



NCDMF Completion Report for Incidental Take Permit 1398

Sea Turtle Bycatch Monitoring of the 2004 Fall Gillnet Fisheries in Southeastern Pamlico Sound, North Carolina

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Introduction

The fall commercial gillnet fisheries throughout Pamlico Sound have been proactively managed by the North Carolina Division of Marine Fisheries (NCDMF) from September through December for the last five years. Management measures have been imposed in this region in response to increased observations of sea turtle strandings in 1999. These measures restrict areas, seasons, gear, and establish allowable sea turtle interactions. This area is now referred to as the Pamlico Sound Gillnet Restricted Area (PSGNRA) (Figure 1). The PSGNRA has been managed by NCDMF, in consultation with the National Marine Fisheries Service (NMFS), under the authority of Section 10 (ESA 1973) Incidental Take Permits (ITPs). The ITPs have been issued to NCDMF in 2000 (#1259), 2001 (#1348), and 2002 (#1398). Each ITP has included Habitat Conservation Plans (HCP) designed to monitor and subsequently reduce protected species interactions in commercial gillnets with the assumption that these will result in decreased sea turtle strandings in Pamlico Sound from September through December of each year.

The closure of the 2004 fishing season marked the termination of a three-year management regime throughout the PSGNRA under ITP #1398. Similar management measures were utilized in this three-year period allowing a more comprehensive assessment of the commercial gillnet effort, catches, finfish bycatch, and protected species interactions. NCDMF has been able to successfully manage the PSGNRA and observed levels of sea turtle interactions have remained below authorized thresholds in this duration. NCDMF intends to continue managing the PSGNRA to protect sea turtles and to maintain the economically important fall southern flounder *Paralichthys lethostigma* large mesh gillnet fishery that operates in the shallow water regions.

Background

Since 2000, adaptive management schemes have been implemented during the fall of each year throughout the Pamlico Sound to properly establish areas, seasons, restricted fishing areas, prohibited corridors, and gear restrictions. Initially, the identification of the deep water and shallow water fishing grounds was established (Figure 2). 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*), (Price 2004, Gearhart 2003).

Observations in 2000 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 (Price 2004, Gearhart 2003). In 2001, the HCP established restricted areas throughout the PSGNRA where fishermen could continue operations as stipulated in the ITP (Figure 3).

From 2002 through 2004, the size and shape of the restricted areas and corridors along the Outer Banks and mainland side of Pamlico Sound have remained stable (Price 2004, Gearhart 2003) (Figure 4). Because the PSGNRA has had similar management measures imposed from 2002 – 2004, the NCDMF has been able to acquire a long-term database detailing total effort, catches, finfish bycatch, and protected species interactions in large mesh commercial gillnet fishing operations. These data are not only used for the continued protection of endangered or threatened species, but also in making better fishery management decisions. NCDMF intends to maintain the flexibility to direct management actions for the purpose of sustaining coastal habitats and resources.

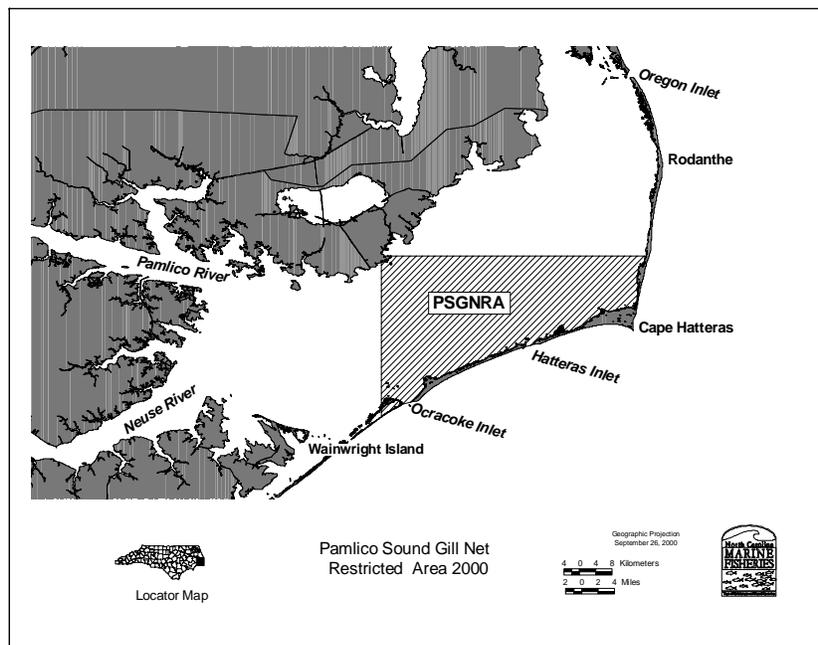


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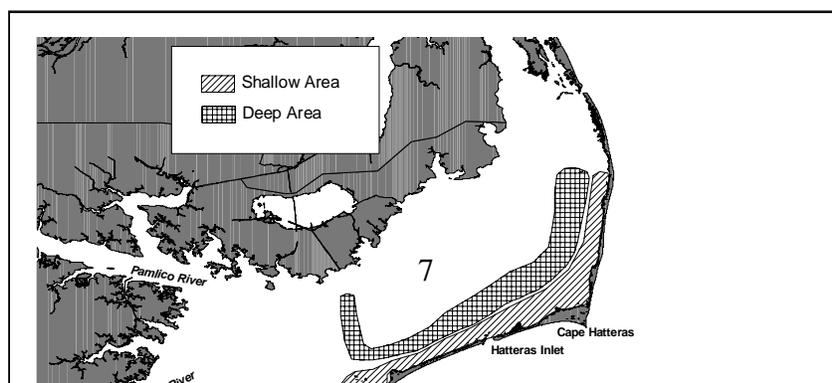


Figure 2. North Carolina 2000 estuarine flounder gillnet fishing grounds in southeastern Pamlico Sound.

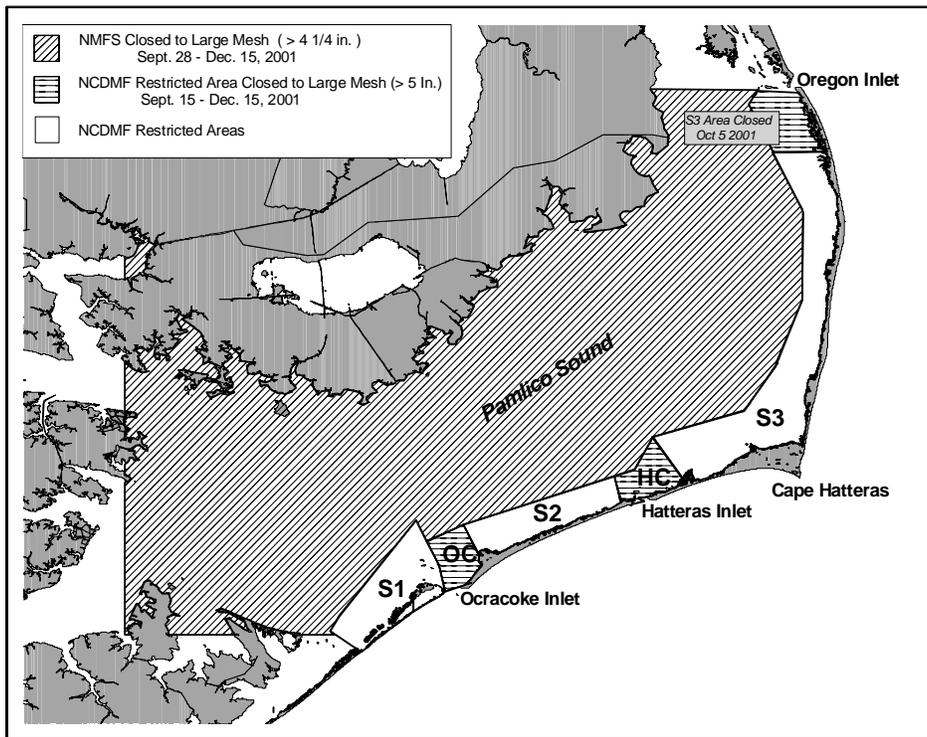


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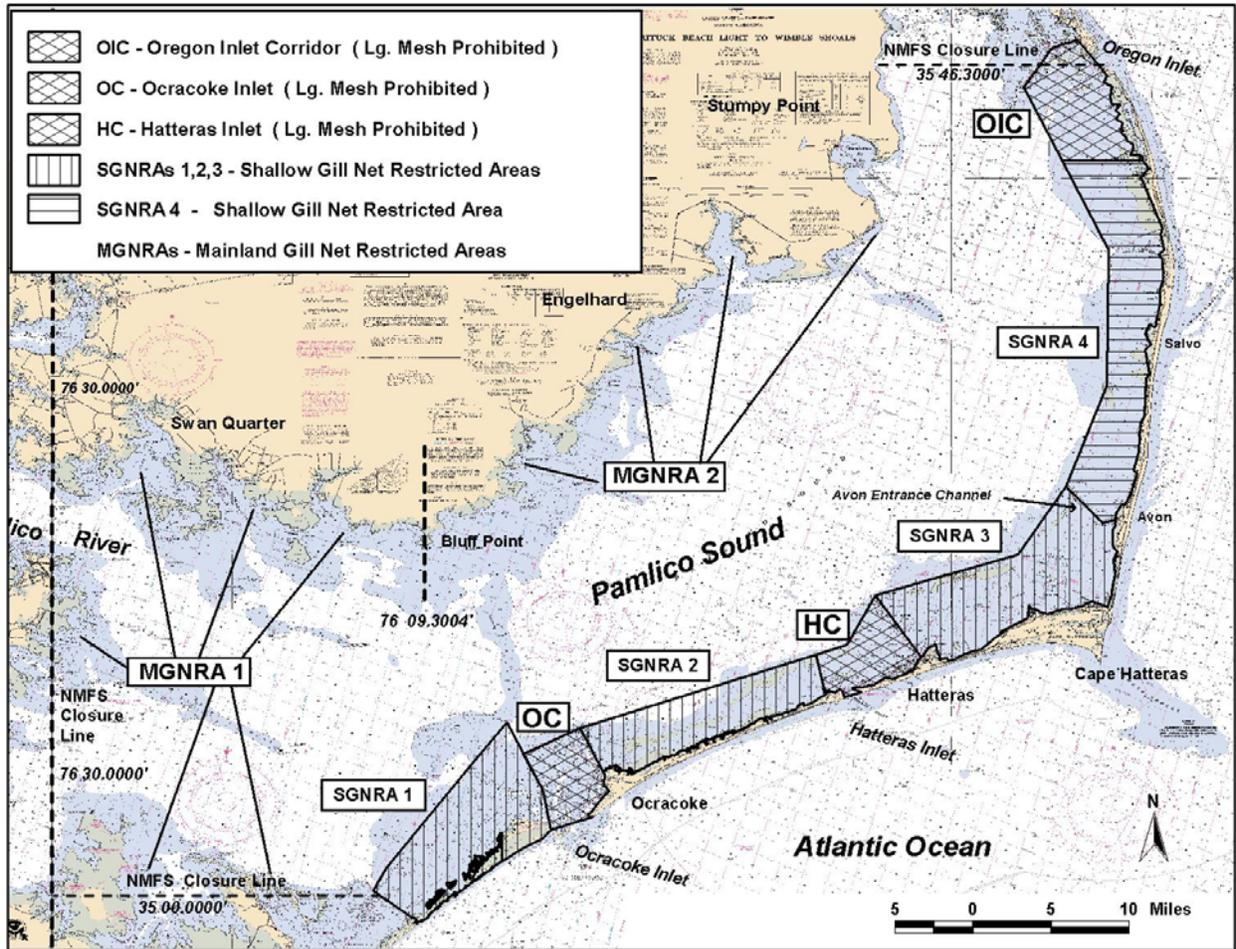


Figure 4. NCDMF 2004 Pamlico Sound Gillnet Restricted Area (PSGNRA) and NMFS closed area. S1=Shallow Water Gillnet Restricted Area 1; S2=Shallow Water Gillnet Restricted Area 2; S3=Shallow Water Gillnet Restricted Area 3; OC=Ocracoke Inlet Corridor; HC=Hatteras Inlet Corridor.

Methods

During 2002, NMFS reviewed NCDMF monitoring data and chose to issue a final rule that would implement the Pamlico Sound large mesh ($> 4 \frac{1}{4}$ inch) gillnet closure each year from September 1 through December 15 (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), (Price 2004, Gearhart 2003). These measures allowed 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 2004 fishing season, there were no changes to the restricted areas, monitoring efforts, sampling protocols, or reporting requirements. There has only been one minor modification to the conservation plan from 2002 – 2004. Specifically, the area from Hatteras Inlet to Oregon Inlet was divided into two separate restricted areas: SGNRA3 and SGNRA4 (Figure 4). This was done to more accurately weight observer coverage and obtain weekly estimates. This action did not increase or decrease authorized fishing grounds in 2004 (Price 2004).

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.

ITP Conservation Plan

In August 2004, NCDMF issued proclamation M-8-2004, 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). 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 (≥ 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 2003 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, 2004.

- 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 2003 PSGNRA trip distribution among ports. Mainland observer coverage was proportionally allocated based on the 2003 trip distribution of flounder gillnet trips among ports derived from trip tickets. Proportional observer coverage along both the Outer Banks and mainland was updated weekly based on the relative effort from the previous week.

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, 2004. Funding for the program was provided by NMFS and NCDMF. 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

Based on 2001 observations, authorized live and lethal take levels were established for each species for 2002 (Table 1). 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 and 2004 fishing season (Table 1). 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 1. Maximum authorized lethal takes and live takes by species from September 1 through December 15 for the PSGNRA during the 2002 - 2004 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

Results

Gillnet fishery monitoring began September 1, 2004 and ended December 15, 2004. Monitoring consisted of assigning permits, collecting logbook reports, and deploying observers in the large and small mesh gillnet fisheries. All reporting, observer deployment, and debriefing were done weekly to provide timely estimates of sea turtle bycatch.

Permit Reporting

Similar to 2003, there was an increased compliance with reporting requirements during the 2004 PSGNRA fishing season. There were no NCDMF notices of violations (NOVs) issued for non-reporting or for late reporters. However, one incident of illegal fishing activity was observed by NMFS enforcement agents, and a federal NOV was issued during week 11 to a fisherman who was fishing in the closed, deep water portion of Pamlico Sound near Ocracoke Island. NCDMF has not been apprised any further of this incident at this time.

There were 153 PSGNRA permits issued during the 16-week season with an average of 39 participants reporting fishing activity weekly (Figure 5). The number of active fishermen peaked in mid-September and remained relatively high through October. Thereafter, a steady decline in active participants was observed for the remainder of the season.

Fishing Activity

As with previous years, inactive permits outnumbered active permits throughout the season (Figure 5). This is due to fishermen fearing a limited entry management approach and obtaining a permit, but never fishing within the PSGNRA. There was an average of 54 active fishermen per week from September 1 through October. Effort decreased significantly thereafter with an average of 21 active fishermen per week from November 1 through the remainder of the season (Figure 5).

Flounder fishing effort and flounder landings peaked during mid-September and remained relatively high through October. In this seven week period there was an average of 57 permitted fishermen conducting a mean of 191 trips per week in the PSGNRA (Figures 5 and 6). Flounder landings were also increased during this time with an average of nearly 18,000 pounds of flounder landed per week. Beginning in November and continuing for the remainder of the season, active fishermen, total effort, and catches were significantly reduced with an average of 59 trips per week for the last six weeks of the season (Figure 6).

The majority of fishing effort (48%) and landings (38%) occurred in SGNRA3 (Table 2, Figure 7). There were greater than one million yards of effort reported from this area during the 2004 season. There were three peaks in effort from SGNRA3 occurring from mid-September through October with the highest peak observed in mid-October (Figure 7). Restricted area SGNRA2 had relatively high effort representing 22% of the total. Significant flounder landings were also reported from this area with 32% of the total landings reported from SGNRA2 (Table 2, Figure 7).

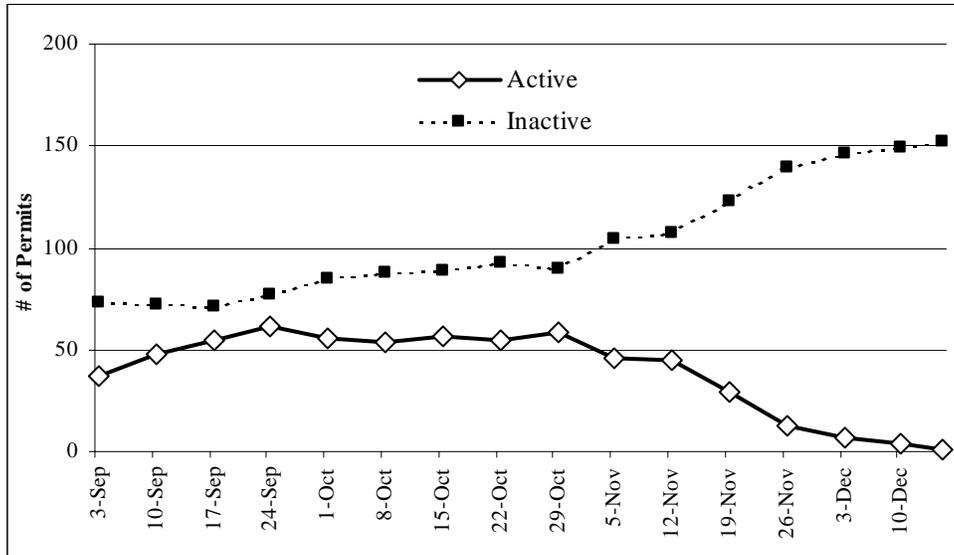


Figure 5. Number of valid and active PSGNRA permits by week for the 2004 fishing season.

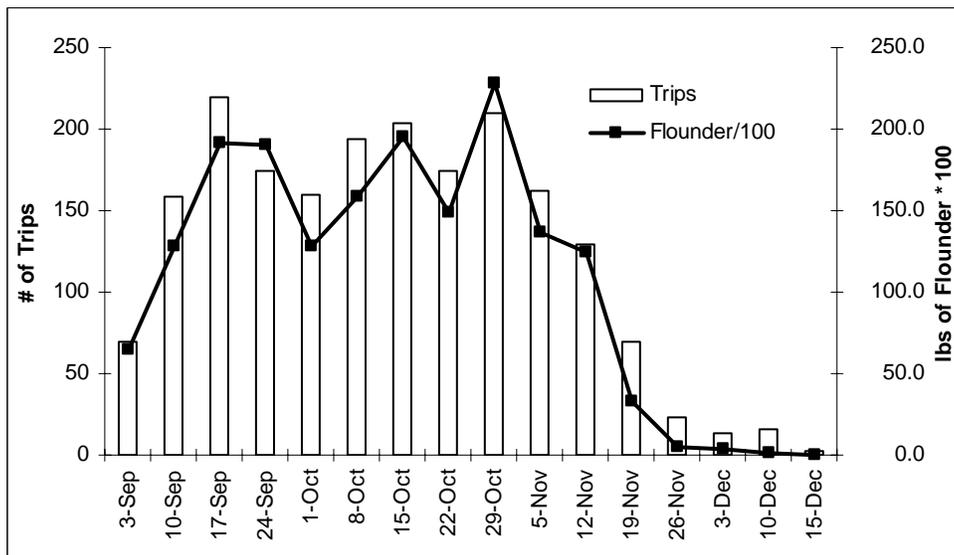


Figure 6. Number of PSGNRA large mesh gillnet trips and flounder landings by week for the 2004 fishing season.

Table 2. The effort (yards * soak days) and flounder landings with relative percent of total for each restricted area throughout the PSGNRA during the 2004 fishing season.

Restricted Area	Effort	Landings	% Total Effort	% Total Landings
M1	108,500	6,660	5	4
M2	66,100	1,743	3	1
S1	203,000	22,859	9	13
S2	510,975	56,007	22	32
S3	1,105,670	65,171	48	38
S4	293,900	21,198	13	12
Totals	2,288,145	173,638		

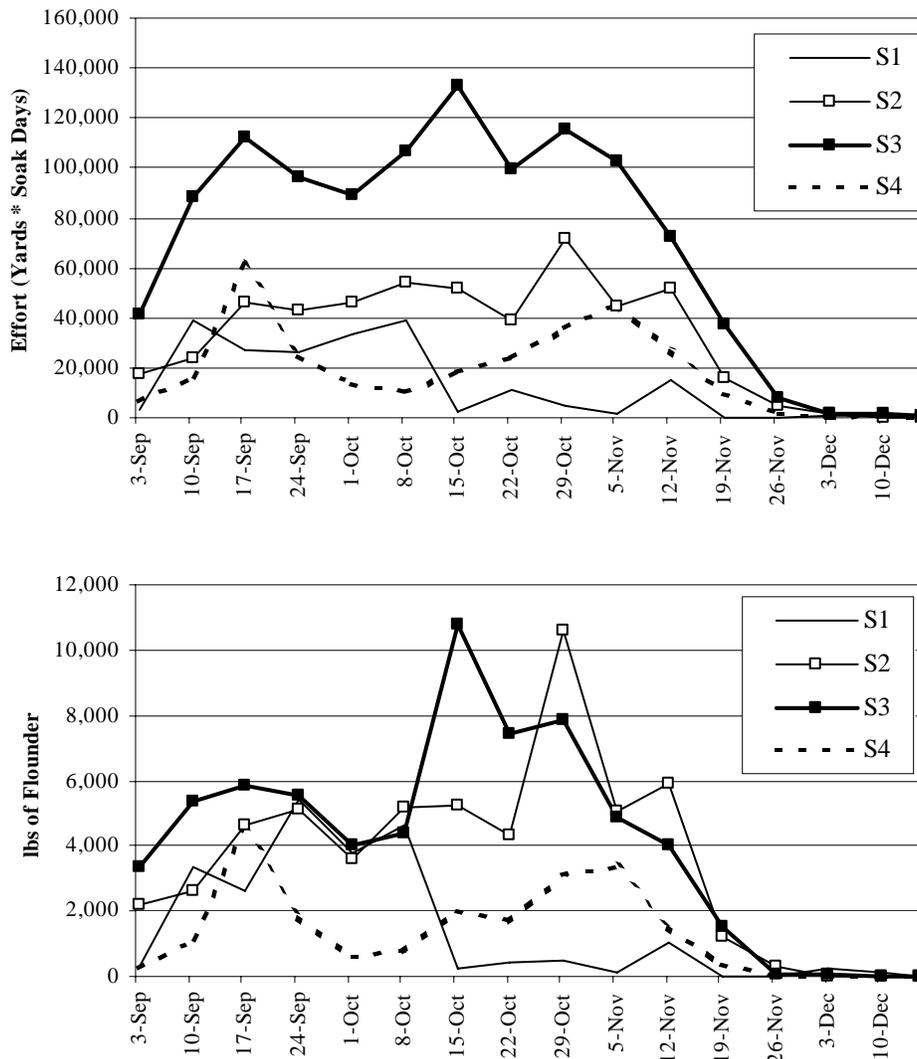


Figure 7. Total amount of large mesh gillnet effort (yards*soak days), and total pounds of flounder landed by week in the Outer Banks PSGNRA restricted areas for 2004.

Compared to SGNRA3 and SGNRA2, there was less effort and landings reported from restricted areas SGNRA1 and SGNRA4 (Table 2, Figure 7). In area SGNRA1, peak effort and landings were reported from mid-September to the first week of October. In area SGNRA4, there were two peaks of effort and landings reported in mid-September and the first week of November. Total effort and landings were low at all other times in SGNRA4 throughout the 2004 fishing season (Figure 7).

On the mainland side of Pamlico Sound, total effort and catches were significantly less than along the Outer Banks (Figure 8). Collectively, areas MGNRA1 and MGNRA2 accounted for 8% of the total effort and 5% of the total landings throughout the PSGNRA in 2004 (Table 2). Effort was consistently higher in MGNRA1 compared to MGNRA2. The majority of effort along the mainland was concentrated from mid-September through October (Figure 8).

Sea Sampling

There was a total of 189 observer trips in the PSGNRA during the 2004 fishing season, including 164 large mesh trips. Fishermen reported 1,980 large mesh gillnet trips in the PSGNRA applying 2,288,295 yards/soak day of fishing effort resulting in 173,638 pounds of flounder landed.

Observers were present on 164 large mesh fishing trips achieving 8.3% coverage (Figure 9). Coverage of fishing effort was similar with observers sampling over 194,000 yards/soak day resulting in 8.5% coverage (Figure 9). Observers documented 10,900 lbs of the total flounder landed representing 6.3 % of the total. Coverage of the fishery appeared to be adequate with observed effort and CPUEs tracking closely with those reported by fishermen (Figure 10). 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 11). Weekly coefficients of variation (CVs) for yards of gillnet fished remained below 50% for the majority of weeks and averaged 46% while landings CVs exceeded 50% for all weeks and averaged greater than 88% (Figure 11).

There were 25 trips and a total of 13,845 yards of small mesh set gillnet observed during the 2004 PSGNRA fishing season (Table 3). No runaround gillnet sets were observed. There were 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.

Spatial coverage of the large mesh gillnet fishery in 2004 was adequate with concentrations of observed net sets close to the shoreline along the Outer Banks and mainland side of Pamlico Sound (Figure 12). There were significantly fewer observations of the small mesh gillnet fishery and they were primarily concentrated in SGNRA3 (Figure 13).

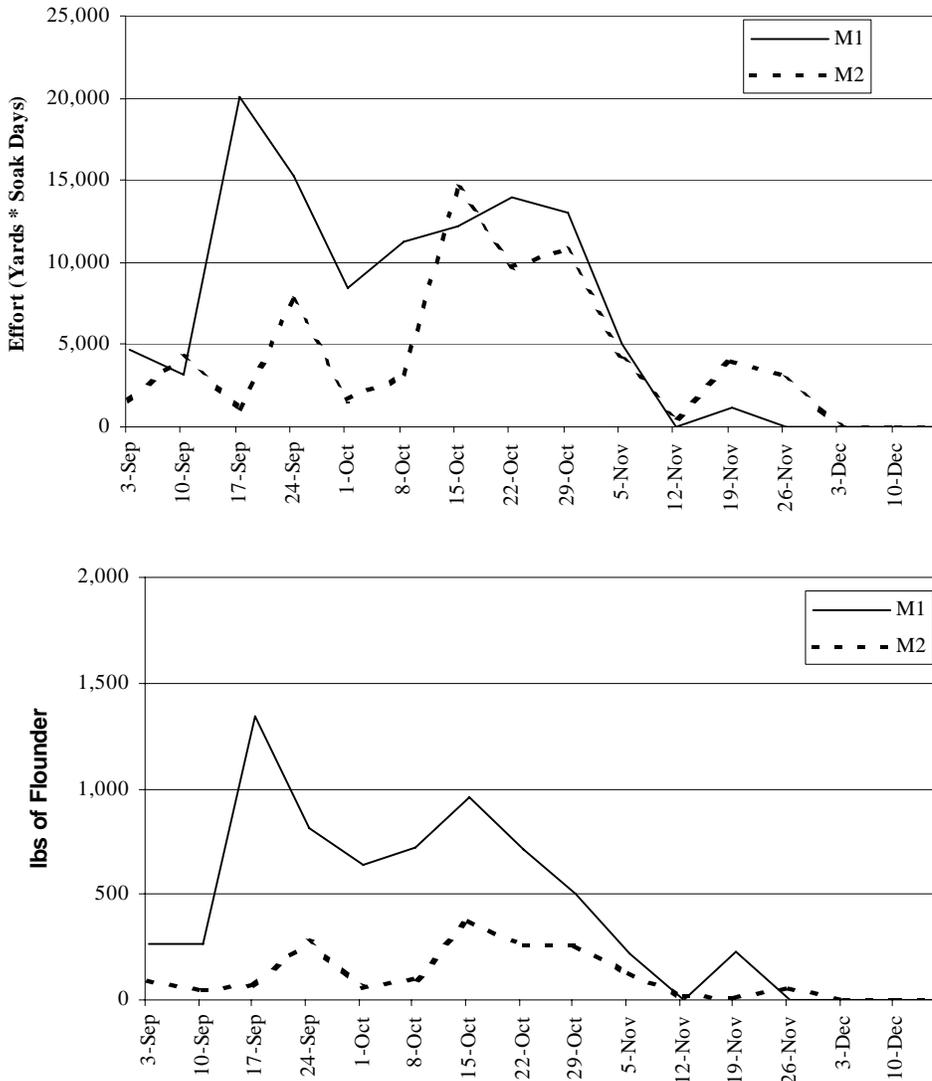


Figure 8. Total amount of large mesh gillnet effort (yards * soak days), and total pounds of flounder landed by week in the mainland PSGNRA restricted areas for 2004.

Gear Parameters

Mesh sizes observed in the large mesh fishery ranged from 5.25 to 7.00 inch stretched mesh with most fishermen using approximately 6 inch (Table 4). Small mesh set nets ranged from 2.87 to 4.75 inch and averaged 3.23 inch (Table 4). Twine sizes for both fisheries averaged approximately 0.50 mm. The mean water depth of net deployments was 0.92 m for the large mesh gillnet fishery, and 2.97 m for the small mesh set gillnet fishery (Table 4). Soak times ranged from 30 minutes to 144 hr throughout the 2004 fishing season with an average of 25.47 hr sets in the large mesh, and 20.11 hr in the small mesh set gillnet fishery. Yards per trip ranged from 150 yards to 2000 yards with a mean of 1,047 yards in the large mesh gillnet fishery, and a mean of 523 yards in the small mesh set gillnet fishery.

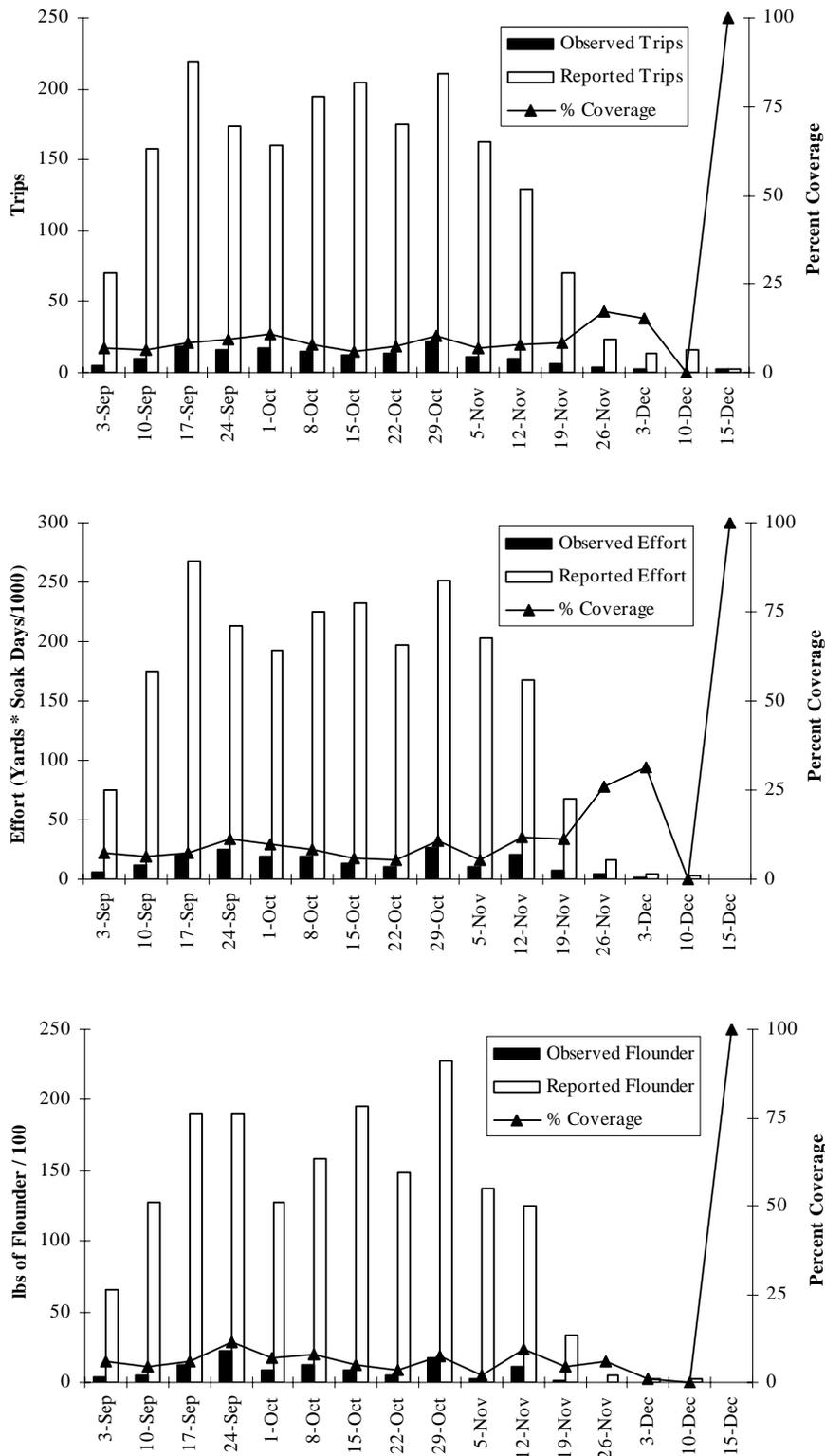


Figure 9. Large mesh trips, fishing effort (yards x soak days), and flounder landings (lbs) observed and reported by week for the 2004 fishing season.

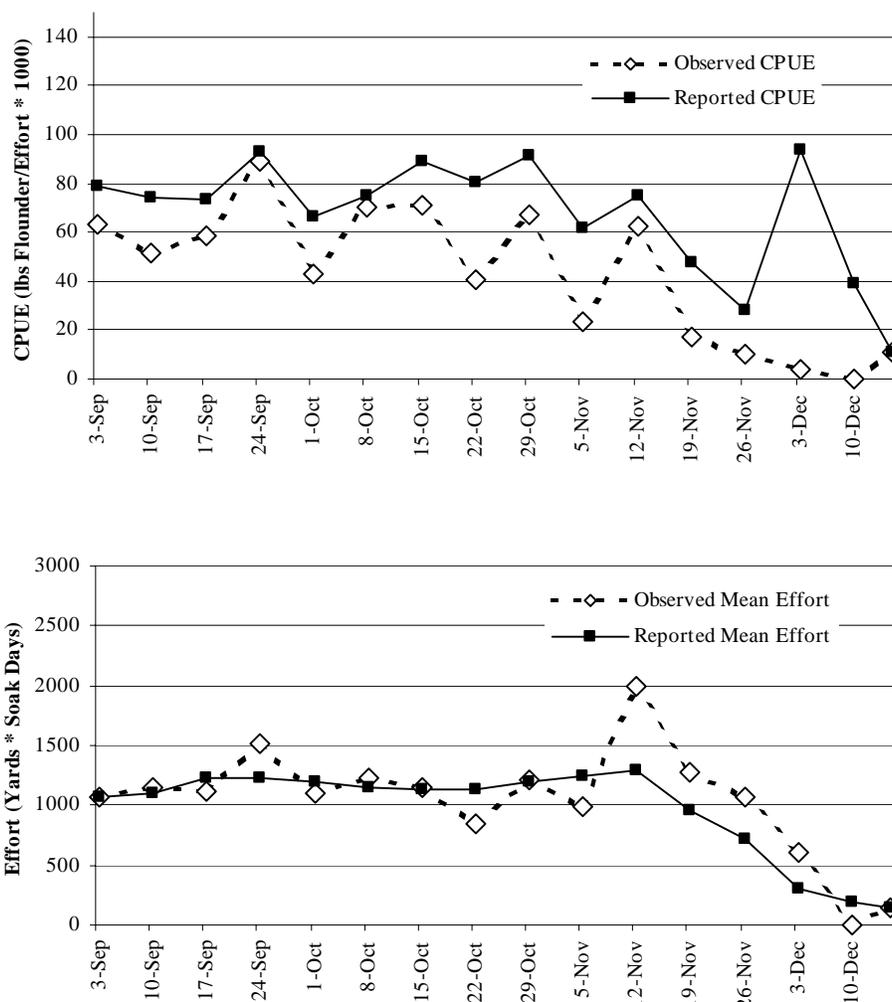


Figure 10. Mean CPUEs (lbs of flounder\1000 yards\day) and effort (yards x soak days) for logbook reports and observed large mesh gillnet trips by week for the 2004 fishing season.

Table 3. Observed trips, effort and sea turtle interactions in the small mesh gillnet fishery throughout the PSGNRA for the 2004 fishing season.

Week Ending	Observed Effort	Observed Trips	Observed Turtles
8-Oct	600	2	0
15-Oct	200	1	0
29-Oct	2,000	1	0
5-Nov	1,600	4	0
19-Nov	2,600	2	0
26-Nov	3,045	3	0
3-Dec	1,800	3	0
10-Dec	700	3	0
15-Dec	1,300	6	0
Totals	13,845	25	0

Finfish and Sea Bird Bycatch

In the large mesh fishery, catches were dominated by Paralichthid flounders, which represented 66% of the catch by weight, and 45% of the catch by number (Table 5). Collectively, bluefish, Atlantic menhaden *Brevoortia tyrannus*, red drum *Sciaenops ocellatus*, and sheephead *Archosargus probatocephalus* comprised another 25% of the total observed catches by weight. There were only three striped bass *Morone saxatilis*, and one Atlantic sturgeon *Acipenser oxyrinchus* observed in large mesh gillnets in 2004. The Atlantic sturgeon was released alive. Sea bird bycatch observed in the large mesh fishery included 72 double-crested cormorants *Phalacrocorax auritus*, 11 common loons *Gavia immer*, 6 hooded mergansers *Lophodytes cucullatus*, 2 brown pelicans *Pelecanus occidentalis*, and 1 laughing gull *Larus atricilla* (Table 5).

In the small mesh gillnet fishery, the top five species observed were weakfish, Atlantic menhaden, kingfishes *Menticirrhus* spp., bluefish, and Atlantic croaker *Micropogonias undulatus* (Table 6). These species combined represented 87% of the total observed catches by number, and 86% of the total by weight. There was only one striped bass observed in small mesh gillnets in 2004, but 48 red drum were observed. Two common loons, and one double-crested cormorant were observed in small mesh set gillnets (Table 6).

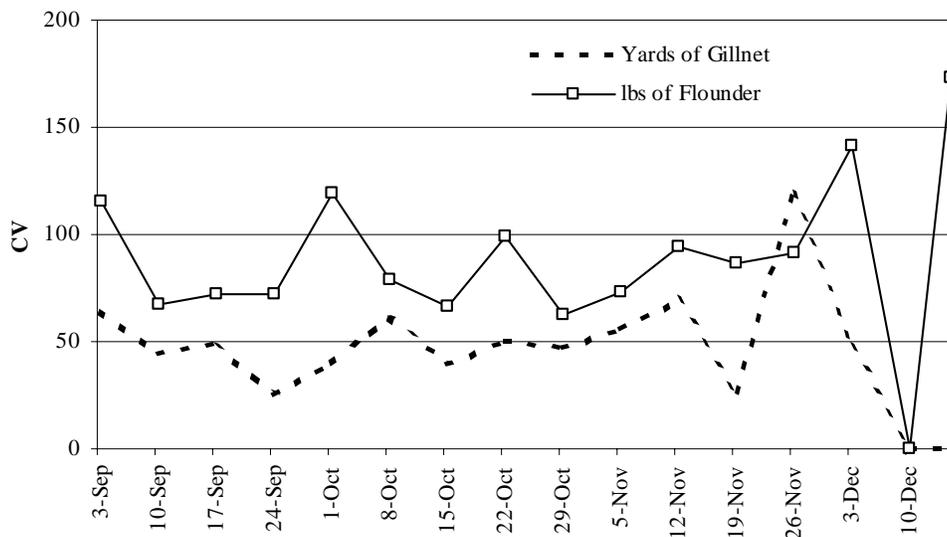


Figure 11. Coefficients of variation (CVs) by week for two measures of large mesh fishing effort (lbs of flounder landed vs. yards of gillnet fished) observed during the 2004 fishing season.

Sea Turtle Bycatch

Nine sea turtles were observed in the large mesh gillnet fishery throughout the PSGNRA in 2004 (Table 7). All sea turtles were observed along the Outer Banks in restricted areas SGNRA3 (n = 4), SGNRA2 (n = 3), and SGNRA1 (n=2). There were four live green and 3 dead green turtles observed, and one live and one dead Kemp's ridley sea turtles observed. The majority (78%) of sea turtle interactions occurred between September 18, 2004 and October 26, 2004. However, there were two interactions in the first part of November, but both turtles were observed alive and released in good condition (Table 7). All green turtles observed were small with carapace lengths ranging from 287 mm to 395 mm. Similarly, the Kemp's ridleys had carapace lengths of 245 mm and 342 mm (Table 7). All live takes were sampled, tagged, and released near inlets in good condition. However, the small Kemp's ridley, and two of the green turtles sampled were only tagged with pit tags (Table 7).

In restricted area SGNRA3, three green turtles were observed near Hatteras Inlet in Sandy Bay (Figure 14). The Kemp's ridley in this area was observed just south of the Avon channel. In SGNRA2, the live Kemp's ridley was observed about in the middle of the restricted area. One of the green turtles observed in this area was located on the edge of the restricted area near the closed deep water region, while the other green turtle was observed behind Ocracoke Island near Ocracoke Inlet (Figure 14). The two live green turtle interactions in SGNRA1 were both just south of the Ocracoke Corridor (Figure 14). No turtles were observed on the mainland side of the PSGNRA or in small mesh gillnets during 2004

Table 4. Summary statistics for gear parameters observed throughout the PSGNRA in the large and small mesh set gillnet fisheries during the 2004 season.

Mesh Size	Net Type	Gear Parameter	N	Min	Mean	Max
Large Mesh	Set Net	Mesh Size (in)	1,725	5.25	5.97	7.00
		Twine Size (mm)	1,725	0.33	0.49	0.57
		Net Set Depth (m)	1,725	0.20	0.92	2.70
		Soak Time (hr)	1,725	10.00	25.47	144.00
		Yards/Trip	163	150	1,047	2,000
Small Mesh	Set Net	Mesh Size (in)	75	2.87	3.23	4.75
		Twine Size (mm)	75	0.47	0.48	0.52
		Net Set Depth (m)	75	0.24	2.97	4.50
		Soak Time (hr)	75	0.50	20.11	48.00
		Yards/Trip	24	200	523	2,000

Table 5. 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, 2004.

Scientific Name	Common Name	% Biomass	% Number	Total Number	Total Weight
<i>Paralichthys</i> spp.	Paralichthid flounders	65.67	45.26	5,336	5,217.83
<i>Pomatomus saltatrix</i>	bluefish	9.93	9.04	1,066	789.27
<i>Brevoortia tyrannus</i>	Atlantic menhaden	6.54	19.96	2,353	519.91
<i>Sciaenops ocellatus</i>	red drum	5.03	3.47	409	399.57
<i>Archosargus probatocephalus</i>	sheepshead	3.21	1.51	178	254.83
<i>Leiostomus xanthurus</i>	spot	2.34	4.92	580	186.29
<i>Cynoscion regalis</i>	weakfish	1.81	2.54	300	144.20
<i>Pogonias cromis</i>	black drum	1.45	0.83	98	115.46
<i>Lagodon rhomboides</i>	pinfish	0.75	1.90	224	59.24
<i>Chaetodipterus faber</i>	Atlantic spadefish	0.66	0.48	57	52.73
<i>Cynoscion nebulosus</i>	spotted seatrout	0.62	0.51	60	49.35
<i>Micropogonias undulatus</i>	Atlantic croaker	0.38	0.65	77	30.33
<i>Mugil cephalus</i>	striped mullet	0.33	0.11	13	26.50
<i>Menticirrhus</i> spp.	kingfishes	0.13	0.27	32	10.35
<i>Morone saxatilis</i>	striped bass	0.13	0.03	3	10.05
<i>Synodus foetens</i>	inshore lizardfish	0.12	0.14	16	9.44
<i>Elops saurus</i>	ladyfish	0.09	0.06	7	6.86
<i>Gymnura micrura</i>	smooth butterfly ray	0.08	0.19	22	6.60
<i>Scophthalmus aquosus</i>	windowpane	0.08	0.20	24	6.07
<i>Astroscopus</i> spp.	Astroscopus stargazers	0.08	0.08	10	6.00
<i>Carcharhinus plumbeus</i>	sandbar shark	0.07	0.01	1	5.50
<i>Lobotes surinamensis</i>	tripletail	0.07	0.01	1	5.50
<i>Mustelus</i> spp.	Mustelus sharks	0.05	0.03	3	4.00
<i>Rachycentron canadum</i>	cobia	0.05	0.02	2	3.90
<i>Dorosoma cepedianum</i>	gizzard shad	0.05	0.03	4	3.80
<i>Orthopristis chrysoptera</i>	pigfish	0.05	0.16	19	3.66
<i>Trachinotus carolinus</i>	Florida pompano	0.04	0.05	6	3.30
<i>Scomberomorus maculatus</i>	Spanish mackerel	0.04	0.02	2	2.80
<i>Malaclemys terrapin</i>	diamondback turtle	0.03	0.02	2	2.60
<i>Urophycis</i> spp.	Urophycis hakes	0.02	0.03	3	1.80
<i>Chilomycterus schoepfi</i>	striped burrfish	0.02	0.03	3	1.60
<i>Stenotomus chrysops</i>	scup	0.02	0.10	12	1.53
<i>Paralichthys squamilentus</i>	broad flounder	0.02	0.01	1	1.20
<i>Caranx hippos</i>	crevalle jack	0.01	0.02	2	0.90
<i>Chilomycterus atinga</i>	spotted burrfish	0.01	0.01	1	0.60
<i>Caranx ruber</i>	bar jack	0.01	0.01	1	0.40
<i>Evorthodus lyricus</i>	lyre goby	0.01	0.02	2	0.40
<i>Peprilus</i> spp.	Peprilus butterfish	0.01	0.02	2	0.40
<i>Peprilus triacanthus</i>	butterfish	0.01	0.02	2	0.40
<i>Acipenser oxyrhynchus</i>	Atlantic sturgeon	.	0.01	1	.
<i>Dasyatidae</i>	stingrays	.	1.72	203	.
<i>Myliobatis freminvillei</i>	bullnose ray	.	0.42	50	.
<i>Rhinoptera bonasus</i>	cownose ray	.	3.19	376	.
<i>Limulus polyphemus</i>	horseshoe crab	.	0.68	80	.
<i>Rajidae</i>	skates	.	0.78	92	.
<i>Callinectes sapidus</i>	blue crab	.	0.44	52	.
<i>Menippe mercenaria</i>	Florida stone crab	.	0.02	2	.
<i>Gavia immer</i>	common loon	.	0.09	11	.
<i>Pelecanus occidentalis</i>	brown pelican	.	0.02	2	.
<i>Phalacrocorax auritus</i>	double-crested cormorant	.	0.61	72	.
<i>Lophodytes cucullatus</i>	hooded merganser	.	0.05	6	.
<i>Larus atricilla</i>	laughing gull	.	0.01	1	.
<i>Chelonia mydas</i>	green turtle	.	0.06	7	.
<i>Lepidochelys kempii</i>	Kemp's ridley	.	0.02	2	.

Table 6. 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, 2004.

Scientific Name	Common Name	% Biomass	% Number	Total Number	Total Weight
<i>Cynoscion regalis</i>	weakfish	27.48	25.23	662	259.63
<i>Brevoortia tyrannus</i>	Atlantic menhaden	22.57	36.17	949	213.27
<i>Menticirrhus</i> spp.	kingfishes	17.39	15.97	419	164.30
<i>Pomatomus saltatrix</i>	bluefish	9.54	4.34	114	90.09
<i>Micropogonias undulatus</i>	Atlantic croaker	7.90	4.99	131	74.60
<i>Leiostomus xanthurus</i>	spot	4.13	3.89	102	39.00
<i>Sciaenops ocellatus</i>	red drum	3.63	1.83	48	34.33
<i>Paralichthys</i> spp.	Paralichthid flounders	2.56	1.30	34	24.21
<i>Cynoscion nebulosus</i>	spotted seatrout	1.15	0.42	11	10.90
<i>Peprilus triacanthus</i>	butterfish	1.10	2.78	73	10.40
<i>Squalus acanthias</i>	spiny dogfish	0.80	0.11	3	7.60
<i>Menticirrhus americanus</i>	southern kingfish	0.57	0.57	15	5.36
<i>Pogonias cromis</i>	black drum	0.33	0.57	15	3.10
<i>Orthopristis chrysoptera</i>	pigfish	0.21	0.46	12	1.96
<i>Archosargus probatocephalus</i>	sheepshead	0.19	0.11	3	1.80
<i>Carcharhinus plumbeus</i>	sandbar shark	0.17	0.04	1	1.60
<i>Morone saxatilis</i>	striped bass	0.12	0.04	1	1.10
<i>Dorosoma cepedianum</i>	gizzard shad	0.10	0.15	4	0.90
<i>Mugil cephalus</i>	striped mullet	0.04	0.04	1	0.40
<i>Alosa mediocris</i>	hickory shad	0.02	0.04	1	0.20
<i>Cnidaria</i>	Jellyfish	.	0.04	1	.
<i>Limulus polyphemus</i>	horseshoe crab	.	0.04	1	.
<i>Penaeus</i> spp.	Penaeus shrimps	.	0.04	1	.
<i>Callinectes sapidus</i>	blue crab	.	0.04	1	.
<i>Scyliorhinidae</i>	cat sharks	.	0.34	9	.
<i>Mustelus canis</i>	smooth dogfish	.	0.04	1	.
<i>Dasyatis americana</i>	southern stingray	.	0.08	2	.
<i>Lepisosteus osseus</i>	longnose gar	.	0.04	1	.
<i>Trachinotus carolinus</i>	Florida pompano	.	0.04	1	.
<i>Lagodon rhomboides</i>	pinfish	.	0.04	1	.
<i>Pleuronectiformes</i>	flounders	.	0.08	2	.
<i>Scophthalmus aquosus</i>	windowpane	.	0.04	1	.
<i>Gavia Immer</i>	common loon	.	0.04	1	.
<i>Phalacrocorax auritus</i>	double-crested cormorant	.	0.08	2	.

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 8 and 9). Total lethal and live take estimates were calculated by adding weekly take estimates by species and area.

Total take estimates based on effort are 28 live green turtles, 19 dead green turtles, 12 live Kemp's ridley, and 7 dead Kemp's ridley (Table 10). Landings-based estimates are higher for green and Kemp's ridley live takes, but comparable for estimated lethal takes (Table 10).

Table 7. Observed large mesh gillnet sea turtle interactions by species, condition, and location observed in the PSGNRA during the 2004 fishing season.

Date	Species	Cond.	Carapace Length	Restricted Area	Location	Inconel Tag1	Inconel Tag2	Pit Tag
9/18/2004	Green	Dead	321	S3	N 35 14.580 W 75 40.350	NA	NA	NA
9/22/2004	Green	Alive	338	S1	N 35 06.009 W 76 03.359	NA	NA	432 F 772 E19
9/26/2004	Green	Dead	287	S3	N 35 13.967 W 75 40.782	NA	NA	NA
10/12/2004	Green	Alive	328	S1	N 35 06.164 W 76 03.404	NA	NA	433 O 095 A42
10/25/2004	Kemp's	Dead	245	S3	N 35 21.576 W 75 34.012	NA	NA	NA
10/26/2004	Green	Alive	330	S3	N 35 14.383 W 75 40.151	XXD 441	XXD 442	433 O 424 00B
10/26/2004	Green	Dead	306	S2	N 35 07.435 W 75 58.066	NA	NA	NA
11/2/2004	Kemp's	Alive	342	S2	N 35 09.620 W 75 53.400	XXP 499	NA	433 A 0A5 F75
11/10/2004	Green	Alive	395	S2	N 35 10.140 W 75 56.417	QQS 265	QQS 266	433 B 7F7 675

Table 8. Observed large mesh gillnet sea turtle interactions, fishing effort (yards x soak days), flounder landings (lbs), and sea turtle bycatch rates by week and area in the PSGNRA during the 2004 fishing season.

Week	Area	Observed Turtles	Species	Observed Effort	Observed Flounder	Effort Bycatch Rate	Landings Bycatch Rate
4	S3	1	Green *	16,000	1,189	0.063	0.084
4	S1	1	Green	4,300	740	0.233	0.135
5	S3	1	Green *	14,160	523	0.071	0.191
7	S1	1	Green	1,340	63	0.746	1.587
9	S3	1	Kemp's *	16,240	1,047	0.062	0.096
9	S3	1	Green	16,240	1,047	0.062	0.096
9	S2	1	Green *	16,240	1,047	0.062	0.096
10	S2	1	Kemp's	3,750	89	0.267	1.124
11	S2	1	Green	4,000	247	0.250	0.405

* Sea turtle observed dead

Table 9. Reported large mesh gillnet sea turtle interactions, fishing effort (yards x soak days), flounder landings (lbs), and sea turtle bycatch estimates in the PSGNRA during the 2004 fishing season. Estimates calculated with rates from Table 8.

Week	Area	Observed Turtles	Species	Reported Effort	Reported Flounder	Effort Bycatch Estimate	Landings Bycatch Estimate
4	S3	1	Green *	96,420	5,569	6.0	4.7
4	S1	1	Green	26,000	5,430	6.0	7.3
5	S3	1	Green *	89,050	4,042	6.3	7.7
7	S1	1	Green	2,700	228	2.0	3.6
9	S3	1	Kemp's *	115,200	7,877	7.1	7.5
9	S3	1	Green	115,200	7,877	7.1	7.5
9	S2	1	Green *	115,200	7,877	7.1	7.5
10	S2	1	Kemp's	44,800	5,060	11.9	56.9
11	S2	1	Green	51,700	5,887	12.9	23.8

* sea turtle observed dead

Table 10. Allowable take thresholds and effort and landings estimates by lethal and live takes in the PSGNRA from September 1 – December 15, 2004.

Species	Authorized Threshold	Effort Estimated	Landings Estimated	Authorized Threshold	Effort Estimated	Landings Estimated
	Live Takes	Live Takes	Live Takes	Lethal Takes	Lethal Takes	Lethal Takes
Green	160	28	43	50	19	21
Kemp's ridley	80	12	57	25	7	8

Core Sound Monitoring

There were 31 trips and 45,720 yards of gillnet effort observed throughout Core Sound from September 1 through December 15, 2004 (Table 11). These included 30 large and one small mesh gillnet observations. Commercial gillnet set locations were observed from approximately Cape Lookout, NC north to PSGNRA restricted area SGNRA1 (Figure 15). Observers sampled more than 2,800 pounds of flounder throughout Core Sound in 2004 (Table 11).

The primary species observed in Core Sound was flounder, which represented 85% of the total weight and 71% of the total number of species observed in 2004 (Table 12). By weight, red drum, bluefish, and Atlantic menhaden accounted for 12% of the total. There were also significant numbers of skate and stingray species Rajidae and Dasyatidae observed throughout

Core Sound (Table 12). Sea bird bycatch in Core Sound monitoring consisted of eight double-crested cormorants. There were two live green turtles and one dead green turtle observed in the Core Sound large mesh gillnet fishery during the 2004 fishing season (Table 13). These green turtles were all small with carapace lengths ranging from 280 mm to 315 mm. The two live green turtles were sampled, tagged, and released in good condition near Barden's Inlet.

Table 11. Total observed trips, effort (yards * soak days), and flounder in both the large and small mesh gillnet fisheries throughout Core Sound, NC from September 1 – December 15, 2004.

Week	Mesh	Observed Trips	Observed Effort	Observed Flounder
3-Sep	Large	5	11,100	672
10-Sep	Large	2	5,100	309
17-Sep	Large	4	5,200	377
24-Sep	Large	5	7,520	450
1-Oct	Large	2	2,600	190
8-Oct	Large	4	4,200	310
15-Oct	Large	2	2,300	142
22-Oct	Large	3	3,700	206
29-Oct	Large	1	1,600	70
5-Nov	Large	1	1,800	47
12-Nov	Large	1	500	68
10-Dec	Small	1	100	0
Totals		31	45,720	2,841

Table 12. Tabulation by species of relative biomass (kgs) and number of individuals sampled in Core Sound from September 1 – December 15, 2004.

Scientific Name	Common Name	% Biomass	% Number	Total Number	Total Weight
<i>Paralichthys</i> spp.	Paralichthid flounders	85.18	71.23	1,773	1,374.0
<i>Sciaenops ocellatus</i>	red drum	6.93	5.66	141	111.7
<i>Pomatomus saltatrix</i>	bluefish	2.63	3.13	78	42.4
<i>Brevoortia tyrannus</i>	Atlantic menhaden	1.56	8.52	212	25.2
<i>Pogonias cromis</i>	black drum	1.28	0.68	17	20.7
<i>Cynoscion regalis</i>	weakfish	0.84	1.08	27	13.6
<i>Archosargus probatocephalus</i>	sheepshead	0.56	0.32	8	9.1
<i>Micropogonias undulatus</i>	Atlantic croaker	0.30	0.96	24	4.9
<i>Leiostomus xanthurus</i>	spot	0.20	0.48	12	3.3
<i>Mugil cephalus</i>	striped mullet	0.19	0.08	2	3.1
<i>Orthopristis chrysoptera</i>	pigfish	0.09	0.32	8	1.4
<i>Lagodon rhomboides</i>	pinfish	0.07	0.44	11	1.1
<i>Mustelus</i> spp.	Mustelus sharks	0.06	0.04	1	1.0
<i>Menticirrhus</i> spp.	kingfishes	0.06	0.08	2	1.0
<i>Elops saurus</i>	ladyfish	0.02	0.08	2	0.4
<i>Scophthalmus aquosus</i>	windowpane	0.01	0.04	1	0.2
<i>Bairdiella chrysoura</i>	silver perch	0.01	0.04	1	0.1
<i>Neogastropoda stenoglossa</i>	conchs	.	0.88	22	.
<i>Limulus polyphemus</i>	horseshoe crab	.	0.24	6	.
<i>Rajidae</i>	skates	.	2.97	74	.
<i>Dasyatidae</i>	stingrays	.	1.93	48	.
<i>Gymnura</i> spp.	butterfly rays	.	0.04	1	.
<i>Rhinoptera bonasus</i>	cownose ray	.	0.16	4	.
<i>Synodus foetens</i>	inshore lizardfish	.	0.04	1	.
<i>Cynoscion nebulosus</i>	spotted seatrout	.	0.08	2	.
<i>Chelonia mydas</i>	green turtle	.	0.12	3	.
<i>Phalacrocorax auritus</i>	double-crested cormorant	.	0.32	8	.

Table 13. Sea turtle take observed in the large mesh flounder gillnet fishery in Core Sound during the 2004 fishing season.

Week	Date	Species	Cond.	Carapace Length	Location	Inconel Tag	Pit Tag
1	9/1/2004	Green	Dead	290	N 34 49.645 W 76 22.384	NA	NA
6	10/7/2004	Green	Alive	315	N 34 50.890 W 76 24.585	NA	433556OF61
8	10/20/2004	Green	Alive	280	N 34 43.366 W 76 33.942	NA	45264C4D17

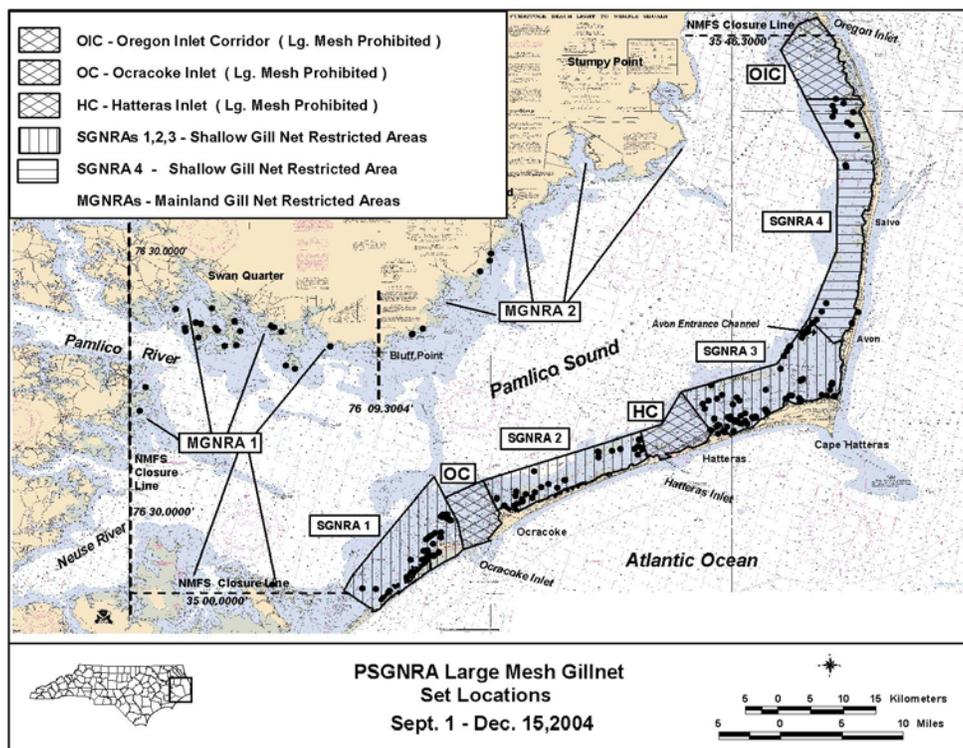


Figure 12. Observed large mesh gillnet sets in the Pamlico Sound Gillnet Restricted Area from September 1 – December 15, 2004.

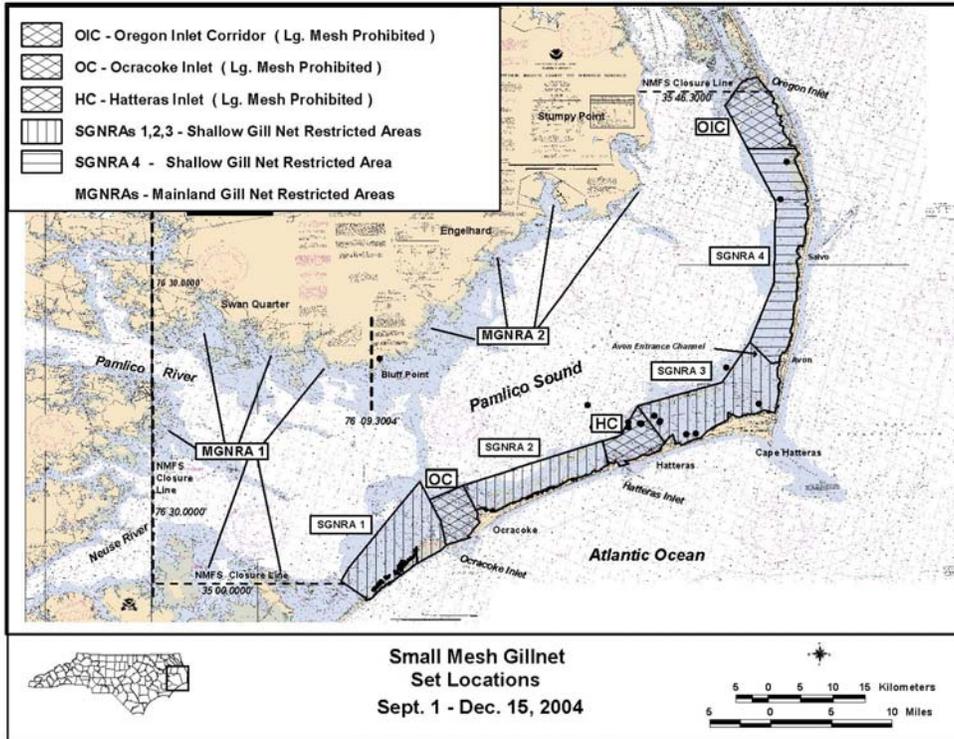


Figure 13. Observed small mesh gillnet sets in the Pamlico Sound Gillnet Restricted Area from September 1 – December 15, 2004.

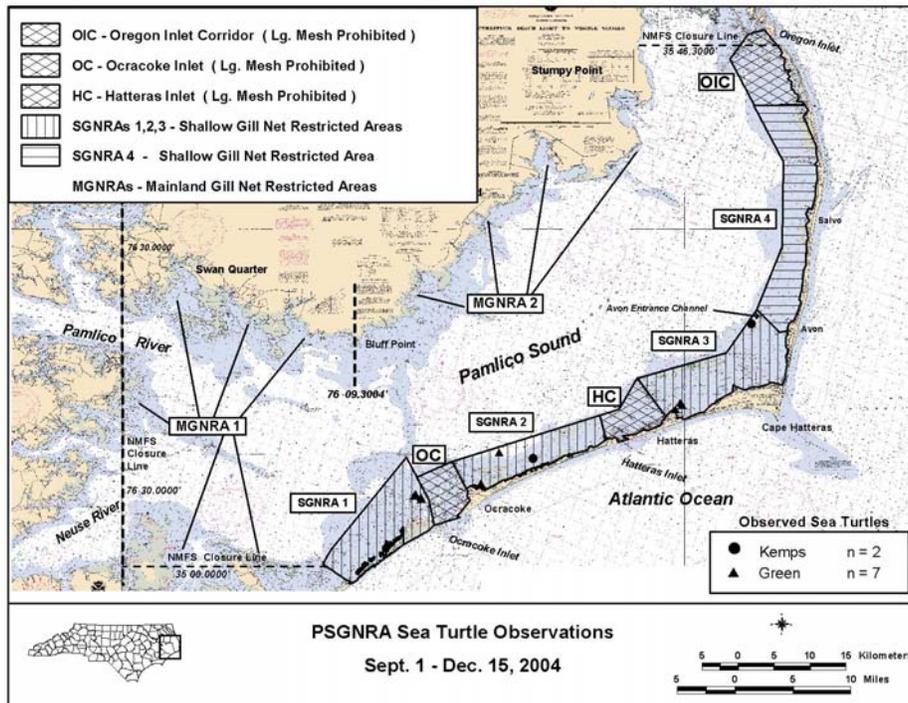


Figure 14. Observed sea turtle interaction in the large mesh gillnet fishery throughout the PSGNRA during the 2004 fishing season.

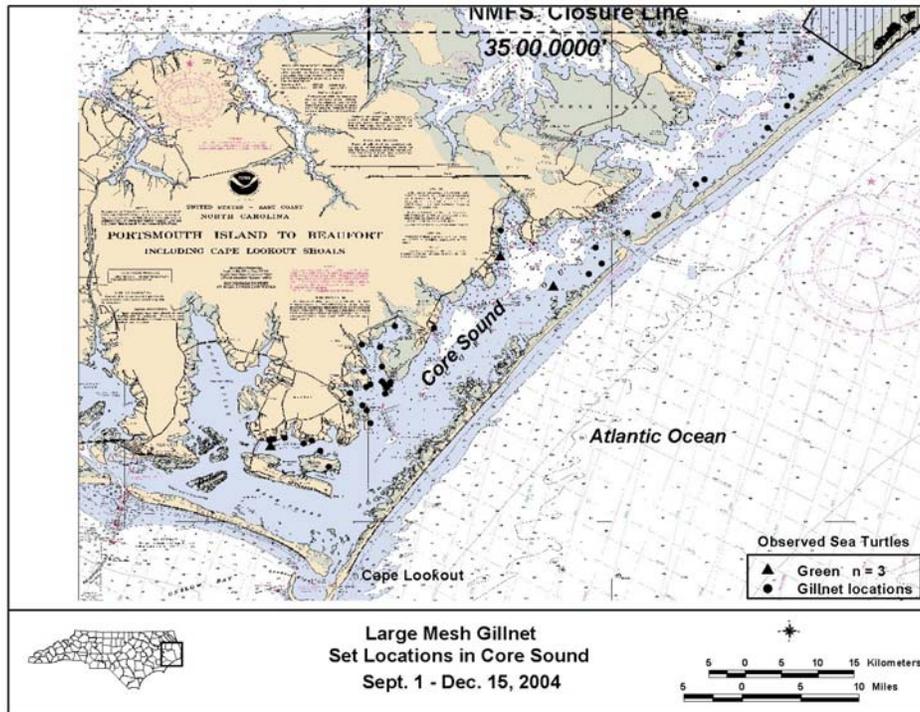


Figure 15. Observed gillnet sets and sea turtle interactions in Core Sound from September 1 – December 15, 2004.

Discussion

Gillnet management measures remained successful in extensively monitoring and characterizing sea turtle interactions in the large mesh gillnet fishery throughout Pamlico Sound from September 1 through December 15, 2004. Thus, NCDMF was able to continue efforts to reduce sea turtle interactions, while simultaneously maintaining the economically valuable fall southern flounder fishery. Compared to 2003, there were more observed sea turtle interactions during 2004. However, estimated interactions remained well below authorized thresholds, and were significantly lower than estimates obtained in 2002 (Price 2004, Gearhart 2003). NCDMF maintains commitment to proactive management measures that will decrease the potential for sea turtle mortality. Continued evaluation of monitoring data throughout the PSGNRA will allow NCDMF to efficiently allocate funds and resources to sustain fisheries, decrease finfish bycatch, and decrease protected species interactions in commercial fisheries.

All sea turtle interactions throughout the PSGNRA in 2004 occurred along the Outer Banks in large mesh gillnets. Sea turtles have not been observed along the mainland side of Pamlico Sound in 2002, 2003, or 2004 (Price 2004, Gearhart 2003). In fact, only one observed

sea turtle interaction has occurred along the mainland side of Pamlico Sound since 1999. Similarly, there have been no sea turtle interactions in small mesh gillnet observations since the inception of the PSGNRA (Price 2004, Gearhart 2003, Gearhart 2002, Gearhart 2001). Due to this, NCDMF is evaluating future management options that may reduce the total cost of the monitoring program and better direct efforts in problematic areas. One option currently being discussed between NCDMF staff, in consultation with NMFS, is the elimination of the mainland restricted areas. However, this would not open any deep water portions of Pamlico Sound to large mesh gillnets, and would not eliminate gear restrictions or observer coverage. If this option is collectively agreed upon, NCDMF could direct resources more efficiently to the Outer Banks side of Pamlico Sound.

NCDMF currently implements management measures in the fall small mesh gillnet fishery that are effective in maintaining reduced sea turtle interaction potential. Specifically, attendance requirements are established 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 (Price 2004, Gearhart 2003). NCDMF anticipates that there will be no change in the trend of no sea turtle interactions in small mesh gillnets by continuing these efforts.

During 2004, the majority (78%) of all sea turtle interactions were observed between September 18 and October 26, 2004. There were only two turtles observed after this time period, both of which were alive and released in good condition. This temporal trend in peak sea turtle interactions in commercial gillnets has remained consistent with little variation since 1999, when intensive, annual monitoring efforts throughout Pamlico Sound began. Future management alternatives may include less intensive monitoring protocols during periods of known decreased sea turtle take potential. Similarly, increased monitoring would be maintained during “peak” times when observed interactions have occurred. Further, observer coverage would be directed towards “hotspots” of known activity (Price 2004, Gearhart 2003).

In the past couple of years, NCDMF has increased the outreach that is conducted to the commercial industry throughout the Pamlico Sound. This has been done to educate the local fishing communities about federal regulations such as the Endangered Species Act (1973), and the Marine Mammal Protection Act (1972). Further, NCDMF attempts to inform the commercial industry about current management programs that adhere to federal law, are designed to sustain resources, and maintain the livelihoods of small coastal communities. Seemingly, this has produced some positive results as fishermen are reportedly altering their fishing practices in attempt to reduce sea turtle interactions. Fishery managers from the federal, state, and private sectors can increase the commercial fishing industry participation and compliance, through continued educational outreach efforts, and by involving the commercial industry in making management decisions. These cooperative efforts have the potential to sustain resources for long-term use, and significantly reduce the incidence of endangered or threatened species interactions.

Conclusions and Recommendations

The Incidental Take Permit facilitating monitoring efforts for the past three years, throughout the PSGNRA expired in December 2004. NCDMF is in the process of reapplying for another long-term ITP that will protect sea turtles and maintain economically critical fisheries to which Outer Banks communities and the state of North Carolina depend upon. From 2002 – 2004, management of the Pamlico Sound fall large mesh gillnet fishery has been successful in maintaining reduced sea turtle interactions while maintaining commercial fisheries in this area. Future management of this fishery will remain proactive and have the flexibility to adjust to current needs for resource conservation.

The only limitation for the continued success of reducing protected species interactions hinges on funding sources to maintain this work. This program remains costly and requires a complex 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 the economies of small coastal communities on many levels. Commercial fishermen are increasingly aware of the need to reduce interactions of federally protected species. The increased understanding, compliance, and participation by the commercial industry in management measures validate this. Sea turtles frequent North Carolina estuarine waters and there is a continued need to reduce sea turtle interactions in Pamlico Sound. Equally important is the need to maintain these viable fisheries to which so many people depend upon. Because of this, NCDMF recommends that the NMFS assist in funding a long-term program. Multi-year management 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.

Finally, the NCDMF organized a Sea Turtle Advisory Committee (STAC) under the Marine Fisheries Commission in 2003 to gather all relevant information pertaining to sea turtle interactions in commercial fisheries throughout North Carolina. Since its inception, the STAC has gathered information from federal, state, private, commercial, and recreational stakeholders pertaining to issues of endangered species interactions in commercial fishing operations throughout North Carolina. Currently, the STAC is in the process of compiling this information, identifying problems (i.e., data needs), and developing solutions for managers and the commercial industry. Collectively, this will be a part of a comprehensive report inclusive with recommendations to the Marine Fisheries Commission, and NMFS. The committee hopes that

the recommendations can be utilized by fishery managers to reduce protected resource interactions, and maintain commercial fisheries.

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