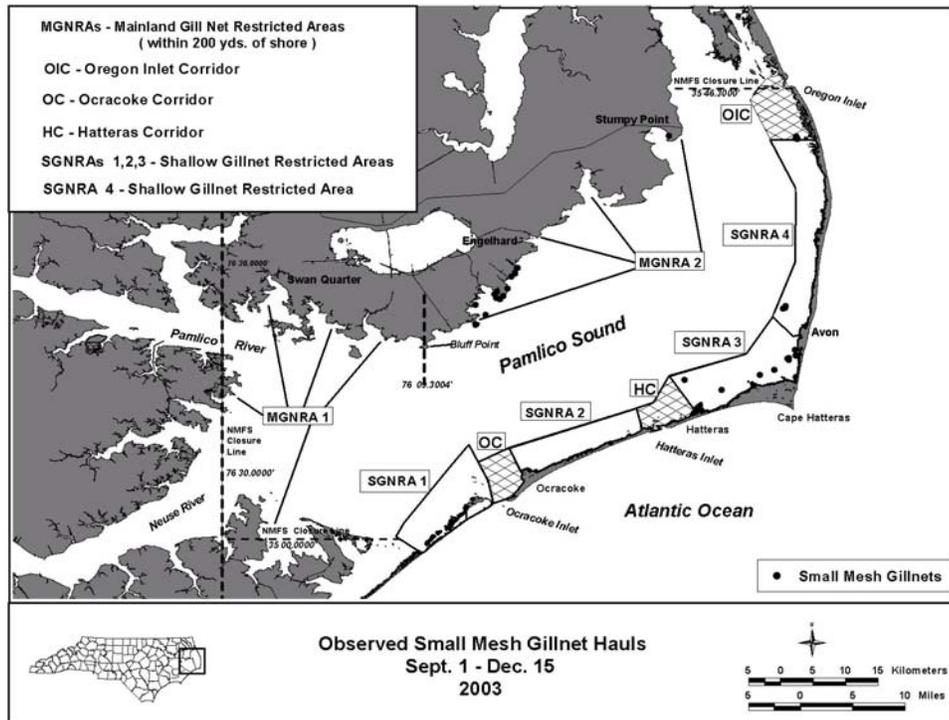


Figure 14. Observed small mesh gillnet sets and sea turtle interactions in the Pamlico Sound Gillnet Restricted Area from September 1 – December 15, 2003.

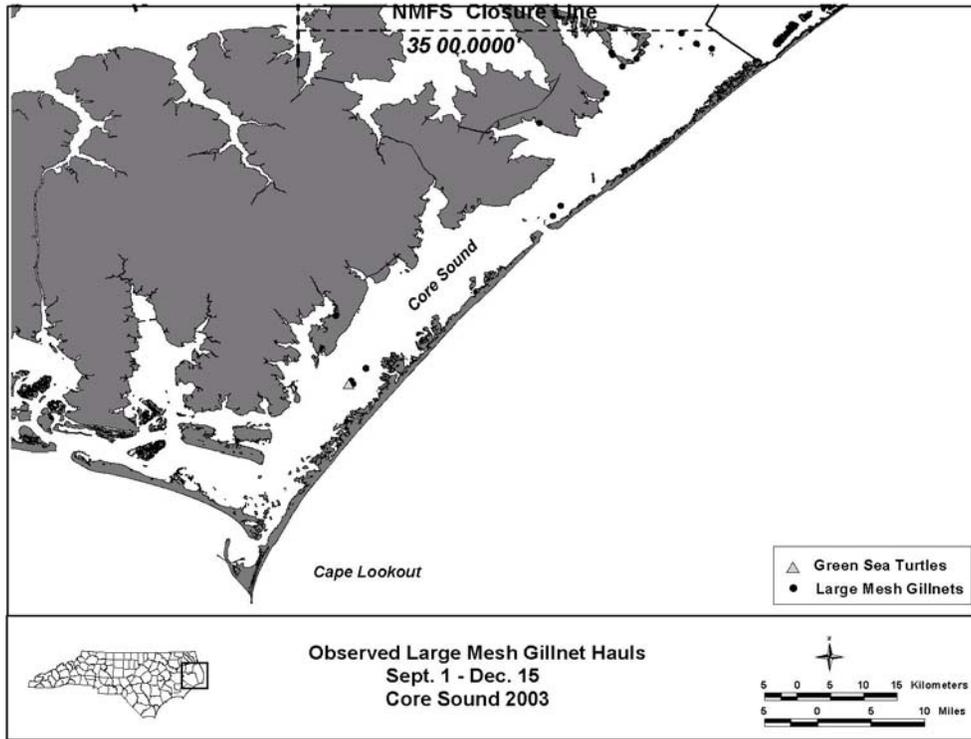


Figure 15. Observed gillnet sets and sea turtle interactions in Core Sound from September 1 – December 15, 2003.

Table 13. Tabulation by species of relative biomass (kgs) and number of individuals sampled in Core Sound from September 1 – December 15, 2003.

Scientific Name	Common Name	Percent Number	Percent Biomass	Total Number	Total Weight (kg)
Paralichthys spp.	Paralichthid flounders	68.90	92.11	412	315.04
Brevoortia tyrannus	Atlantic menhaden	9.20	.	55	.
Dasyatidae	stingrays	4.52	.	27	.
Rajiformes	rays	3.01	.	18	.
Cynoscion regalis	weakfish	1.84	1.39	11	4.77
Neogastropoda stenoglossa	conchs	1.51	.	9	.
Sela. Lamni. Scyliorhinoidei	cat sharks	1.34	0.97	8	3.31
Limulus polyphemus	horseshoe crab	1.34	.	8	.
Dorosoma cepedianum	gizzard shad	1.34	.	8	.
Orthopristis chrysoptera	pigfish	1.00	0.36	6	1.22
Pomatomus saltatrix	bluefish	0.84	0.60	5	2.05
Leiostomus xanthurus	spot	0.84	0.34	5	1.15
Micropogonias undulatus	Atlantic croaker	0.84	0.30	5	1.01
Raja eglanteria	clearnose skate	0.84	.	5	.
Sciaenops ocellatus	red drum	0.67	2.13	4	7.30
Cynoscion nebulosus	spotted seatrout	0.50	0.94	3	3.20
Pogonias cromis	black drum	0.33	0.47	2	1.60
Lagodon rhomboides	pinfish	0.33	.	2	.
Phalacrocorax Auritus	double-crested cormorant	0.33	.	2	.
Mugil cephalus	striped mullet	0.17	0.29	1	1.00
Archosargus probatocephalus	sheepshead	0.17	0.11	1	0.36

DISCUSSION

During the 2003 fishing season in Pamlico Sound, gillnet management measures were successful in reducing sea turtle interactions and maintaining economically important commercial fisheries. In 2002, there were an estimated 162 live and 8 lethal takes comprised of Kemp's Ridley's, Loggerheads and Green turtles (Gearhart 2003). By contrast, there were an estimated 19 live and 15 lethal takes during 2003 with the species composition entirely made up of relatively small green turtles. Of the five observed interactions, four occurred along the Outer Banks side of Pamlico Sound, while one green turtle was observed in Core Sound. All interactions occurred in large mesh gillnets.

Unlike the previous year where sea turtle interactions primarily occurred prior to the third week in October, there was one observed interaction in September, two observed interactions in October, and two in November in the 2003 fishing season. These temporal differences in number of observed sea turtle interactions by month may be related to the varying water quality conditions as a result of Hurricane Isabel, which struck the North Carolina coast in mid-September 2003. Fishermen reported, and observers confirmed increased amount of debris throughout the water column from late-September through mid-October. This may have had a 'scattering effect' on the habitat use in Pamlico Sound by migrating sea turtles and the decreased number observed during the 2003 fishing season. Commercial fishermen participation can also be attributed to the decrease in sea turtle interactions as fishermen are reportedly altering their fishing practices and where set nets are deployed in attempt to reduce sea turtle interactions.

There have been no sea turtle interactions observed in small mesh gillnet fisheries in 2001, 2002 or 2003. The NCDMF establishes attendance requirements prior to November 1 of each year in small mesh gillnet fisheries, which decreases the number of set-net gillnet fishermen, and increases the runaround gillnet fishery. In the runaround small mesh gillnet fishery, schools are visually sighted, and nets are deployed for short durations in shallow water, which minimize bycatch and reduce mortality (Gearhart 2003).

Prior to the 2003 fishing in the PSGNRA, all of the sea turtle interactions in the large mesh gillnet fishery have occurred prior to October 20 (Gearhart 2003). In 2003, while there were fewer observed interactions ($n = 5$), three of the five interactions were observed after October 20 with the last observed interaction occurring on November 25 2003 (Table 8, Table 12). However, the majority of fishing effort continues to occur during the first 6 weeks of the season (Figure 9, Figure 10). Because of the increased fishing effort from September 1 – October 15, and given the past sea turtle interactions during this time frame, it remains a priority to continue management measures in the PSGNRA, which will assist in the reduction of sea

turtle interactions and simultaneously maintain Pamlico Sound commercial fisheries from September – December of each year.

Finally, noteworthy is the fact that observed sea turtle strandings have not decreased in Pamlico Sound in the last four years, despite the entire deep water closure and intensive management of the shallow water fishery throughout Pamlico Sound from September through December of each year since 2000 (Figure 16). Seemingly, this area was closed based upon the increased observations of sea turtle strandings in Pamlico Sound in 1999, and subsequent observations of interactions in the large mesh southern flounder gillnet fishery. However, sea turtle strandings have not decreased. Rather, observations of sea turtle strandings depict a slight increasing trend in the last decade (Figure 16). This may be an indication that inshore gillnets are not as significantly related to sea turtle strandings as originally assessed. Further, from North Carolina sea turtle stranding data, it is apparent that greater than 80% of all strandings fall in the category of ‘undetermined cause’ (*Dr. Matthew Godfrey, NCWRC personal communication*).

Collectively, this information lends great need to accurately determine the cause of sea turtle strandings prior to implementation of stringent management actions such as closure of an entire fishery. Fishery closures affect not only the commercial industry, but the local and state economy as well. North Carolina commercial fishermen show an increasing willingness to assist in collaborative efforts with the scientific community to better manage state fisheries for the reduction and incidence of bycatch, while simultaneously maintaining economically important commercial fisheries. Cooperative efforts among the multitude of stakeholders at the federal, state, and industry level can result in the reduction of endangered or threatened species interactions, while maintaining the commercial industry.

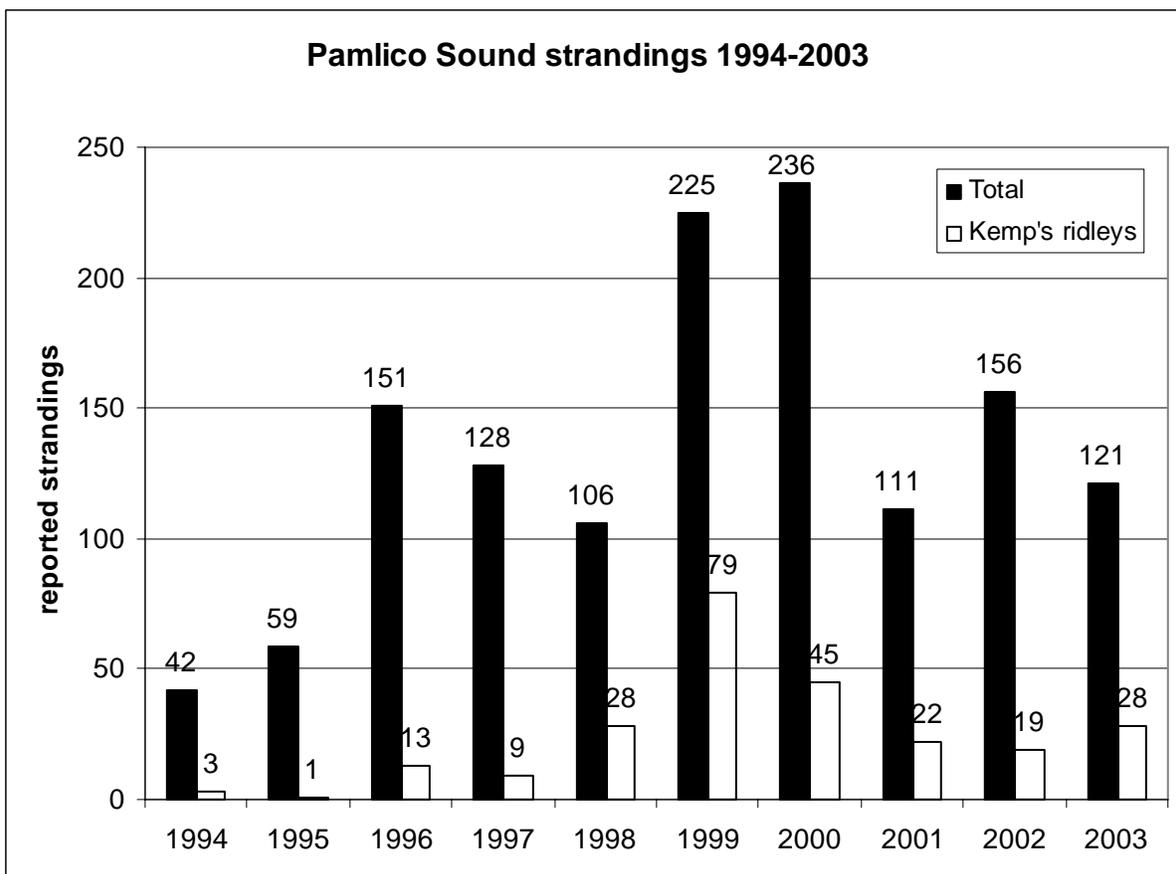


Figure 16. Total and Kemp's ridleys sea turtle strandings observed by the North Carolina Stranding Network from 1994 through 2003 throughout Pamlico Sound. Source: Matthew Godfrey, NCWRC.

CONCLUSIONS AND RECOMMENDATIONS

Management of the Pamlico Sound large mesh gillnet fishery was successful in reducing sea turtle interactions while maintaining commercial fisheries in this area. The last few years of managing the Pamlico Sound gillnet fishery from September – December indicates that the habitat conservation plan designed to reduce sea turtle interactions, has been effective and could be used in subsequent years to continue the reduction of interactions in gillnet fisheries. The primary limitation for the success of this reduction and management of this fishery hinges on funding sources to maintain this work.

This project remains costly and requires a multi-faceted approach involving many different sections and NCDMF personnel, as well as intensive participation of the commercial industry. The federal closure of Pamlico Sound in 2001 has affected commercial fishermen living in small coastal communities on many levels. Commercial fishermen are increasingly aware of the need to reduce interactions of federally protected species, and their increased compliance and participation in management measures allots credit to them. Because there is a continued need to reduce sea turtle interactions in Pamlico Sound, and simultaneously maintain these viable fisheries, to which so many people depend upon, NCDMF recommends that the NMFS assist in funding this monitoring program on a long-term (>3 years) basis.

Long-term, ample funding sources for this monitoring program would allow NCDMF to dedicate personnel to Pamlico Sound monitoring efforts, as well as throughout the state. This would allow increased coverage of the fisheries. Increased observations with participating commercial fishermen will allow better quantification of bycatch numbers and trends to be assessed, which can be used collaboratively among federal and state agencies to maintain fisheries, and reduce protected species interactions.

Management and monitoring of the commercial gillnet fisheries in Pamlico Sound, NC from September through December for the last three years has proved successful in reducing the number of sea turtle interactions in gillnets. Commercial fishermen are increasing their willingness to participate in these management measures, as well as their understanding of the need to protect threatened and endangered species. By working collectively the NMFS, NCDMF and the commercial industry will continue to conserve habitat, and minimize bycatch, while simultaneously maintaining vital fisheries.

Finally, the NCDMF has organized a Sea Turtle Advisory Committee (STAC) under the Marine Fisheries Commission to gather all relevant information pertaining to sea turtle interactions in commercial fisheries throughout North Carolina. The committee would like to address the issues of endangered species interactions, and develop solutions for managers and the commercial industry. The STAC will identify problems and concerns, generate discussion, and develop potential solutions. This information will be presented in a fact finding document inclusive with recommendations to the NMFS. It is the hope of NCDMF and the STAC committee that the recommendations be considered for incorporation into working, and future NMFS documents to assist in the continued reduction of endangered and threatened species interactions, while maintaining commercial fisheries.

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