



Sea Turtle Bycatch Monitoring of the 2008 Fall Gillnet Fisheries in Southeastern Pamlico Sound, North Carolina

**Completion Report for Activities under Endangered Species Act
Section 10 Incidental Take Permit # 1528**

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March 2009

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Introduction

The Pamlico Sound Gillnet Restricted Area (PSGNRA) originated in 2000, and has been managed since under protocols established by the North Carolina Division of Marine Fisheries (NCDMF) and the National Marine Fisheries Service (NMFS). The PSGNRA is a permanent closure of Pamlico Sound to large mesh gillnets (> 4 ¼ in. stretch mesh, FR Vol. 67, No 173 56931), established due to increased observations of sea turtle strandings, and subsequent observed gillnet interactions in 1999 along the Outer Banks (Gearhart 2001). A limited, shallow water gillnet fishery continues to operate through Section 10 Incidental Take Permits (ESA 1973) along the mainland side and Outer Banks of Pamlico Sound.

Habitat Conservation Plans (HCPs) within Section 10 Incidental Take Permits (ITPs) allowed establishment of an extensive monitoring program in this region since 2000 (Gearhart 2001, 2002, 2003; Price 2004, 2005, 2006, 2007, 2008). Fishery management measures within HCPs restrict areas, seasons, and gear, mandate observer coverage, and require weekly reporting. These actions protect sea turtles, allow a limited shallow water gillnet fishery, and characterize catch, effort, and bycatch along the Outer Banks and mainland side of Pamlico Sound from September through December of each year.

In August 2005, ITP # 1528 was issued to the NCDMF to manage the PSGNRA. The ITP #1528 was authorized for six years and will expire December 31, 2010. Since 2005, management methods throughout the PSGNRA have been consistent.

Characterization of the large mesh gillnet fishery in terms of sea turtle bycatch has depicted some changes to past trends. Subsequently, and in conjunction with commercial fishery outreach, proposed management changes are currently being considered for the 2009 PSGNRA and include net-shot length requirements and an increase in enforcement.

Methods

The management of the PSGNRA during the 2008 fishing season was consistent with measures established in ITP # 1528 (ESA 1973) and remained identical to protocols established since 2005 (Price 2006, 2007, 2008). Stipulations of the conservation plan included: weekly logbook reporting, mandatory observer coverage, an enforced violation system, NCDMF Marine Patrol monitoring, and immediate closure of the fishery should authorized sea turtle take levels be exceeded.

Habitat Conservation Plan

In August 2008, the NCDMF issued proclamation M-13-2008, which established the PSGNRA. This proclamation closed all internal waters of Pamlico Sound south and west of the 35° 46.3000' N latitude line, east of the 76° 30'.0000 W longitude line, and north of the 35° 00.0000' N latitude line except for the restricted areas SGNRA1 – SGNRA4, and a 200-yard corridor along the mainland side of the sound (MGNRA), (Figure 1). Proclamation M-13-2008 also established gear restrictions including a 2,000-yard limit for all gillnet fishing operations and required small mesh gillnet attendance until November 1. Sea turtle interaction reporting was required. All fishermen along the Outer Banks (SGNRA 1 – SGNRA4) using large mesh gillnets were required to obtain a PSGNRA permit from the NCDMF. Provisions of the permit established mandatory logbooks, weekly reports from active fishermen, and observer coverage.

Weekly Reporting

PSGNRA active permit holders operating along the Outer Banks (SGNRA1 – SGNRA4, Figure 1) were required to submit weekly fishing reports to NCDMF. Each fishing week began on Saturday and ended on Friday. Fishermen were required to submit reports by 6:00 p.m. on Sunday for the previous week's catch and effort information. Active permit holders reported the following information each week: port of landing, restricted area fished, length (yards) of gillnet fished, soak time (days), number and disposition of sea turtles caught, and whether the fishermen had taken an observer during the week.

Failure to report accurate and timely information each week resulted in permit suspensions. Fishermen were required to report all sea turtle interactions to the NCDMF within 24 hours. Penalties for late and non-reporting increased with subsequent offenses ranging from a 10-day suspension to a 6-month revocation of the PSGNRA permit. A cross-reference system was implemented with NCDMF Marine Patrol and local community fish house reports in 2005 and continued in the 2008 PSGNRA fishing season to ensure industry compliance with reporting requirements.

Compliance Checks

NCDMF observers and NCDMF Marine Patrol conducted weekly fish house visits, boat patrols, fisherman spot checks, gear checks, and continued outreach to the industry for the purpose of ensuring industry compliance and communicating efforts throughout the PSGNRA (e.g., timely/accurate reporting, proper gear use). Aerial surveys were scheduled for the 2008 season.

NCDMF observers obtained trip ticket information from all fish houses throughout the PSGNRA to cross-reference with a weekly reporting database and determine late reporters, accuracy of reports, and non-reporters. Boat patrols, fishermen and gear checks were conducted regularly from September 1 – November 30, 2008 by NCDMF Marine Patrol. NCDMF Marine Patrol and staff were responsible for submitting weekly logs of these activities along with updated lists of violations.

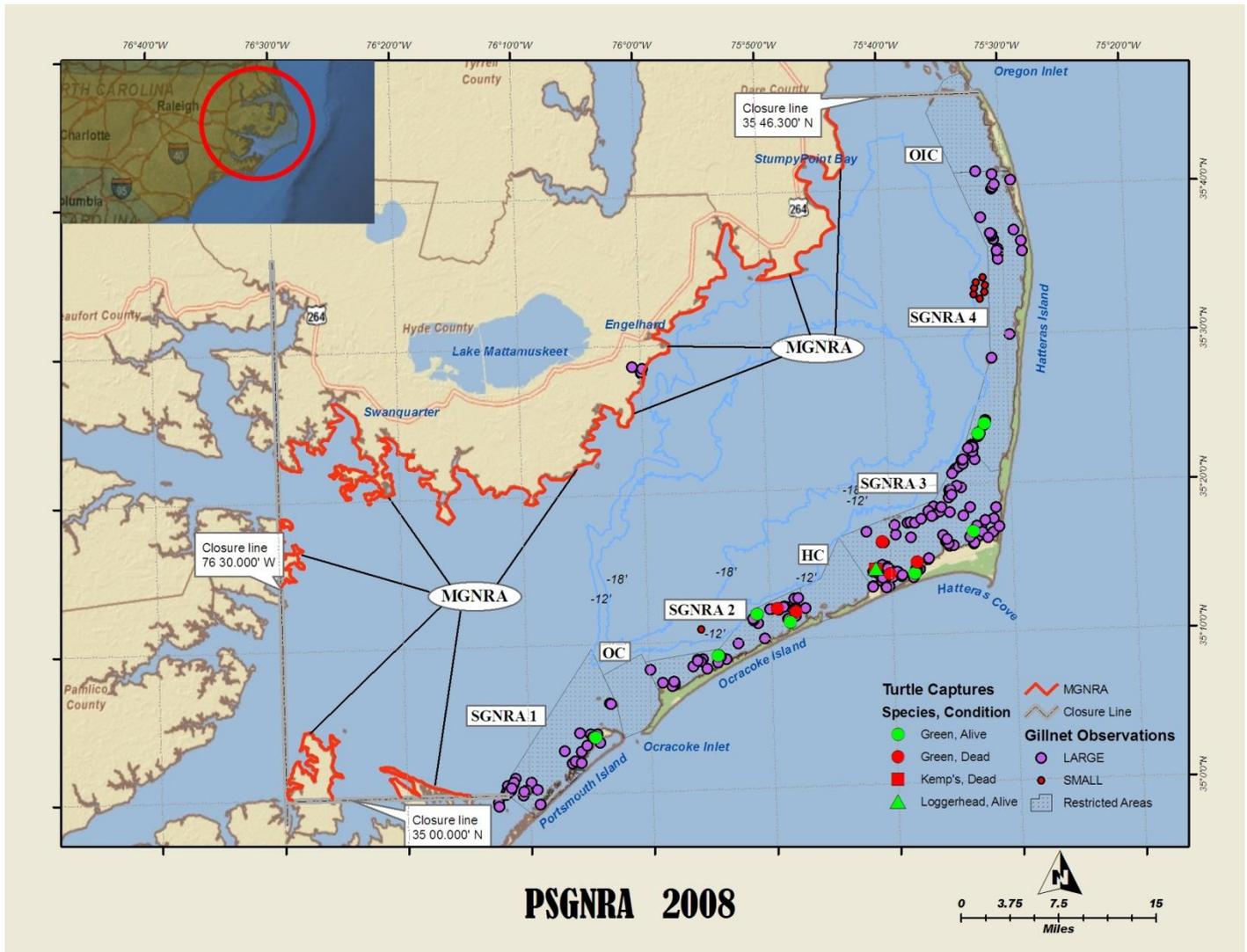


Figure 1. The Pamlico Sound Gillnet Restricted Area (PSGNRA) inclusive with large (≥ 5 in. stretch) and small (< 5 in. stretch) mesh gillnet observations, and observed sea turtle interactions for the 2008 season. SGNRA 1 – SGNRA 4 refer to Shallow Water Gillnet Restricted Area. MGNRA refers to the Mainland Gillnet Restricted Area. OC = Ocracoke Inlet Corridor (prohibited area); HC = Hatteras Inlet Corridor (prohibited area); OIC = Oregon Inlet Corridor (prohibited area).

Sea Sampling

Each observer was trained to identify, measure, resuscitate, and tag sea turtles by NMFS – Beaufort Lab and NCDMF. 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 (mm) were recorded for each turtle observed. Dead sea turtles were brought to shore when feasible. Carcasses not brought in for post-mortem examinations were marked with external flipper tags or spray-painted before disposal overboard. All live, debilitated sea turtles were brought to shore for examination and treatment. 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 (kgs) were obtained. Data were coded on NCDMF data sheets, double keyed, visually proofed, and uploaded to NCDMF Biological Database (Program 466) 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 ITP required a minimum goal of 2% coverage of the total large mesh gillnet fishing effort between September 1 and September 15, and from November 1 to November 30. A goal of 10% coverage of the total large mesh gillnet fishing effort was established from September 16 to October 31 2008. Observers were also required to obtain small mesh gillnet trips throughout the PSGNRA when feasible.

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 used to randomly assign observers to vessels by area 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 2007 PSGNRA trip distribution among ports. Mainland observer coverage was proportionally allocated based on the 2007 trip distribution of flounder gillnet trips among ports derived from trip tickets. Proportional observer coverage along the Outer Banks was updated weekly based on the relative effort from the previous week. Observer coverage along the mainland was obtained through contacts during regular fish house visits, and use of the PSGNRA database.

The total bycatch of sea turtles in the PSGNRA was estimated using the stratified ratio method (SAS 1989). 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 SGNRA1, SGNRA2, SGNRA3, SGNRA4, OIC, OC, and HC. Fishing effort was the product of net length (yds) and soak time (days). Total bycatch estimates were calculated weekly by adding estimates for each fishery within each restricted area. Estimates were accumulated each week to ensure authorized take levels were not being approached.

Authorized Takes

Take levels for the 2008 PSGNRA fishing season were the same as the 2007 season and based upon 2002 through 2004 observations using the upper 95% confidence limits around the estimated mean number of takes to account for a worst case scenario. The authorized take levels established in ITP # 1528 are scheduled to remain consistent each year from 2005 through 2010 (Table 1).

Table 1. Authorized live and lethal takes under ITP # 1528.

Species	Maximum	Maximum	Total
	Authorized	Authorized	Authorized
	Estimated Lethal Takes	Estimated Live Takes	Take
Kemp's Ridley ¹	14	27	41
Green	48	120	168
Loggerhead ¹	3	38	41
Species Aggregate	65	185	250
<hr/>			
Species			Total Observed Take
Hawksbill	2 lethal or live, observed, all areas		2
Leatherback	2 lethal or live, observed, all areas		2
Kemp's ridley, green, loggerhead	6 lethal or live, any combination of species, observed, on the western shore of Pamlico Sound only		6
Total Observed Take	10		10
Total Estimated and Observed Take			260

¹ Kemp's ridley and Loggerhead estimated take will be based on a 3-year period (i.e, Kemp's ridley = 81 live, 42 lethal for 2005 - 2007 and 81 live, 42 lethal for 2008 - 2010; Loggerhead = 114 live, 9 lethal for 2005-2007 and 114 live, 9 lethal for 2008-2010) for purposes of exceeding the threshold. Estimated take of Kemp's ridleys and loggerheads varies greatly by year, thus combining years will account for some of the variability across years.

Conference Calls/Consultations

Conference calls were conducted between NCDMF and NMFS-Office of Protected Resources (Silver Spring, Md., and St. Petersburg, Fla.) throughout the 2008 PSGNRA season. Additional consultations were necessary during the 2008 PSGNRA season due to an increased number of observed sea turtle interactions, which resulted in the development of interim management measures during the first two of weeks of the season.

Results

Permit Activity

There were 151 PSGNRA permits issued throughout the 2008 season with a maximum of 52 reporting fishing activity during week 6 (Figure 2). An average of 32 fishermen reported weekly activity during the 14-week season. Peak activity was reported during the last week of September and continued through the second week in October.

A trend of an increased total number of permits issued relative to the total number of active fishermen during the PSGNRA continues (Figure 2), (Gearhart 2003, Price 2007). A total of 80 PSGNRA permits were active at least one trip during the 2008 PSGNRA season.

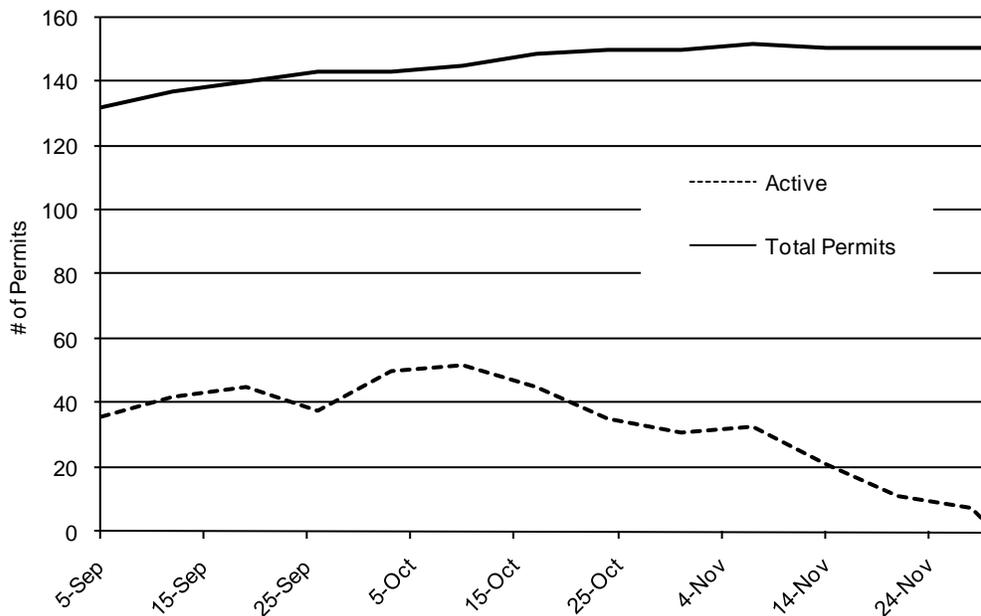


Figure 2. Number of total and active PSGNRA permits by week from 1 September – 30 November 2008.

Effort

There were 1,580 reported large mesh gillnet trips along the Outer Banks (Figure 1; SGNRA1 – SGNRA4) during the PSGNRA from 1 September to 30 November (Figure 3). Two primary peaks in effort were observed during the second week and between the fifth and seventh weeks of the 2008 PSGNRA. The maximum number of trips reported occurred during week 6 with 232 reported trips. There was an average of 159 trips per week for the first seven weeks, and an average of 66 trips per week for the last seven weeks of the 2008 PSGNRA (Figure 3).

Fishermen reported about 1.9 million yards of large mesh gillnet effort landing over 121,000 pounds of flounder (Table 2). Effort and landings were greatest around Hatteras Island (S1), where more than half of the total effort, and 46% of the total landings were reported. The percent of the total effort was similar in S1 and S2, but landings were increased in S2 relative to S1 (Figure 1, Table 2).

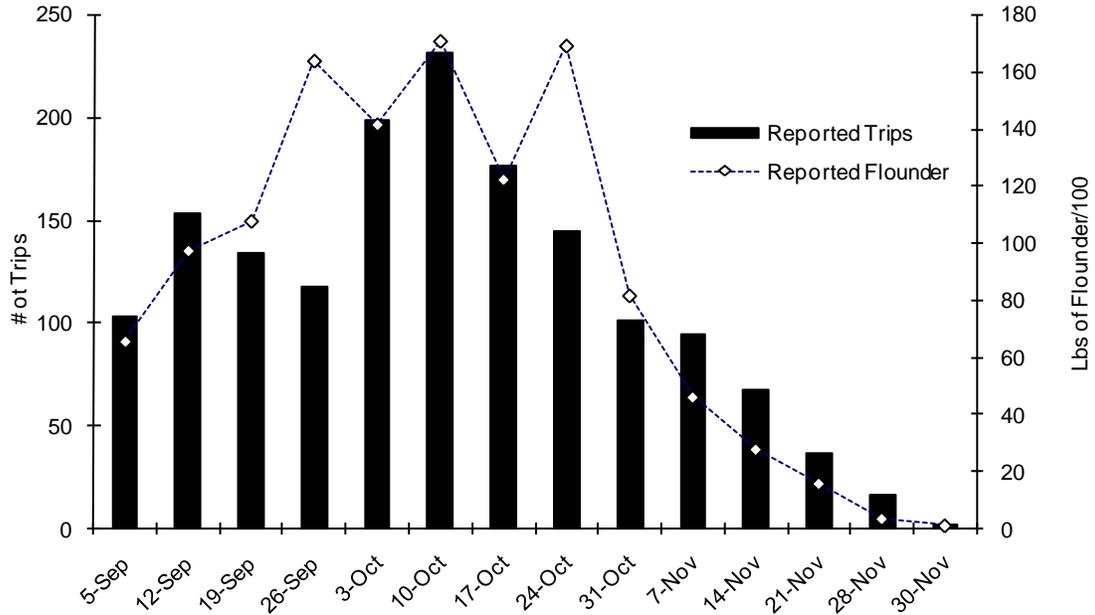


Figure 3. Total trips and pounds of southern flounder landed in the PSGNRA by week from 1 September to 30 November 2008.

Table 2. Reported effort (gillnet yd * soak day) and landings (lbs of flounder) with relative percent of total by area in the 2008 PSGNRA.

Area	Effort	Landings	% Total Effort	% Total Landings
S1	237,960	17,991	13	15
S2	251,320	23,061	13	19
S3	993,045	55,620	52	46
S4	418,685	24,605	22	20
Totals	1,901,010	121,277		

Three general peaks in weekly effort were observed during the second, fifth, and tenth week in the 2008 PSGNRA (Figure 4). Effort remained consistently higher by week in S3 relative to the other SGNRAs, barring similar effort in both S3 and S4 during the last few weeks of the season. Similar trends were observed with weekly flounder landings with a significant increase in flounder landings reported during week 8 of the 2008 PSGNRA. The highest reported effort occurred in week 6, while the highest reported landings occurred in week 8 (Figure 4, Table 3).

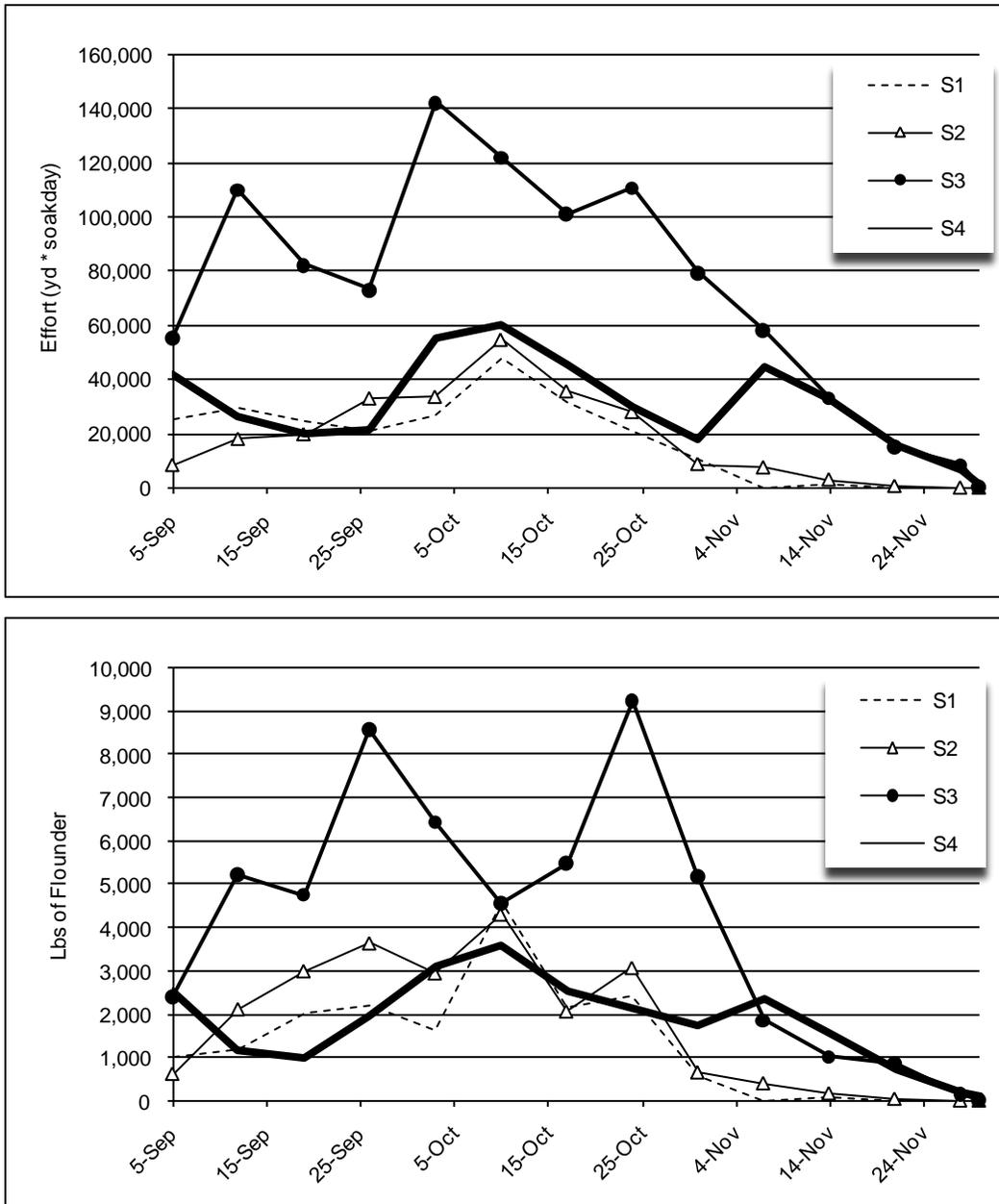


Figure 4. Large mesh gillnet effort and pounds of flounder by week in the PSGNRA from 1 September to 30 November 2008.

Coverage

A total of 166 observer trips were conducted aboard commercial gillnet vessels throughout the 2008 PSGNRA (Table 3). These were comprised of 157 large mesh and four small mesh gillnet trips along the Outer Banks, four large mesh trips along the mainland side of Pamlico Sound, and one large mesh trip in Core Sound. Observers covered more than 221,000 yards of gillnet during the 2008 PSGNRA with 214,000 of these along the Outer Banks. Observer coverage of the total reported effort ranged from 4 % to 19% by week barring the last two days of the season where no coverage of two reported trips was obtained. Observer coverage of the total reported trips ranged from approximately 3% to 21% throughout the 2008 season.

Combining weeks and areas, observers achieved an overall 11.3% coverage of the total reported large mesh gillnet fishing effort and a 9.9% of the total reported large mesh gillnet trips along the Outer Banks from 1 September to 30 November 2008 (Table 3).

Table 3. Observed and reported large mesh gillnet trips and effort (yd * soak day) in areas SGNRA1 – SGNRA4 with relative percent coverage by week in the PSGNRA from 1 September to 30 November 2008.

Week	Observed		Reported		%Coverage	
	Trips	Effort	Trips	Effort	Trips	Effort
5-Sep	6	9,515	103	130,880	5.8	7.3
12-Sep	19	30,550	153	184,150	12.4	16.6
19-Sep	10	11,830	134	146,200	7.5	8.1
26-Sep	4	5,900	118	148,485	3.4	4.0
3-Oct	18	23,565	199	258,315	9.0	9.1
10-Oct	20	28,590	232	285,400	8.6	10.0
17-Oct	23	32,690	177	213,980	13.0	15.3
24-Oct	11	19,305	145	189,675	7.6	10.2
31-Oct	12	15,235	101	116,700	11.9	13.1
7-Nov	14	17,580	95	110,600	14.7	15.9
14-Nov	14	13,070	68	69,900	20.6	18.7
21-Nov	5	4,800	37	31,375	13.5	15.3
28-Nov	1	1,800	16	14,750	6.3	12.2
30-Nov	0	0	2	600	0.0	0.0
Totals	157	214,430	1,580	1,901,010	9.9	11.3

Coefficients of variation (CV) were computed for both observed effort (yd * soak day) and observed flounder (lbs) for comparison (Figure 5). These calculations show the importance of using effort as a bycatch extrapolation factor as opposed to observed flounder catches. An increased variability was observed using landings for CV calculations and CV's average greater than 81% with this parameter. CV's remained below 50% for the majority (79%) of all fishing weeks, while the CV's for observed flounder were significantly greater than 50% for all fishing weeks (Figure 5).

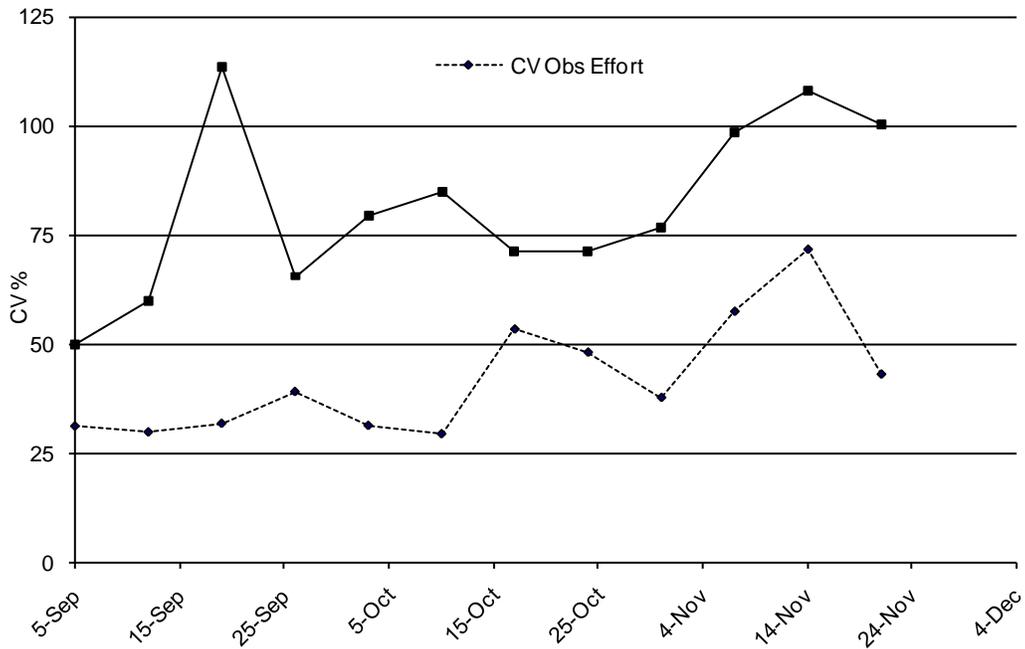


Figure 5. Coefficients of variation (CV) by week for two measures of large mesh gillnet fishing effort (lbs of flounder landed vs. effort (yd * soak day) observed in the PSGNRA from 1 September to 30 November 2008.

Fishermen logbooks and observer weekly reports for flounder catches and effort tracked closely throughout the 2008 PSGNRA (Figure 6). Some divergence was apparent with reported and observed effort in the first and middle of the PSGNRA season as logbooks appeared to be reporting less yards than actually fished. The divergence towards the later week of the season was a typical observation as effort plummets towards the close of the season.

Observed and reported catches tracked closely throughout the season barring a divergent trend during the later weeks of the PSGNRA (Figure 6). Trends in both reported and observed effort remained consistent with previous years of PSGNRA management and continue to appear accurate. Representative coverage of the fishery was obtained during the 2008 PSGNRA season (Figure 6).

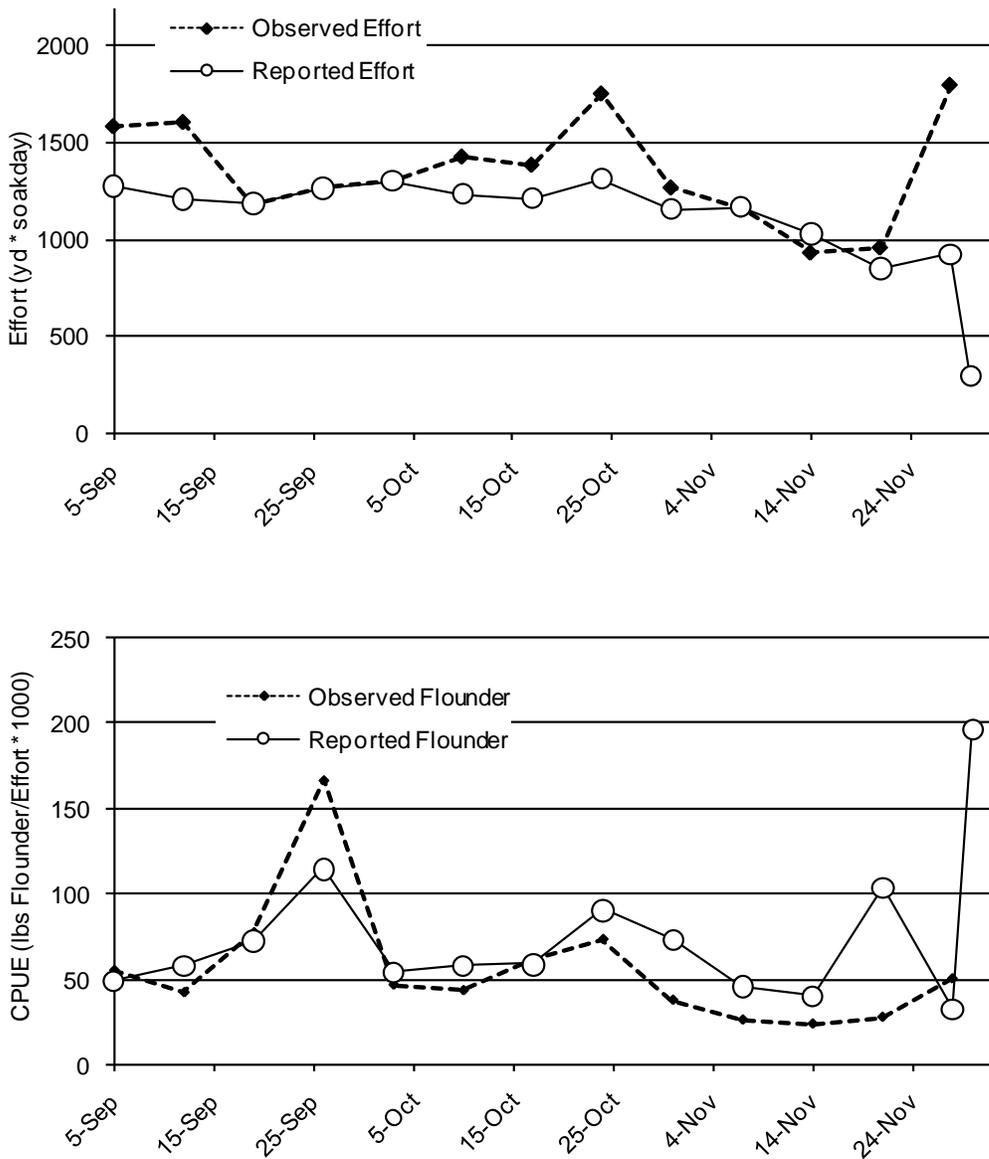


Figure 6. Effort (yd * soak day) and catch per unit effort (CPUE: lbs flounder\1000 yd\day) for observed large mesh gillnet trips and fishermen logbooks in the PSGNRA from 1 September - 30 November 2008.

Gear Parameters

More than 1,900 large mesh gillnet sets were observed during the 2008 PSGNRA season. The most common stretch mesh size observed a 6-inch stretch mesh with 0.49 mm twine soaking for just under 24 hr (Table 4). Fishermen generally deployed an average of 1,355 yards of gillnet per trip soaking the gear in less than 1 m of water. Net sets were observed in as

little as 0.2 m depth. A maximum of a 144 hr soak time was observed on a 60 yd shot of gillnet that had been lost and then retrieved with an observer. This net contained relatively no catch as the net had been grassed and rolled by prevailing winds.

Fewer small mesh gillnet sets were observed during the 2008 PSGNRA as observers concentrated efforts primarily on large mesh operations. The typical small mesh set was a 3-inch stretch with 0.52 mm twine deployed in about 2.6 m of water. These nets observed exclusively soaked for 24 hours and the operations consisted of nets that totaled 870 yds in length.

It should be noted for both large and small mesh gillnet fisheries operating throughout the Pamlico Sound during the fall of each year, total net shot lengths were significantly less than the total yards per trip. This was due to fishermen deploying multiple shots of net (~75 yd in length) to comprise their operation.

Table 4. Summary statistics for large (> 5 in stretch) and small (< 5 in stretch) mesh gillnet observations in the PSGNRA from 1 September to 30 November 2008.

Mesh	Gear Parameter	N	Min	Mean	Max
Large	Mesh Size (in)	1,913	5.25	6.02	7.50
	Twine Size (mm)	1,913	0.47	0.49	0.58
	Set Depth (m)	1,913	0.20	0.90	3.00
	Soak Time (hr)	1,913	12.00	23.67	144.00
	Yards/Trip	152	350.00	1355.00	2000.00
Small	Mesh Size (in)	45	2.88	3.04	4.00
	Twine Size (mm)	45	0.47	0.52	0.52
	Set Depth (m)	45	0.60	2.63	4.10
	Soak Time (hr)	45	24.00	24.00	24.00
	Yards/Trip	4	80.00	872.00	1800.00

Observed Species

Paralichthid flounders represented the majority (46%) of the large mesh gillnet catches by number (Table 5). Another 30% of the total catch by number was comprised of Atlantic menhaden *Brevoortia tyrannus*, bluefish *Pomatomus saltatrix*, cownose rays *Rhinoptera bonasus*, red drum *Sciaenops ocellatus*, and stingrays *Dasyatidae*. Atlantic sturgeon *Acipenser oxyrinchus*, were not observed in the 2008 PSGNRA. Sea bird bycatch consisted of double-crested cormorants *Phalacrocorax auritus*, common loons *Gavia immer*, brown pelicans *Pelecanus occidentalis*, and herring gulls *Larus argentatus* (Table 5).

Table 5. Species, biomass sampled (kg) and number of individuals observed in large mesh gillnets in the PSGNRA from 1 September to 30 November 2009.

Scientific Name	Common Name	Total Number	Weight (kg) *	% Number	% Biomass
<i>Paralichthys lethostigma</i>	Southern Flounder	5,981	5,316.3	46.22	59.67
<i>Brevoortia tyrannus</i>	Atlantic Menhaden	1,126	227.6	8.70	2.55
<i>Pomatomus saltatrix</i>	Bluefish	987	610.0	7.63	6.85
<i>Rhinoptera bonasus</i>	Cownose Ray	606	.	4.68	.
<i>Sciaenops ocellatus</i>	Red Drum	538	928.0	4.16	10.42
Dasyatidae	Stingrays	519	.	4.02	.
<i>Callinectes sapidus</i>	Blue Crab	436	.	3.37	.
<i>Pogonias cromis</i>	Black Drum	412	549.1	3.18	6.16
<i>Paralichthys dentatus</i>	Summer Flounder	316	236.9	2.44	2.66
<i>Archosargus probatocephalus</i>	Sheepshead	260	309.0	2.01	3.47
<i>Paralichthys albigutta</i>	Gulf Flounder	176	89.7	1.36	1.01
<i>Limulus polyphemus</i>	Horseshoe Crab	168	.	1.30	.
<i>Synodus foetens</i>	Inshore Lizardfish	163	59.2	1.26	0.66
<i>Gymnura micrura</i>	Smooth Butterfly Ray	140	14.0	1.08	0.16
<i>Cynoscion regalis</i>	Weakfish	130	53.7	1.00	0.60
<i>Phalacrocorax Auritus</i>	Double-crested Cormorant	112	.	0.87	.
<i>Lagodon rhomboides</i>	Pinfish	111	27.1	0.86	0.30
<i>Trachinotus carolinus</i>	Florida Pompano	96	114.2	0.74	1.28
<i>Cynoscion nebulosus</i>	Spotted Seatrout	88	119.9	0.68	1.35
<i>Raja eglanteria</i>	Clearnose Skate	63	.	0.49	.
<i>Menticirrhus americanus</i>	Southern Kingfish	51	15.8	0.39	0.18
<i>Micropogonias undulatus</i>	Atlantic Croaker	50	14.7	0.39	0.16
<i>Leiostomus xanthurus</i>	Spot	45	9.3	0.35	0.10
<i>Menticirrhus</i> spp.	Kingfishes	34	10.6	0.26	0.12
Triglidae	Searobins	30	6.0	0.23	0.07
<i>Chaetodipterus faber</i>	Atlantic Spadefish	27	16.7	0.21	0.19
<i>Orthopristis chrysoptera</i>	Pigfish	25	5.9	0.19	0.07
<i>Astroscopus</i> spp.	Astroscopus Stargazers	23	11.5	0.18	0.13
Scyliorhinidae	Cat Sharks	16	29.6	0.12	0.33
<i>Chelonia Mydas</i>	Green Turtle	15	46.5	0.12	0.52
<i>Elops saurus</i>	Ladyfish	15	6.2	0.12	0.07
<i>Mugil cephalus</i>	Striped Mullet	14	24.9	0.11	0.28
<i>Malaclemys terrapin</i>	Diamondback Turtle	14	14.0	0.11	0.16
<i>Libinia</i> spp.	Libinia Spider Crabs	14	.	0.11	.
<i>Menticirrhus saxatilis</i>	Northern Kingfish	12	4.1	0.09	0.05
<i>Myliobatis freminvillei</i>	Bullnose Ray	10	.	0.08	.
<i>Gymnura</i> spp.	Butterfly Rays	9	.	0.07	.
<i>Gymnachirus melas</i>	Naked Sole	8	2.4	0.06	0.03
<i>Caranx hippos</i>	Crevalle Jack	7	4.8	0.05	0.05
<i>Rachycentron canadum</i>	Cobia	7	1.4	0.05	0.02
<i>Menippe mercenaria</i>	Florida Stone Crab	7	.	0.05	.
<i>Rhizoprionodon terraenovae</i>	Atlantic Sharpnose Shark	6	7.2	0.05	0.08
Ascidicea	Tunicates	5	.	0.04	.
<i>Caranx</i> spp.	Caranx Jacks	4	0.9	0.03	0.01
<i>Mustelus canis</i>	Smooth Dogfish	4	.	0.03	.
<i>Gavia Immer</i>	Common Loon	4	.	0.03	.
<i>Opsanus tau</i>	Oyster Toadfish	3	2.7	0.02	0.03
<i>Paralichthys</i> spp.	Paralichthid Flounders	3	1.8	0.02	0.02
<i>Ancylopsetta quadrocellata</i>	Ocellated Flounder	3	0.9	0.02	0.01
<i>Scomberomorus maculatus</i>	Spanish Mackerel	3	0.6	0.02	0.01
<i>Sphyrna tiburo</i>	Bonnethead Shark	3	.	0.02	.
<i>Dorosoma cepedianum</i>	Gizzard Shad	2	2.4	0.02	0.03
Cnidaria	Jellyfish	2	.	0.02	.
<i>Stomolophus meleagris</i>	Jelly Bomb	2	.	0.02	.
<i>Crassostrea virginica</i>	Eastern Oyster	2	.	0.02	.
<i>Pelecanus Occidentalis</i>	Brown Pelican	2	.	0.02	.
<i>Lobotes surinamensis</i>	Atlantic Tripletail	1	7.3	0.01	0.08
<i>Epinephelus guttatus</i>	Red Hind	1	5.2	0.01	0.06
<i>Seriola</i> spp.	Amberjacks	1	0.7	0.01	0.01
<i>Mycteroperca microlepis</i>	Gag	1	0.5	0.01	0.01
<i>Esox</i> spp.	Pikes	1	0.3	0.01	0.00
Purgamentum	Rubbish	1	.	0.01	.
<i>Carcharhinus</i> spp.	Requiem Sharks	1	.	0.01	.
<i>Carcharhinus leucas</i>	Bull Shark	1	.	0.01	.
<i>Leucoraga radiata</i>	Thorny Skate	1	.	0.01	.
<i>Caretta caretta</i>	Loggerhead Sea Turtle	1	.	0.02	.
<i>Lepidochelys kempii</i>	Kemp's Ridley Sea Turtle	1	.	0.02	.
<i>Larus Argentatus</i>	Herring Gull	1	.	0.01	.

Small mesh gillnet observations showed primarily weakfish *Cynoscion regalis* (45% by number), bluefish (25% by number) and southern kingfish *Menticirrhus americanus* (22% by number) catches (Table 6). There were only two red drum observed in small mesh nets and no sea bird were observed.

Table 6. Species, biomass sampled (kg) and number of individuals observed in small mesh gillnets in the PSGNRA from 1 September to 30 November 2008.

Scientific Name	Common Name	Total Number	Weight (kg) *	% Number	% Biomass
<i>Cynoscion regalis</i>	Weakfish	211	89.00	45.28	52.63
<i>Pomatomus saltatrix</i>	Bluefish	116	42.40	24.89	25.07
<i>Menticirrhus americanus</i>	Southern Kingfish	69	22.40	14.81	13.25
<i>Brevoortia tyrannus</i>	Atlantic Menhaden	26	2.97	5.58	1.76
<i>Cynoscion nebulosus</i>	Spotted Seatrout	16	6.93	3.43	4.10
<i>Leiostomus xanthurus</i>	Spot	6	0.40	1.29	0.24
<i>Paralichthys albigutta</i>	Gulf Flounder	4	0.50	0.86	0.30
Cnidaria	Jellyfish	3	.	0.64	.
<i>Sciaenops ocellatus</i>	Red Drum	2	1.60	0.43	0.95
<i>Pepilus triacanthus</i>	Butterfish	2	0.20	0.43	0.12
<i>Micropogonias undulatus</i>	Atlantic Croaker	2	0.10	0.43	0.06
<i>Dasyatis sabina</i>	Atlantic Stingray	2	.	0.43	.
<i>Mugil cephalus</i>	Striped Mullet	1	1.10	0.21	0.65
<i>Pogonias cromis</i>	Black Drum	1	1.00	0.21	0.59
<i>Menticirrhus saxatilis</i>	Northern Kingfish	1	0.50	0.21	0.30
<i>Callinectes sapidus</i>	Blue Crab	1	.	0.21	.
Scyliorhinidae	Cat Sharks	1	.	0.21	.
<i>Paralichthys dentatus</i>	Summer Flounder	1	.	0.21	.
<i>Sphoeroides maculatus</i>	Northern Puffer	1	.	0.21	.

Protected Species Bycatch

There were no marine mammals observed in the 2008 PSGNRA season. There were 17 sea turtles observed in large mesh gillnet operations from 8 September to 9 November 2008 (Table 7, Figure 1). All interactions occurred in the shallow water gillnet restricted areas (SGNRA 1 - SGNRA 4) along the outer banks. There was a total of 17 observed sea turtle interactions comprised of 15 green sea turtle *Chelonia mydas* (8 live, 7 dead); one live loggerhead *Caretta caretta*, and one dead Kemp's ridley *Lepidochelys kempii*. Greater than 41% of all interactions occurred during week 2 in SGNRA3 from 8 September - 11 September 2008 (Table 7).

Table 7. Observed sea turtle interactions by date, species, condition, carapace length (mm), and location in the PSGNRA from 1 September to 30 November 2008.

Week #	Date	Species	Condition	Carapace Length	Restricted Area	Location	Inconel Tag 1 (R R)	Inconel Tag 2 (L R)	Pit Tag	
2	1	8-Sep-08	Green	Dead	264	SGNRA3	N 35 14.543 W 75 41.250	na	na	na
2	2	8-Sep-08	Kemp's	Dead	496	SGNRA3	N 35 14.499 W 75 41.280	na	na	na
2	3	8-Sep-08	Loggerhead	Alive	569	SGNRA3	N 35 14.543 W 75 41.250	XXP 612	XXP 611	433 C373 B0A
2	4	9-Sep-08	Green	Dead	286	SGNRA3	N 35 16.333 W 75 40.655	na	na	na
2	5	10-Sep-08	Green	Dead	279	SGNRA3	N 34 14.569 W 75 41.269	na	na	na
2	6	10-Sep-08	Green	Alive	290	SGNRA3	N 35 14.176 W 75 38.066	XXP 532	na	485 8225 D47
2	7	11-Sep-08	Green	Dead	280	SGNRA3	N 35 14.184 W 75 40.082	na	na	na
3	8	15-Sep-08	Green	Alive	305	SGNRA1	N 35 03.793 W 76 04.507	XXP610	na	483 B3C0 B07
4	9	9/21/2008	Green	Alive	325	SGNRA2	N 35 11.749 W 75 51.063	XXP546	na	485 3371 A5E
5	10	9/29/2008	Green	Alive	278	SGNRA2	N 35 09.029 W 75 54.349	XXP548	XXP547	485 8480 D06
6	11	10/4/2008	Green	Dead	315	SGNRA2	N 35 12.095 W 75 49.379	na	na	na
6	12	10/8/2008	Green	Dead	335	SGNRA3	N 35 14.899 W 75 37.870	na	na	na
7	13	10/13/2008	Green	Dead	283	SGNRA2	N 35 11.814 W 75 47.909	na	na	na
8	14	10/22/2008	Green	Alive	301	SGNRA3	N 35 16.845 W 75 33.156	XXP609	na	485 32F6 976
10	15	11/3/2008	Green	Alive	305	SGNRA2	N 35 11.148 W 75 48.374	XXP608	na	485 6501 B4C
11	16	11/8/2008	Green	Alive	285	SGNRA4	N 35 23.436 W 75 32.527	XXP533	XXP534	485 23F3 30B
11	17	11/9/2008	Green	Alive	319	SGNRA4	N 35 24.096 W 75 32.007	XXP535	XXP536	485 1593 A60

Sea Turtle Bycatch Estimates

Weekly observations by area were used with the stratified ratio method to determine estimates of weekly sea turtle takes by species and disposition (Table 8). Fishing effort was measured by the yards of gillnet multiplied by the soak days. The bycatch rate was calculated by the number of interactions (by species, disposition, and area) divided by the observed fishing effort. The bycatch rate was then multiplied by the total reported effort for each week and each area that sea turtle interactions occurred. Weekly estimates were compiled by species and disposition and added cumulatively to ensure timely management measures could be implemented if necessary (Table 8).

Table 8. Observed large mesh gillnet sea turtle interactions by area and week with calculated bycatch rate, reported effort, total bycatch estimates throughout the PSGNRA from 1 September to 30 November 2008.

Week	Area	Observed Turtles	Species *	Observed Effort	Effort Bycatch Rate **	Reported Effort	Bycatch Estimate ***
2	S3	1	Green *	25,950	0.0385	110,300	4.25
2	S3	1	Kemp's *	25,950	0.0385	110,300	4.25
2	S3	1	Loggerhead	25,950	0.0385	110,300	4.25
2	S3	1	Green *	25,950	0.0385	110,300	4.25
2	S3	1	Green *	25,950	0.0385	110,300	4.25
2	S3	1	Green	25,950	0.0385	110,300	4.25
2	S3	1	Green *	25,950	0.0385	110,300	4.25
3	S1	1	Green	4,280	0.2336	24,500	5.72
4	S2	1	Green	2,900	0.3448	33,050	11.40
5	S2	1	Green	3,400	0.2941	33,650	9.90
6	S2	1	Green *	6,340	0.1577	54,780	8.64
6	S3	1	Green *	16,050	0.0623	122,510	7.63
7	S2	1	Green *	11,500	0.0870	35,700	3.10
8	S3	1	Green	8,400	0.1190	111,000	13.21
10	S2	1	Green	3,600	0.2778	7,500	2.08
11	S4	1	Green	5,130	0.1949	32,730	6.38
11	S4	1	Green	5,130	0.1949	32,730	6.38

* Denotes mortality

** Effort bycatch rate (# sea turtles/observed effort) is presented per 1,000 yards here

*** Decimals shown for total estimate purposes

A total of 103 sea turtle interactions was estimated from the observed 17 sea turtles in large mesh gillnets (Table 9). These were comprised of 59 live and 36 dead green sea turtles, four live loggerhead sea turtles and four dead Kemp's ridley sea turtles. Collectively, this represents a mortality rate of 39%. The four live loggerheads and four dead Kemp's will remain cumulative through the 2010 season (Table 9).

An increased interaction event occurred during week 2 of the PSGNRA and resulted in more than 40% of all interactions and 56% of the mortalities observed throughout the entire season. Thereafter, for the remainder of the season observed interactions were approximately one per week through week 11 of the 2008 PSGNRA and estimates remained below authorized thresholds for the 2008 PSGNRA season (Table 9).

Table 9. Allowable sea turtle take thresholds and total bycatch estimates by species and disposition in the PSGNRA from 1 September to 30 November 2008.

Species	Authorized Threshold Live Takes	Effort Estimate Live Takes	Authorized Threshold Lethal Takes	Effort Estimated Lethal Takes
Green	120	59	48	36
Kemp's Ridley ¹	27	0	14	4
Loggerhead ¹	38	4	3	0

¹ Kemp's ridley and Loggerhead estimated take will be based on a 3-year period (i.e., Kemp's ridley = 81 live, 42 lethal for 2005 - 2007 and 81 live, 42 lethal for 2008 - 2010; Loggerhead = 114 live, 9 lethal for 2005-2007 and 114 live, 9 lethal for 2008-2010) for purposes of exceeding the threshold. Estimated take of Kemp's ridleys and loggerheads varies greatly by year, thus combining years will account for some of the variability across years.

Sea Turtle Stranding Summary

Reported sea turtle strandings in North Carolina increased from 1995 to 2000. Prior to 1995, annual stranding totals averaged less than 200. Strandings reached their highest level in 2000 with 831 reported statewide. Strandings throughout North Carolina since that time averaged 417 strandings per year (2001 - 2008). Total reported strandings increased this past year from 342 in 2007 to 538 in 2008. From 2001 to 2007, strandings were made up of 62% loggerhead and 19% green. The species composition of strandings shifted in 2008 to 33% loggerhead and 54% green (North Carolina Wildlife Resources Commission Sea Turtle Stranding Network Database 2008).

NCDMF Marine Patrol Monitoring

There were 52 boat patrols and 3 flight surveys conducted by NCDMF Marine Patrol officers throughout the 2008 PSGNRA seasons (Table 10). Officers observed a total of 344 vessels and checked 169 of these for potential violations (e.g., undersize flounder, not having PSGNRA permit, improper gear). The table below shows five violations consisting of one written warning and four citations being issued during this time. However, there were more warnings issued during this time that have not been uploaded to the database at this time. In addition to boat and aerial patrols, NCDMF Marine Patrol officers frequented fish houses and made direct contacts with PSGNRA permit holders on a weekly basis to ensure compliance of management protocols were being adhered to.

Table 10. NCDMF Marine Patrol activity summary throughout the PSGNRA from 1 September to 30 November 2008.

Week	Boat Patrols	Aerial Patrols	Vessels Observed	Boats Checked	Violations	Areas Surveyed	Comments
1	3	1	6	6	0	S1, S2, S3	6 PSGNRA vessels boarded - 1 written warning
2	8	0	37	23	1	S1, S2, S3, S4, M, PS, HC, OC	8 PSGNRA vessels boarded - 1 violation
3	4	0	25	10	1	S2, M, PS, OC	11 PSGNRA vessels boarded - 1 violation
4	2	0	8	8	0	S3, M	17 recreational vessels observed / 4 vessels boarded
5	9	1	64	41	2	S2, S3, S4, M, PS, OIC, HC	39 PSGNRA vessels boarded - 2 violations; 2 recreational vessels boarded - 0 violations
6	8	1	107	37	0	S1, S2, S3, S4, M, PS, OIC, HC, OC	37 PSGNRA vessels boarded - 0 violations
7	2	0	6	6	0	S1, S2, OC	6 PSGNRA vessels boarded - 0 violations
8	3	0	11	11	0	S3, M, PS, HC	11 PSGNRA vessels boarded - 0 violations
9	1	0	6	6	0	S1, S2, OC	6 PSGNRA vessels boarded - 0 violations
10	2	0	18	5	0	S1, S2, M, PS, OC	5 PSGNRA vessels boarded - 0 violations; 13 mechanical dredgers observed in PS
11	3	0	16	16	0	S1, S2, M, OC, HC	16 PSGNRA vessels boarded - 0 violations
12	6	0	40	0	0	M, PS	mechanical dredgers observed only
13	1	0	0	0	0	M	no gill nets observed in area
Totals	52	3	344	169	4		

Industry Outreach

As with previous years, NCDMF conducted extensive outreach to the commercial fishing industry participating in the PSGNRA during the 2008 season (Price 2007). This was primarily accomplished through direct calls to key fishermen, and through a series of mail outs. The purpose of regular communications with the commercial fishermen is two-fold. First, it provides an opportunity for NCDMF to be apprised and respond to any reported or foreseeable problems. Secondly, it offers a chance to reiterate the importance of the process and for NCDMF to obtain active input from the industry. In the early fall of 2008, this was especially important following an increased number of sea turtle interactions during the second week of the PSGNRA. This prompted immediate NCDMF/NMFS conference calls and subsequent implementation of NCDMF Proclamation M-15-2008. This proclamation restricted net shot lengths and required a gear removal each day from 10 a.m. to 6:00 p.m.

The intent of this proclamation was to provide immediate increased protection to sea turtles. However, following a week of outreach and observations, it was determined that a serious safety hazard existed for many commercial fishermen having the gear removal requirement, and this was eliminated via proclamation M-16-2008. These events sparked daily communications from many industry fishermen and representatives. Outreach to the PSGNRA fishermen remains a necessary function of the management of this area for continuous information exchange and discussion of alternatives.

2001 – 2008 Net Interactions

Summary statistics were reviewed from PSGNRA large mesh gillnet observations from 2001 to present for the purpose of assessing trends with net parameters and sea turtle interactions. However, more than 14,500 individual nets and nearly 1.5 million yards of gillnet were observed in the PSGNRA in the fall southern flounder fishery during this time with only 80 sea turtle interactions observed. This created an inherent lack of statistical validity to a logistic regression model, and therefore only summary statistics were presented.

The vast majority (54%) of large mesh gillnet observations were of 6" stretch mesh with about 27% of these nets observed with less than 6" stretch mesh. The total range of mesh sizes was from 5 ¼ " stretch to 8 ¼ " stretch mesh. Most (66%) of these nets observed soaked for 24 hrs with 93% of all nets observed soaked for 24 hr or less. Vertical mesh counts (number of meshes from the leadline to the floatline) ranged from five to 40. The majority (42%) of gillnets were observed with 20 meshes deep. An additional 28% of gillnets were observed with 25 meshes deep. Gillnets were primarily (83%) deployed in one meter or less of water. Net shot lengths averaged 100 yd throughout this time period.

There was a total of 80 sea turtles observed in the PSGNRA from 2001 to 2008 with an approximate 30% at net mortality rate. These were observed in nets with stretch mesh sizes ranging from 5 ½ " to 6 ½ " stretch mesh with the majority (67%) observed in 6" stretch mesh. About 89% of the mortalities and 97% of the live interactions occurred in nets that soaked 24 hr or less. Most (61%) of the interactions occurred in net shots with lengths less than or equal to 100 yd with 54% of the mortalities occurring in net shots with lengths less than or equal to 100yd. Nearly 40% of all observed mortalities occurred in 400 yd shot nets. Most interactions occurred in nets that were 20 meshes deep (46%) and 25 meshes deep (25%). In review of more than 14,500 nets observed since 2001, the majority of observed net types (mesh size, meshes deep, etc), also represent the majority of sea turtle takes.

Discussion

The 2008 PSGNRA operated the entire season from 1 September through November. The total number of observed sea turtle interactions was fewer than the 2007 season, and estimates for the 2008 season remained below authorized thresholds. The fishery continued despite increased sea turtle interactions during the second week of the season. During this time, a total of seven sea turtle interactions were observed with a mortality rate exceeding 70%. Immediately following, and in consultation with NMFS, the NCDMF implemented proclamation M-15-2008 for one week. This proclamation required commercial fishermen to reduce net shot lengths (total yd of each string of net), established increased buoy marking requirements (for enforcement), and required fishermen to remove gillnets during the daytime. The idea of this proclamation was to reduce the potential for sea turtle interactions in large mesh gillnets by reducing the total amount of webbing in the water throughout the day. However, this created a severe safety hazard for commercial fishermen due to age, prevailing winds, and length of time to conduct operations. Because of this, proclamation M-16-2008 was established the following week, which eliminated the gear removal requirement. The net shot lengths and buoy requirements remained throughout the season.

Decreased interaction and mortality rates were observed following the second week of the 2008 PSGNRA. From the 15 September through the 9 November 2009, there were ten observed interactions with a significantly reduced mortality rate (30%) and represented trends more indicative of historic management of the PSGNRA. Multiple consultations were made between NCDMF staff, NCDMF Marine Patrol and commercial fishermen and fish dealers following the events during the second week of the PSGNRA. It was determined that some fishermen were using longer net shots, and deeper nets, while continuing to fish in relatively shallow water. Increased net depth and tie downs have an increased potential for sea turtle interactions and subsequent mortalities. However, the majority of commercial fishermen in the PSGNRA do not use these higher profile nets.

The NCDMF, through numerous past public meetings and personal correspondence has strongly encouraged and recommended the use of lower profile nets, which may have the potential to reduce interactions and mortality especially in the shallow water fishery throughout the PSGNRA. This line of reasoning and open communications will continue in the future management of the PSGNRA. Additionally, NCDMF is currently discussing some potential management changes for the 2009 season. These include such things as a permanent requirement of net shot length, establishing a maximum 24 hr soak time for gillnet gear, and mandating lower profile nets without the use of tie-downs. However, the latter may be limited in overall positive impact to sea turtles due to enforcement issues (e.g., officers would have to pull every piece of gear out of the water), and due to further burden to the commercial industry in having to purchase and rebuild new fishing gear. NCDMF will continue discussions among staff in and in conjunction with NMFS to collaboratively decide any potential changes for successive seasons.

The relative increase in interactions observed in 2007 and 2008 combined with reports from the commercial industry that more sea turtles have been observed in the shallow waters of North Carolina, remain a concern for fishery managers. Seemingly, natural resource conservation measures are working to increase sea turtle populations in the Pamlico Sound of North Carolina. Future management of commercial and recreational fisheries must respond and adapt in a fashion that will allow valuable resources to be harvested at a sustainable level, and continue to protect endangered/threatened species. This has been accomplished to date in the management of the Pamlico Sound large mesh gillnet fishery, and the PSGNRA provides an

prime example of functional fishery management and concurrent protection of sea turtles. The PSGNRA must remain a flexible, proactive, and responsive management regime.

The PSGNRA operating under an ITP allows for timely and effective management measures to be implemented in the event of severe events or anomalies as described above. However, the rigidity of such management measures may at times prevent immediate adaptation. In the case of the PSGNRA, the fishery is currently, relatively static (in terms of effort and lack of fishermen recruitment), and one that operates with a threshold of authorized sea turtle takes. The fishery operates with coexisting sea turtle distributions, and thus an inherent and potential predicament exists. Due to the relative increase in observed interactions in 2007 and 2008, logically NCDMF is in a position to review current authorized takes (ITP # 1528), reassess expected CPUEs of sea turtle bycatch, and ultimately apply for an amendment to existing parameters of the permit.

While this is not an option being considered at this time, it is important to understand that this may be part of NCDMF/NMFS considerations for future applications. If sea turtle populations increase, and commercial fishing remains static, a certain increase in the number of sea turtle interactions will likely ensue. Large scale fishery closures are not the primary option for many reasons. Foremost, industry resource and consumer use remain an integral part of our economy. Fishery closures not only eliminate this opportunity for one fishery or user group, but also have a confounding effect of fishery shifts and potential impacts in other sectors. With this said, increased pressure on other resources may only add to the potential for sea turtle interactions.

One potential necessity is a stakeholder review of the parameters and relevant sections of the Endangered Species Act (1973) in order to address protected species interaction concerns from a more practical standpoint. In addition, accurate population estimates of endangered or threatened species need to be obtained. Takes are authorized with the understanding that these will not impact recovering populations of sea turtles. The PSGNRA is authorized an estimated 260 takes annually and has rarely approached these numbers.

In addition, the continued development of bycatch reducing gears on a national and global scale is a must. Information exchange and collaboration between multiple global entities is critical in this process (Gilman et al. 2009). Many countries with known or increased sea turtle interaction problems have limited fishery management resources or awareness of the issue. Therefore, as sea turtle populations and distributions potentially increase and expand throughout United States waters, managers have a responsibility to address the problem on a local and regional scale.

The PSGNRA season remains authorized under Section 10 ITP # 1528, and will continue as scheduled beginning in the fall of 2009.

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