INTERSTATE FISHERIES MANAGEMENT PROGRAM IMPLEMENTATION FOR NORTH CAROLINA:

Study II: Documentation and Reduction of Bycatch in North Carolina Fisheries

Job 3: Characterization of the near-shore commercial shrimp trawl fishery from Carteret County to Brunswick County, North Carolina

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Study II

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Abstract

Observations were made of commercial shrimp trawl fisheries in the near shore waters of North Carolina from Carteret County to Brunswick County from 1 July 2007 to 30 June 2008. These observations were used to characterize the fishery and determine relative effort and discards of weakfish (*Cynoscion regalis*), spotted sea trout (*Cynoscion nebulosus*), spot (*Leiostomus xanthurus*), Atlantic croaker (*Micropogonias undulatus*), bluefish (*Pomatomus saltatrix*), Atlantic menhaden (*Brevoortia tyrannus*), southern flounder (*Paralichthys lethostigma*), and striped mullet (*Mugil cephalus*) as well as other federally and state managed species of finfish. Observations were made on 143 trips, consisting of 314 tows. Two different net types were observed: double seamed nets and tongue nets. The three commercially important species of shrimp (brown, white, pink) (*Farfantepenaeus aztecus*, *Litopenaeus setiferus*, *F. duorarum*) represented 21% of the total observed catch by weight. Atlantic croaker and spot were the most abundant finfish bycatch, representing 25% and 7% of the total observed catch by weight, respectively. Weakfish represented the largest regulatory discard by weight in both net types. The results of this study offer insights for fishery managers developing Fishery Management Plans and may assist in bycatch mortality estimates. Recommendations include expansion of the observer coverage in commercial shrimp trawl fisheries to encompass all seasons, establishing a long-term observer program throughout North Carolina commercial fisheries and requiring mandatory observer coverage in North Carolina commercial fisheries.

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Introduction

North Carolina's shrimp fishery targets three species of shrimp (brown, pink, and white) (*Farfantepenaeus aztecus*, *Litopenaeus setiferus*, *F. duorarum*), which are considered annual crops. Environmental conditions rather than fishery pressure regulates population size. All three commercially important shrimp in North Carolina are considered viable (NCDMF 2006 and 2008). The near shore ocean fishery accounts for 24% of the total harvest of shrimp in North Carolina, and is concentrated off the southern coast of North Carolina. Low cost imported shrimp, regulatory changes, and increased fuel prices have strained the industry and are likely contributing factors to the gradual decline in shrimp trawling effort since the mid 1990s (NCDMF 2006).

Commercial shrimp trawling in North Carolina began in 1916 in the Southport area (NCDMF 2006). The practice spread throughout the rest of North Carolina over the next couple of decades. Following World War II, there was a considerable increase in effort. Technological advances in the shrimp industry have increased the catching efficiency of larger boats. In the 1940s and early 1950s, a 45-60 foot vessel pulled a single trawl with a head rope length of 60-65 feet. Due to improvements in engine design, the same sized vessel, using four-barreled rigs, can now pull four nets with a combined head rope length of 120-160 feet. Four-barreled rigs allow fishermen to pull two nets from each outrigger. In the southern area (south of Beaufort Inlet) the near shore ocean fishery is conducted primarily on a day trip basis, mostly during the daylight hours.

Currently, the shrimp trawl fishery is allowed to operate in the estuarine and oceanic water of North Carolina, which is controversial because of its bycatch and discards, especially of commercial and recreationally valuable species such as flounder spp. (*Parlichthys lethostigma*, *P. dentatus*, and *P. albigutta*), gray trout (weakfish) (*Cynoscion regalis*), spot (*Leiostomus xanthurus*), and Atlantic croaker (*Micropogonias undulatus*). Bycatch is defined as "the portion of a catch taken incidentally to the targeted catch because of non-selectivity of the fishing gear to either species or size differences" (ASMFC 1994). Bycatch can be divided into two components: incidental catch and discarded catch. Incidental catch refers to retained or marketable catch of non-targeted species, while discarded catch is that portion of the catch returned to the sea as a result of regulatory, economic, or personal preference. Although several bycatch studies have examined the inshore shrimp trawl fishery (Logothetis and McCuistion, 2005), few characterize the near shore fishery of North Carolina's southern coast. Scientists, natural resource managers, and the general public agree that bycatch is an important issue that needs to be addressed; however characterizing the nature and extent of bycatch has proven difficult. The amount of bycatch can vary greatly from fisherman to fisherman, trip to trip and tow to tow. Factors that may affect bycatch include water temperature, water clarity, fishing location, tow time, and gear configuration (NCDMF 2006). Fishery managers continually face the issue of bycatch and discards in commercial and recreational fisheries. Discards impact fishery yields and fishery managers' ability to accurately assess fishery stocks (Fennessy 1994; Hall 1999).

Fishery managers understand the importance of obtaining accurate and timely bycatch and discard data from commercial fisheries. Scientists can obtain estimates through fishery-independent research projects, which can provide accurate size selectivity information, however, components of effort, catch, and discards in relation to commercial fisheries cannot be obtained. One way to obtain accurate estimates of effort, catch, and discards is through scientific observations made aboard commercial fishing vessels. Commercial fishery (fishery-dependent) observations allow the collection of real time catch and discard information, while

simultaneously utilizing the knowledge and expertise of commercial fishermen (Price and Rulifson 2004). Observer programs at both the state and federal level have proven to be valuable tools for fishery managers to characterize both directed catch and bycatch, document endangered or threatened species interactions, and provide information that can be used for stock assessments. All will assist in sustaining economically important populations of finfish species (French et al. 1982).

This project quantified bycatch of federally and state managed species of finfish including but not limited to: weakfish (*Cynoscion regalis*), spotted sea trout (*C. nebulosus*), spot (*Leiostomus xanthurus*), Atlantic croaker (*Micropogonias undulatus*), bluefish (*Pomatomus saltatrix*), Atlantic menhaden (*Brevoortia tyrannus*), southern flounder (*Paralichthys lethostigma*), and striped mullet (*Mugil cephalus*). These data will assist managers in sustaining coastal stocks, which are an important resource for both commercial and recreational fishermen. Protected species interactions were also documented: bottlenose dolphin (*Tursiops truncatus*) and loggerhead (*Caretta caretta*) sea turtles.

Methods

This study was conducted from 1 July 2007 to 30 June 2008 from Carteret County to Brunswick County, North Carolina (Figure 1). The National Marine Fisheries Service (NMFS) and the North Carolina Division of Marine Fisheries (NCDMF) trained observers to conduct weekly observer trips aboard commercial vessels operating in the near-shore ocean shrimp trawl fishery. Commercial fishermen were randomly selected, and observer effort was weighted by region using the NCDMF Trip Ticket Program to ensure that observers obtained proportional effort and catch data.

Each observer was trained to collect data under NCDMF protocols. NMFS staff provided training on protected species identification, handling, and tagging protocols. Observers sampled every tow, randomly taking approximately one fish basket (32 kg) sample to determine species composition. Total weight (kg) of shrimp of each tow was collected, and used to extrapolate total weights of all species. Data collections included: enumerating, measuring, weighing, and recording disposition of target and bycatch species; noting date, time, location, and net characteristics (head rope length, mesh size of wing and tail bag, turtle excluder device (TED) type, bycatch reduction device (BRD) type, etc.) of all sets and retrievals; and recording all protected species interactions, including tagging.

The results were stratified by net type (double seamed and tongue nets) and season (Winter: January - March, Spring: April - June, Summer: July – September, Fall: October - December). The results were analyzed to determine trends, to look for any key areas where management improvements are needed; and characterize currently unknown fishery parameters in these areas.

Results

The results provided varying trends among the two strata of season and net type. Observations were made in three seasons (spring, summer, and fall) and on two different net types (double seamed and tongue nets). Double seamed nets and tongue nets are both types of otter trawls. Otter trawls are cone shaped nets constructed of twine webbing of various types (nylon, spectra, and polypropylene). The net is forced open horizontally by the use of doors (or planers), one on either side of the net. The bottoms of the doors are typically rounded along the leading edge, with a metal runner protecting the typically wooden door and providing weight.

Typically a single float in the center of the top line, and weights (lengths of chain) run along the bottom line and are used to vertically open the mouth of the trawl. The nets are equipped with tickler chains, which are attached to the doors and drag along the bottom just in front of the footrope. The nets terminate in a tail bag (or cod end) where the catch is concentrated and retained during the tow. Double seamed nets typically fish lower in the water column and are used to target brown shrimp, while tongue nets fish higher in the water column and are used to target white shrimp. The following sections will discuss findings ranging from observed net sets to discard estimates and provide an overall characterization of effort, catch, and bycatch in commercial shrimp trawl fishery in the near shore waters from Carteret County to Brunswick County, North Carolina from 1 July 2007 to 30 June 2008.

Coverage

According to preliminary trip ticket data, there were 2,417 commercial shrimp trawl trips in the observed areas between 1 July 2007 and 30 June 2008. Observers were present on 143 commercial shrimp trawl fishing trips, consisting of 314 tows, and achieving 5.92% coverage (Figure 1). Observers obtained trips with 17 fishermen throughout the study. There were no observations in the winter (January, February, and March). Observers obtained 12.04% coverage during the spring (April, May, and June), 5.61% in the summer (July, August, and September), and 4.73% in the fall (October, November, and December) (Table 1).

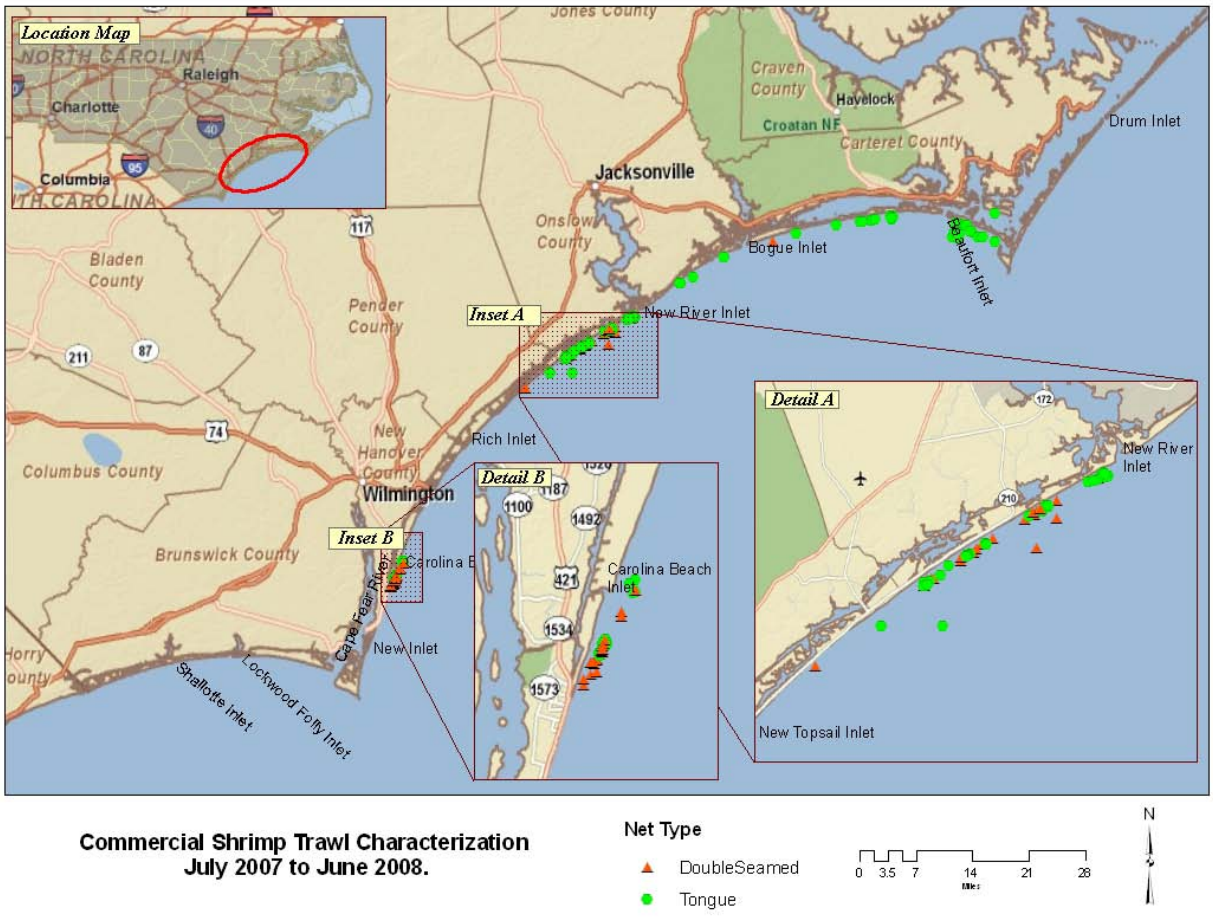

Figure 1. Study areas for commercial shrimp trawl observations made in North Carolina from 1 July 2007 through 30 June 2008.

Table 1. Total reported trips, total trips observed and percent coverage by month for commercial shrimp trawl observations made from Carteret County to Brunswick County, North Carolina, 1 July 2007 to 30 June 2008.

Month	Year	Total Observed	Total Trips	% Observed
July	2007	16	492	3.25
August		16	242	6.61
September		23	247	9.31
October		26	277	9.39
November		9	465	1.94
December		7	146	4.79
January*	2008	0	83	0.00
February*		0	60	0.00
March*		0	23	0.00
April*		4	42	9.52
May*		27	215	12.56
June*		15	125	12.00
Total		46	548	8.39

*Based on preliminary trip ticket data for 2008

Gear Parameters

Observers sampled commercial shrimp trawls consisting of two different net types: double seamed and tongue nets. Varying trends were observed in the two fisheries.

Double Seamed Net Fishery

There were 51 trips consisting of 100 tows observed in the double seamed net commercial shrimp trawl fishery. The majority (55%) of these trips were with four barrel rigs, while the remaining trips (45%) were with double rigged vessels (two barrel rigs). The head rope length ranged from 30 to 60 feet with the mean being 40 ft. The observed tow speed ranged from 1.90 to 3.50 knots with the mean being 2.72 knots. Tow time ranged from 30 to 140 minutes with the mean being 94.25 minutes. Polypropylene represented 41% of the type of webbing observed in this fishery, spectra represented 33% and nylon represented the remaining 26%. Spectra webbing is lighter than Kevlar, does not absorb water, and is a very strong, durable, low stretch fiber. The vast majority (92%) of observed trips used Super Shooter TEDs, while Straight Bar TEDs were observed on 6% of trips, and Inshore Hooped Hard TEDs accounted for the remaining 2%. All of the observed BRD types were the Florida Fish Excluder (Table 2).

Table 2. Summary statistics for the double seamed trawl net gear parameters from observations made from Carteret County to Brunswick County, North Carolina, 1 July 2007 to 30 June 2008.

Net Type	Gear Parameter	N	Min	Mean	Max
Double Seamed Net	Head Rope Length (ft)	51	30.00	40.04	60.00
	Wing Net Mesh (in)	51	0.88	0.88	0.88
	Tailbag Mesh (in)	51	0.75	0.76	0.88
	Depth (m)	50	6.10	7.56	9.10
	Tow Speed (kt)	51	1.90	2.72	3.50
	Placement of BRD/TT	51	60.00	64.61	65.00
	Placement of BRD/CL	51	8.00	9.88	10.00
	Vessel Length (ft)	50	50.00	54.30	65.00
	Tow Time (min)	100	30.00	94.25	140.00
	TED Type				
	Inshore Hooped Hard TED	1	*	*	*
	Super Shooter TED	47	*	*	*
	Straight Bar TED	3	*	*	*
	Rig Type				
	Two Barrel/Double Rigged	23	*	*	*
	Four Barrel	28	*	*	*
	Type of Webbing				
	Nylon	13	*	*	*
	Poly	21	*	*	*
	Spectra	17	*	*	*
	BRD Type				
	Florida Fish Excluder	51	*	*	*

*Not applicable

Tongue Net Fishery

There were 92 trips consisting of 214 tows observed in the tongue net commercial shrimp trawl fishery. Four barrel rigs represented 51% of the observed, double rigged vessels (two barrel rigs) represented 45% and single rigged nets accounted for the remaining 4% of observed trips. Head rope length ranged from 30 to 60 feet with a mean of 38 feet. The observed tow speeds in this fishery ranged from 1.4 to 4.0 knots with the mean being 2.45 knots. Vessel length observed ranged from 21 to 65 feet with the mean being 48 feet. Tow times ranged from 15 to 180 minutes, with the mean being 75.65 minutes. The vast majority (88%) of observed TED types were Super Shooter TEDs, while Straight Bar TEDs accounted for 5%, Inshore Hooped Hard TEDs accounted for 2%, and the remaining 4% of observed trips used no TED. No TED is required if the fisherman hauls back manually. Nylon webbing was observed on 49% of trips, polypropylene accounted for 28% of trips and the remaining 23% used spectra webbing. All observed trips used the Florida Fish Excluder (Table 3).

Table 3. Summary statistics for the tongue trawl net gear parameters from observations made from Carteret County to Brunswick County, North Carolina, 1 July 2007 to 30 June 2008.

Net Type	Gear Parameter	N	Min	Mean	Max
Tongue Net	Head Rope Length (ft)	92	30.00	38.20	60.00
	Wing Net Mesh (in)	91	0.81	0.88	0.94
	Tailbag Mesh (in)	91	0.75	0.76	0.88
	Depth (m)	92	3.40	7.96	12.00
	Tow Speed (kt)	91	1.40	2.45	4.00
	Placement of BRD/TT	92	5.00	63.47	65.00
	Placement of BRD/CL	92	8.00	10.55	65.00
	Vessel Length (ft)	92	21.00	47.98	65.00
	Tow Time (min)	214	15.00	75.65	180.00
	TED Type				
	Inshore Hooped Hard TED	2	*	*	*
	Super Shooter TED	81	*	*	*
	Straight Bar TED	5	*	*	*
	None	4	*	*	*
	Rig Type				
	Single rigged	4	*	*	*
	Two barrel/Double Rigged	41	*	*	*
	Four barrel	47	*	*	*
	Type of webbing				
	Nylon	45	*	*	*
	Poly	26	*	*	*
	Spectra	21	*	*	*
	BRD Type				
	Florida Fish Excluder	92	*	*	*

*Not applicable

Species Composition

The composition of species caught varied by net type. The net type corresponded to the time of year and the target species. Miscellaneous includes invertebrates not identified to genus level.

All Nets

There were more than 100 different species observed throughout the study in all net types. The three commercially important species of shrimp (brown, white, pink) combined represented 21.00% of the catch by weight (Table 4). Atlantic croaker accounted for 24.79% of the catch by weight. Spot represented 6.68% of the catch by weight. The three commercially important flounder species combined to represent 0.59% of the catch by weight. Other commercially important species of note include weakfish, kingfish (*Menticirrhus* spp.), and spotted sea trout which represented 2.08, 1.20, and 0.04% of the catch by weight, respectively (Table 4).

Table 4. Relative biomass (kg) observed in all net types combined in the commercial shrimp trawl fisheries from Carteret County to Brunswick County, North Carolina, 1 July 2007 to 30 June 2008.

Scientific Name	Common Name	Total Weight	% Biomass
Micropogonias undulatus	Atlantic Croaker	18,033.86	24.79
Farfantepenaeus aztecus	Brown Shrimp	7,919.18	10.88
Litopenaeus setiferus	White Shrimp	6,654.23	9.15
Leiostomus xanthurus	Spot	4,863.03	6.68
Cnidaria	Jellyfish	4,451.65	6.12
Trichiurus lepturus	Atlantic Cutlassfish	2,925.96	4.02
Gymnura micrura	Smooth Butterfly Ray	1,780.31	2.45
Larimus fasciatus	Banded Drum	1,752.48	2.41
Lagodon rhomboides	Pinfish	1,708.52	2.35
Miscellaneous	Miscellaneous	1,543.81	2.12
Cynoscion regalis	Weakfish	1,515.18	2.08
Rubbish	Rubbish	1,302.81	1.79
Synodus foetens	Inshore Lizardfish	1,281.03	1.76
Rhizoprionodon terraenovae	Atlantic Sharpnose Shark	1,114.74	1.53
Portunus spp.	Portunus Crabs	980.14	1.35
Cynoscion nothus	Silver Seatrout	965.87	1.33
Lolliguncula brevis	Atlantic Brief Squid	881.43	1.21
Anchoa hepsetus	Striped Anchovy	882.48	1.21
Menticirrhus americanus	Southern Kingfish	874.63	1.20
Raja eglanteria	Clearnose Skate	796.38	1.09
Dasyatis sabina	Atlantic Stingray	709.73	0.98
Farfantepenaeus duorarum	Pink Shrimp	703.89	0.97
Stenotomus caprinus	Longspine Porgy	655.80	0.90
Bairdiella chrysoura	Silver Perch	606.62	0.83
Rhinoptera bonasus	Cownose Ray	553.02	0.76
Stomolophus meleagris	Jelly Bomb	496.16	0.68
Peprilus paru	Harvestfish	410.76	0.56
Pomatomus saltatrix	Bluefish	392.23	0.54
Scomberomorus maculatus	Spanish Mackerel	377.26	0.52
Selene setapinnis	Atlantic Moonfish	369.05	0.51
Mustelus canis	Smooth Dogfish	339.88	0.47
Orthopristis chrysoptera	Pigfish	337.79	0.46
Squilla empusa	Mantis Shrimp	262.94	0.36
Dasyatis americana	Southern Stingray	244.24	0.34
Opisthonema oglinum	Atlantic Thread Herring	249.20	0.34
Paralichthys lethostigma	Southern Flounder	241.90	0.33
Peprilus triacanthus	Butterfish	229.25	0.32
Chlorophyta	Unidentified Green Algae	232.54	0.32
Myliobatis freminvillei	Bullnose Ray	225.85	0.31
Triglidae	Searobins	207.63	0.29
Scophthalmus aquosus	Windowpane	193.63	0.27
Citharichthys spilopterus	Bay Whiff	188.08	0.26
Paralichthys dentatus	Summer Flounder	181.35	0.25
Sphyrna tiburo	Bonnethead Shark	182.10	0.25
Limulus polyphemus	Horseshoe Crab	145.30	0.20
Archosargus probatocephalus	Sheepshead	120.78	0.17
Chloroscombrus chrysurus	Atlantic Bumper	125.04	0.17
Gymnura spp.	Butterfly Rays	127.28	0.17
Carcharhinus limbatus	Blacktip Shark	107.31	0.15
Trinectes maculatus	Hogchoker	77.68	0.11
Callinectes sapidus	Blue Crab	79.89	0.11
Selene vomer	Lookdown	69.27	0.10
Scomberomorus cavalla	King Mackerel	70.24	0.10
Chaetodipterus faber	Atlantic Spadefish	70.65	0.10
Eucinostomus argenteus	Spotfin Mojarra	65.70	0.09
Urophycis floridana	Southern Hake	66.29	0.09
Caranx ruber	Bar Jack	60.48	0.08
Chilomycterus schoepfii	Striped Burrfish	42.21	0.06
Menticirrhus saxatilis	Northern Kingfish	43.46	0.06
Symphurus spp.	Tonguefishes	45.56	0.06
Menidia menidia	Atlantic Silverside	33.27	0.05
Brevoortia tyrannus	Atlantic Menhaden	33.32	0.05

Table 4. Continued

Scientific Name	Common Name	Total Weight	% Biomass
Trachinotus carolinus	Florida Pompano	37.57	0.05
Dorosoma petenense	Threadfin Shad	39.37	0.05
Xiphopenaeus kroyeri	Atlantic Seabob	25.68	0.04
Ancylopsetta quadrocellata	Ocellated Flounder	25.96	0.04
Cynoscion nebulosus	Spotted Seatrout	28.46	0.04
Carcharias taurus	Sand Tiger Shark	29.44	0.04
Carcharhinus plumbeus(milberti)	Sandbar Shark	29.50	0.04
Lagocephalus laevigatus	Smooth Puffer	31.84	0.04
Libinia spp.	Libinia Spider Crabs	32.38	0.04
Centropristis ocyurus	Bank Sea Bass	32.45	0.04
Scyliorhinidae	Cat Sharks	19.82	0.03
Menippe mercenaria	Florida Stone Crab	20.32	0.03
Sphyraena borealis	Northern Sennet	21.25	0.03
Squalus acanthias	Spiny Dogfish	24.07	0.03
Busycon spp.	Whelks	10.94	0.02
Dasyatidae	Stingrays	11.26	0.02
Narcine bancroftii	Lesser Electric Ray	11.82	0.02
Alectis ciliaris	African Pompano	13.07	0.02
Diplodus holbrookii	Spottail Pinfish	13.49	0.02
Peprilus spp.	Peprilus Butterfish	13.69	0.02
Sphoeroides maculatus	Northern Puffer	3.90	0.01
Echinodermata	Starfish	3.92	0.01
Prionotus evolans	Striped Searobin	4.81	0.01
Pinnotheridae	Pea Crabs	4.96	0.01
Rachycentron canadum	Cobia	5.19	0.01
Paralichthys albigutta	Gulf Flounder	6.65	0.01
Aluterus spp.	Aluterus Filefishes	7.40	0.01
Mullus auratus	Red Goatfish	9.32	0.01
Pogonias cromis	Black Drum	10.48	0.01
Arbacia punctulata	Atlantic Purple Sea Urchin	10.86	0.01
Diapterus auratus	Irish Pompano	0.09	0.00
Anchoa mitchilli	Bay Anchovy	0.17	0.00
Hypleurochilus geminatus	Crested Blenny	0.36	0.00
Remora remora	Remora	0.40	0.00
Scomberomorus regalis	Cero	0.43	0.00
Balistes spp.	Balistes Triggerfishes	0.51	0.00
Paralichthys squamilentus	Broad Flounder	0.61	0.00
Arenaeus cribarius	Speckled Swimming Crab	0.70	0.00
Sicyonia parri	Parri Rock Shrimp	0.71	0.00
Mercenaria spp.	Quahogs	0.84	0.00
Menticirrhus littoralis	Gulf Kingfish	0.85	0.00
Neogastropoda stenoglossa	Conchs	1.18	0.00
Anomura paguridea	Hermit Crabs	1.27	0.00
Sciaenops ocellatus	Red Drum	1.50	0.00
Alosa mediocris	Hickory Shad	1.53	0.00
Octopus vulgaris	Common Octopus	1.61	0.00
Centropristis striata	Black Sea Bass	1.69	0.00
Menidia beryllina	Inland Silverside	2.63	0.00
Totals		72,759.35	100.00

Double Seamed Nets

There were more than 80 different species observed in the double seamed shrimp trawl nets. Shrimp was the most abundant species by weight, with all three commercially important species representing 27.61% of the catch. Brown shrimp accounted for most of the shrimp catch in these nets, representing 25.81% of the catch by weight. Atlantic croaker represented 25.11% of the catch by weight. Spot represented 7.64% of the catch by weight. The three commercially important species of flounder combined to represent 0.49% of the catch by weight. Weakfish represented 1.78% of the catch by weight (Table 5).

Table 5. Relative biomass (kg) observed in the double seamed commercial shrimp trawl fisheries from Carteret County to Brunswick County, North Carolina, 1 July 2007 to 30 June 2008.

Scientific Name	Common Name	% Number	Total Weight	% Biomass
Farfantepenaeus aztecus	Brown Shrimp	4.10	6,418.18	25.81
Micropogonias undulatus	Atlantic Croaker	1.59	6,244.09	25.11
Cnidaria	Jellyfish	6.12	2,044.17	8.22
Leiostomus xanthurus	Spot	2.32	1,898.67	7.64
Trichiurus lepturus	Atlantic Cutlassfish	2.85	840.96	3.38
Larimus fasciatus	Banded Drum	2.27	609.78	2.45
Gymnura micrura	Smooth Butterfly Ray	0.21	591.24	2.38
Lolliguncula brevis	Atlantic Brief Squid	5.34	588.69	2.37
Cynoscion regalis	Weakfish	2.12	443.75	1.78
Rubbish	Rubbish	0.00	403.13	1.62
Rhizoprionodon terraenovae	Atlantic Sharpnose Shark	0.17	361.30	1.45
Synodus foetens	Inshore Lizardfish	0.84	344.96	1.39
Lagodon rhomboides	Pinfish	1.30	344.76	1.39
Litopenaeus setiferus	White Shrimp	2.05	322.41	1.30
Portunus spp.	Portunus Crabs	6.11	254.73	1.02
Cynoscion nothus	Silver Seatrout	1.59	234.32	0.94
Anchoa hepsetus	Striped Anchovy	6.57	195.68	0.79
Stenotomus caprinus	Longspine Porgy	0.61	193.98	0.78
Rhinoptera bonasus	Cownose Ray	0.01	161.83	0.65
Menticirrhus americanus	Southern Kingfish	1.53	141.66	0.57
Bairdiella chrysoura	Silver Perch	1.89	133.74	0.54
Selene setapinnis	Atlantic Moonfish	11.95	129.80	0.52
Triglidae	Searobins	4.68	125.81	0.51
Farfantepenaeus duorarum	Pink Shrimp	1.54	123.17	0.50
Miscellaneous	Miscellaneous	0.09	121.84	0.49
Scomberomorus maculatus	Spanish Mackerel	0.73	117.59	0.47
Carcharhinus limbatus	Blacktip Shark	0.06	102.29	0.41
Squilla empusa	Mantis Shrimp	3.24	97.99	0.39
Scophthalmus aquosus	Windowpane	1.29	87.08	0.35
Sphyrna tiburo	Bonnethead Shark	0.00	86.93	0.35
Pomatomus saltatrix	Bluefish	0.29	80.05	0.32
Paralichthys lethostigma	Southern Flounder	0.09	78.04	0.31
Orthopristis chrysoptera	Pigfish	0.69	77.55	0.31
Scomberomorus cavalla	King Mackerel	0.84	70.05	0.28
Dasyatis sabina	Atlantic Stingray	0.03	68.47	0.28
Callinectes sapidus	Blue Crab	0.09	60.66	0.24
Citharichthys spilopterus	Bay Whiff	2.16	57.56	0.23
Mustelus canis	Smooth Dogfish	0.03	55.30	0.22
Paralichthys dentatus	Summer Flounder	0.34	41.88	0.17
Peprilus triacanthus	Butterfish	0.48	36.03	0.14
Chloroscombrus chrysurus	Atlantic Bumper	1.75	34.21	0.14
Selene vomer	Lookdown	3.59	29.42	0.12

Table 5. Continued

Scientific Name	Common Name	% Number	Total Weight	% Biomass
Trinectes maculatus	Hogchoker	1.06	27.75	0.11
Myliobatis freminvillei	Bullnose Ray	0.00	27.66	0.11
Dasyatis americana	Southern Stingray	0.04	25.72	0.10
Peprilus paru	Harvestfish	1.19	24.44	0.10
Brevoortia tyrannus	Atlantic Menhaden	0.24	24.19	0.10
Opisthonema oglinum	Atlantic Thread Herring	1.31	22.31	0.09
Menidia menidia	Atlantic Silverside	2.20	19.91	0.08
Scyliorhinidae	Cat Sharks	0.00	19.82	0.08
Ancylopsetta quadrocellata	Ocellated Flounder	0.23	19.39	0.08
Chlorophyta	Unidentified Green Algae	0.00	18.39	0.07
Raja eglanteria	Clearnose Skate	0.00	18.16	0.07
Chaetodipterus faber	Atlantic Spadefish	0.09	18.09	0.07
Gymnura spp.	Butterfly Rays	0.01	16.62	0.07
Libinia spp.	Libinia Spider Crabs	0.08	15.04	0.06
Caranx ruber	Bar Jack	0.50	13.36	0.05
Dasyatidae	Stingrays	0.01	11.26	0.05
Sphyraena borealis	Northern Sennet	1.39	11.03	0.04
Urophycis floridana	Southern Hake	0.05	9.09	0.04
Menticirrhus saxatilis	Northern Kingfish	0.18	8.16	0.03
Symphurus spp.	Tonguefishes	0.32	6.07	0.02
Alectis ciliaris	African Pompano	1.73	5.28	0.02
Rachycentron canadum	Cobia	0.00	5.19	0.02
Aluterus spp.	Aluterus Filefishes	2.21	4.75	0.02
Arbacia punctulata	Atlantic Purple Sea Urchin	0.06	4.34	0.02
Menippe mercenaria	Florida Stone Crab	0.01	4.28	0.02
Trachinotus carolinus	Florida Pompano	0.18	3.98	0.02
Centropristis ocyurus	Bank Sea Bass	0.20	3.68	0.01
Lagocephalus laevigatus	Smooth Puffer	1.11	3.64	0.01
Xiphopenaeus kroyeri	Atlantic Seabob	0.61	3.34	0.01
Prionotus evolans	Striped Searobin	0.10	3.30	0.01
Menidia beryllina	Inland Silverside	0.23	2.63	0.01
Paralichthys albigutta	Gulf Flounder	0.02	2.21	0.01
Octopus vulgaris	Common Octopus	0.00	1.61	0.01
Alosa mediocris	Hickory Shad	0.15	1.27	0.01
Menticirrhus littoralis	Gulf Kingfish	0.02	0.85	0.00
Mercenaria spp.	Quahogs	0.00	0.84	0.00
Paralichthys squamilentus	Broad Flounder	0.00	0.61	0.00
Balistes spp.	Balistes Triggerfishes	0.48	0.51	0.00
Scomberomorus regalis	Cero	0.14	0.43	0.00
Anchoa mitchilli	Bay Anchovy	0.22	0.17	0.00
Eucinostomus argenteus	Spotfin Mojarra	0.05	0.09	0.00
Totals		100.00	24,863.15	100.00

Tongue Nets

Over 90 species were observed in the commercial tongue net shrimp trawls (Table 6). The three commercially important shrimp species combined to represent 17.56% of the catch by weight. Atlantic croaker was the most abundant species by weight, accounting for 24.62% of the catch by weight. Spot represented 6.19% of the catch by weight. Weakfish represented 2.24% of the catch by weight. The three commercially important flounder species combined to represent 0.64% of the catch by weight. Kingfish (Southern (*Menticirrhus americanus*) and Northern(*M. saxatilis*)) represented 1.6% of the catch by weight. Spotted sea trout accounted for 0.06% of the catch by weight (Table 6).

Table 6. Relative biomass (kg) observed in tongue nets in the commercial shrimp trawl fishery from Carteret County to Brunswick County, North Carolina, 1 July 2007 to 30 June 2008.

Scientific Name	Common Name	Total Weight	% Biomass
Micropogonias undulatus	Atlantic Croaker	11,789.78	24.62
Litopenaeus setiferus	White Shrimp	6,331.82	13.22
Leiostomus xanthurus	Spot	2,964.37	6.19
Cnidaria	Jellyfish	2,407.49	5.03
Trichiurus lepturus	Atlantic Cutlassfish	2,085.01	4.35
Farfantepenaeus aztecus	Brown Shrimp	1,501.00	3.13
Miscellaneous	Miscellaneous	1,421.98	2.97
Lagodon rhomboides	Pinfish	1,363.75	2.85
Gymnura micrura	Smooth Butterfly Ray	1,189.06	2.48
Larimus fasciatus	Banded Drum	1,142.70	2.39
Cynoscion regalis	Weakfish	1,071.44	2.24
Synodus foetens	Inshore Lizardfish	936.07	1.95
Rubbish	Rubbish	899.67	1.88
Raja eglanteria	Clearnose Skate	778.22	1.62
Rhizoprionodon terraenovae	Atlantic Sharpnose Shark	753.43	1.57
Menticirrhus americanus	Southern Kingfish	732.98	1.53
Cynoscion nothus	Silver Seatrout	731.55	1.53
Portunus spp.	Portunus Crabs	725.41	1.51
Anchoa hepsetus	Striped Anchovy	686.79	1.43
Dasyatis sabina	Atlantic Stingray	641.27	1.34
Farfantepenaeus duorarum	Pink Shrimp	580.72	1.21
Stomolophus meleagris	Jelly Bomb	496.16	1.04
Bairdiella chrysoura	Silver Perch	472.88	0.99
Stenotomus caprinus	Longspine Porgy	461.83	0.96
Rhinoptera bonasus	Cownose Ray	391.18	0.82
Peprilus paru	Harvestfish	386.32	0.81
Pomatomus saltatrix	Bluefish	312.18	0.65
Lolliguncula brevis	Atlantic Brief Squid	292.75	0.61
Mustelus canis	Smooth Dogfish	284.58	0.59
Orthopristis chrysoptera	Pigfish	260.25	0.54
Scomberomorus maculatus	Spanish Mackerel	259.68	0.54
Selene setapinnis	Atlantic Moonfish	239.25	0.50
Opisthonema oglinum	Atlantic Thread Herring	226.88	0.47
Dasyatis americana	Southern Stingray	218.52	0.46
Chlorophyta	Unidentified Green Algae	214.15	0.45
Myliobatis freminvillei	Bullnose Ray	198.19	0.41
Peprilus triacanthus	Butterfish	193.23	0.40
Squilla empusa	Mantis Shrimp	164.95	0.34
Paralichthys lethostigma	Southern Flounder	163.86	0.34
Limulus polyphemus	Horseshoe Crab	145.30	0.30
Paralichthys dentatus	Summer Flounder	139.47	0.29
Citharichthys spilopterus	Bay Whiff	130.53	0.27
Archosargus probatocephalus	Sheepshead	120.78	0.25
Gymnura spp.	Butterfly Rays	110.67	0.23
Scophthalmus aquosus	Windowpane	106.55	0.22
Sphyrna tiburo	Bonnethead Shark	95.17	0.20
Chloroscombrus chrysurus	Atlantic Bumper	90.83	0.19
Triglidae	Searobins	81.82	0.17
Eucinostomus argenteus	Spotfin Mojarra	65.61	0.14
Urophycis floridana	Southern Hake	57.21	0.12
Chaetodipterus faber	Atlantic Spadefish	52.56	0.11
Trinectes maculatus	Hogchoker	49.94	0.10
Caranx ruber	Bar Jack	47.12	0.10

Table 6. Continued

Scientific Name	Common Name	Total Weight	% Biomass
Chilomycterus schoepfii	Striped Burrfish	42.21	0.09
Selene vomer	Lookdown	39.85	0.08
Symphurus spp.	Tonguefishes	39.49	0.08
Dorosoma petenense	Threadfin Shad	39.37	0.08
Menticirrhus saxatilis	Northern Kingfish	35.31	0.07
Trachinotus carolinus	Florida Pompano	33.59	0.07
Carcharhinus plumbeus(milberti)	Sandbar Shark	29.50	0.06
Carcharias taurus	Sand Tiger Shark	29.44	0.06
Centropristis ocyurus	Bank Sea Bass	28.77	0.06
Cynoscion nebulosus	Spotted Seatrout	28.46	0.06
Lagocephalus laevigatus	Smooth Puffer	28.20	0.06
Squalus acanthias	Spiny Dogfish	24.07	0.05
Xiphopenaeus kroyeri	Atlantic Seabob	22.34	0.05
Callinectes sapidus	Blue Crab	19.24	0.04
Libinia spp.	Libinia Spider Crabs	17.33	0.04
Menippe mercenaria	Florida Stone Crab	16.05	0.03
Peprilus spp.	Peprilus Butterfish	13.69	0.03
Diplodus holbrookii	Spottail Pinfish	13.49	0.03
Menidia menidia	Atlantic Silverside	13.36	0.03
Narcine bancroftii	Lesser Electric Ray	11.82	0.02
Busycon spp.	Whelks	10.94	0.02
Pogonias cromis	Black Drum	10.48	0.02
Sphyraena borealis	Northern Sennet	10.23	0.02
Mullus auratus	Red Goatfish	9.32	0.02
Brevoortia tyrannus	Atlantic Menhaden	9.12	0.02
Alectis ciliaris	African Pompano	7.79	0.02
Ancylopsetta quadrocellata	Ocellated Flounder	6.57	0.01
Arbacia punctulata	Atlantic Purple Sea Urchin	6.52	0.01
Carcharhinus limbatus	Blacktip Shark	5.02	0.01
Pinnotheridae	Pea Crabs	4.96	0.01
Paralichthys albigutta	Gulf Flounder	4.44	0.01
Echinodermata	Starfish	3.92	0.01
Sphoeroides maculatus	Northern Puffer	3.90	0.01
Aluterus spp.	Aluterus Filefishes	2.65	0.01
Centropristis striata	Black Sea Bass	1.69	0.00
Prionotus evolans	Striped Searobin	1.51	0.00
Sciaenops ocellatus	Red Drum	1.50	0.00
Anomura paguridea	Hermit Crabs	1.27	0.00
Neogastropoda stenoglossa	Conchs	1.18	0.00
Sicyonia parri	Parri Rock Shrimp	0.71	0.00
Arenaeus cribarius	Speckled Swimming Crab	0.70	0.00
Remora remora	Remora	0.40	0.00
Hypleurochilus geminatus	Crested Blenny	0.36	0.00
Alosa mediocris	Hickory Shad	0.26	0.00
Scomberomorus cavalla	King Mackerel	0.19	0.00
Diapterus auratus	Irish Pompano	0.09	0.00
Totals		47,896.20	100.00

Effort

Effort was defined as head rope length multiplied by number of nets multiplied by tow time and was calculated per hour. Season was defined as winter (January, February, and March), spring (April, May, and June), summer (July, August, and September) and fall (October, November, and December). Observed effort varied by season and net type.

Observed effort was highest during the summer in the double seamed shrimp trawl fishery. The summer accounted for 88% of the total observed effort. The spring fishery accounted for 12% of the total observed effort, while no effort was observed in the fall or winter season (Table 7 and Figure 2).

Table 7. Total number of trips, total number of tows, and tow times observed in the commercial shrimp trawl fishery from Carteret County to Brunswick County, North Carolina, 1 July 2007 to 30 June 2008.

Net Type	# Trips			# Tows			Min Tow Time (min)			Max Tow Time (min)			Avg Tow Time (min)		
	Spring	Summer	Fall	Spring	Summer	Fall	Spring	Summer	Fall	Spring	Summer	Fall	Spring	Summer	Fall
Double Seamed	15	36	0	24	76	0	30	40	*	105	140	*	64	104	*
Tongue	31	19	42	72	43	99	20	45	15	180	120	180	82	75	71

In contrast, the total observed effort in the tongue net fishery occurred primarily in the fall (42%) and spring (33%). The summer fishery accounted for the remaining 25% of total observed effort in the double seamed shrimp trawl fishery. No effort was observed in the winter season (Figure 2).

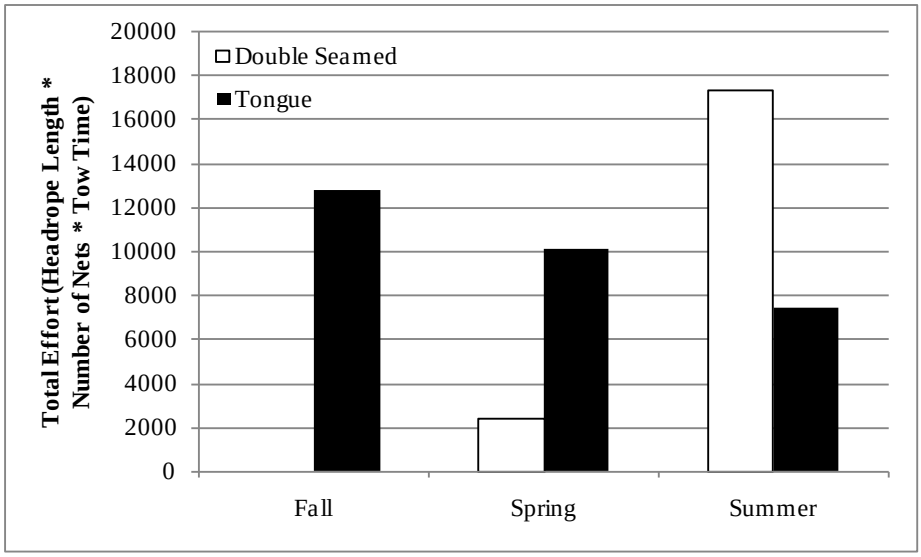

Figure 2. Total effort (head rope length*number of nets*tow time) per hour by net type observed in the commercial shrimp trawl fishery from Carteret County to Brunswick County, North Carolina from 1 July 2007 to 30 June 2008.

Key Species Catches

Total catch of key species was determined by calculating total weight (kg) by season and net type. Paralichthys species (flounder) and Mentichirrus species (weakfish) were combined to the genus level because of the relatively low numbers of individual species observed. Trends are discussed between double seamed and tongue nets.

Double Seamed Net Fishery

The double seamed net fishery primarily targeted brown shrimp, with the majority (98%) harvested during the summer. Atlantic croaker represented the largest bycatch of commercially important species in this fishery, while spot was the second most abundant. The majority of both Atlantic croaker (78%) and spot (95%) were harvested during the summer months (Figure 3).

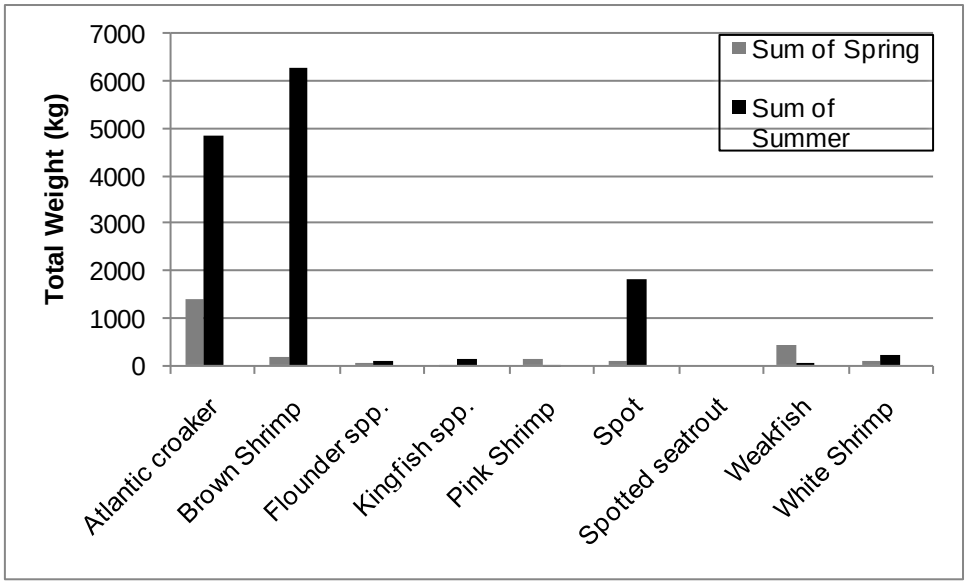

Figure 3. Total weight (kg) of commercially important species observed in the double seamed commercial shrimp trawl fishery from Carteret County to Brunswick County, North Carolina from 1 July 2007 to 30 June 2008.

Tongue Net Fishery

The tongue net fishery primarily targeted white shrimp. The majority (50%) of white shrimp in this fishery were caught in the fall, another 38% were caught in the summer, with the remaining 12% caught in the spring. Atlantic croaker was the most predominant commercially important bycatch associated with this fishery. Nearly half (45%) of the Atlantic croaker caught in this fishery were in the summer, another 29% were in the fall, and the remaining 26% occurred in the spring. Similar to the double seamed net fishery, spot was the second most abundant commercially important bycatch associated with the tongue net fishery. The spring accounted for 47% of the spot caught in this fishery, closely followed by the fall (41%), with the summer accounting for the remaining 12% (Figure 4).

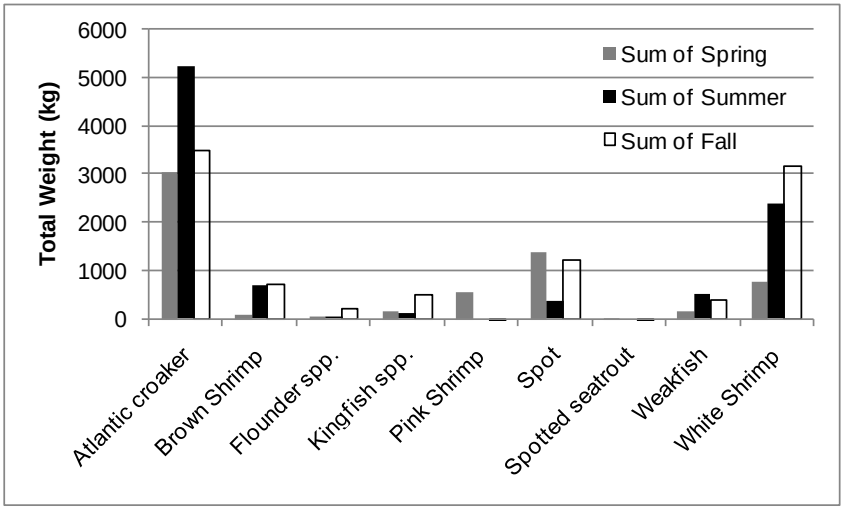

Figure 4. Total weight (kg) of commercially important species observed in the tongue net commercial shrimp trawl fishery from Carteret County to Brunswick County, North Carolina from 1 July 2007 to 30 June 2008.

Length Frequencies of Key Species

Length frequency data of a given population is important information used in the assessments of that population. Length frequency of commercially and recreationally important species in this study was stratified by season and binned into 10 mm groups.

The length frequency distribution of brown shrimp show the expected growth patterns of individuals maturing from the spring through the fall. The majority of individuals measured in the spring were between 80 and 100 mm, the majority of individuals measured in the summer were between 100 and 130 mm, and the majority measured in the fall ranged between 130 and 150 mm (Figure 5). The vast majority of pink shrimp were measure in the spring and the majority of those ranged between 100 and 130 mm (Figure 5). White shrimp length frequency distributions showed seasonal variation, with the majority of individuals measured in the summer ranging between 120 and 150 mm. The majority of individuals measured in the fall ranged between 140 and 180 mm and the majority in the spring ranged from 170 to 190 mm (Figure 5).

The vast majority of spotted sea trout measured (n=51) were in the spring with the majority of these ranging from 130 to 150 mm (Figure 6). Weakfish length frequency distributions showed no discernable trends, however 99.9% of those measured were under sized fish (less than 305 mm (12 in)) (Figure 6).

The majority of spot measured ranged from 120 to 140 mm in the spring, 90 to 130 mm in the summer, and 120 to 140 mm in the fall (Figure 7). Atlantic croaker length frequencies showed similar trends throughout the spring, summer, and fall. The majority of all Atlantic croaker measured ranged from 120 to 180 mm (Figure 7).

Southern kingfish length frequency distributions showed no discernable trends, however the majority of individuals measured ranged from 100 to 180 mm (Figure 8). The length frequency distributions of both summer flounder (n=109) and southern flounder (n=101) showed no discernable trends (Figure 9). The majority of individuals measured of both species were

undersized fish (less than 355 mm (14 in)), with only 3% of summer flounder and 5% of southern flounder being legal sized fish (Figure 9).

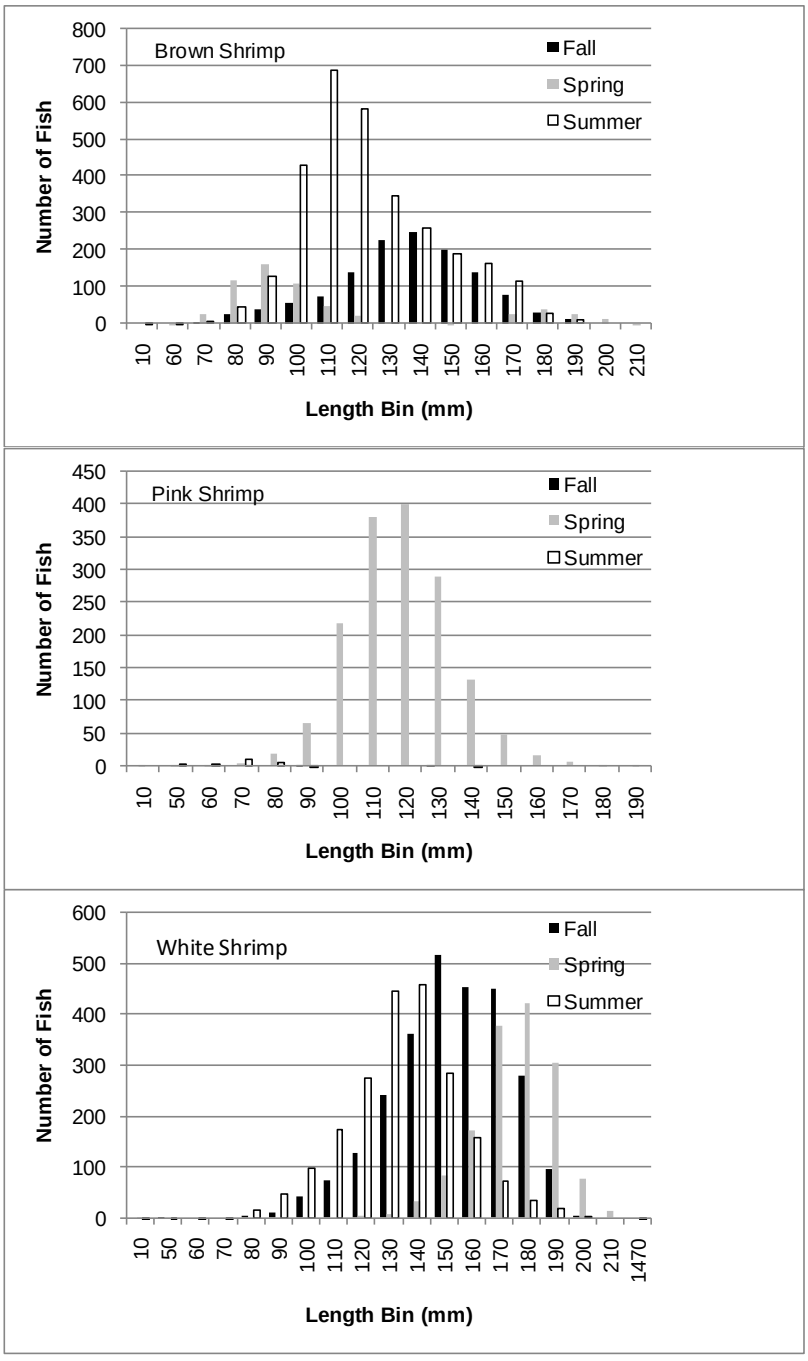

Figure 5. Length frequency of the three commercially important species of shrimp (brown, pink, white) observed in the commercial shrimp trawl fishery from Carteret County to Brunswick County, North Carolina from 1 July 2007 to 30 June 2008.

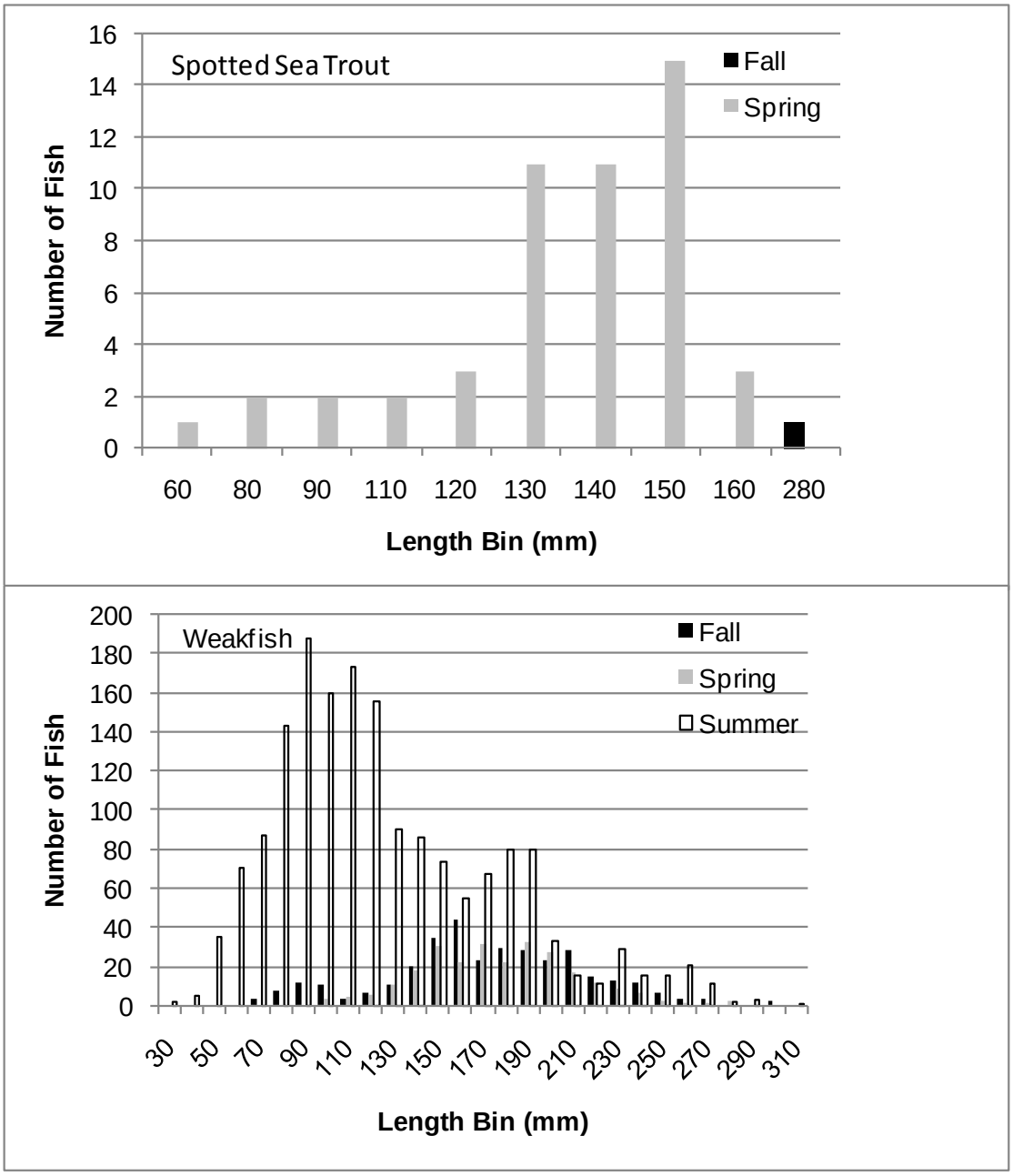

Figure 6. Length frequency of spotted sea trout and weakfish observed in the commercial shrimp trawl fishery from Carteret County to Brunswick County, North Carolina from 1 July 2007 to 30 June 2008.

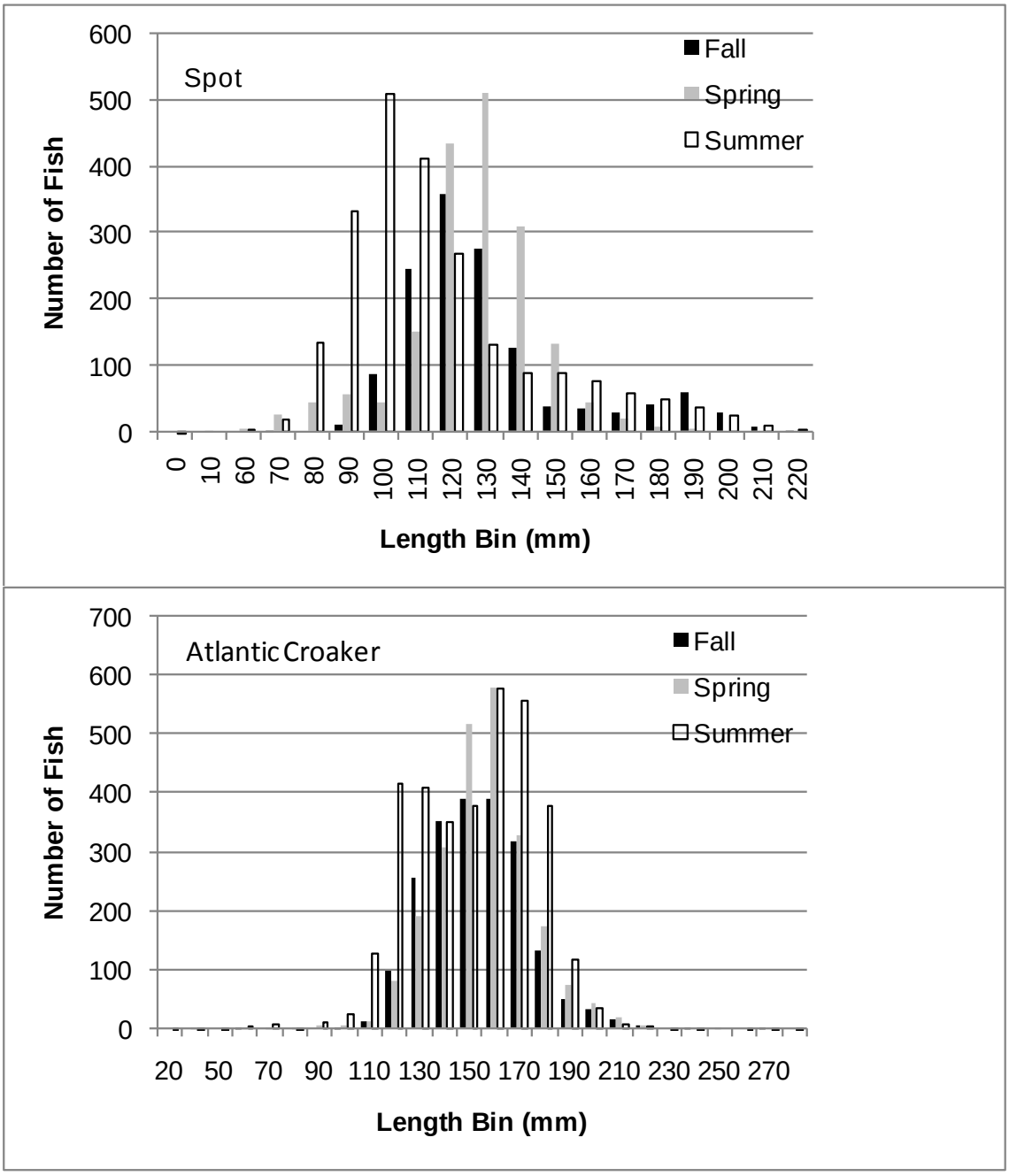

Figure 7. Length frequency of spot and Atlantic Croaker observed in the commercial shrimp trawl fishery from Carteret County to Brunswick County, North Carolina from 1 July 2007 to 30 June 2008.

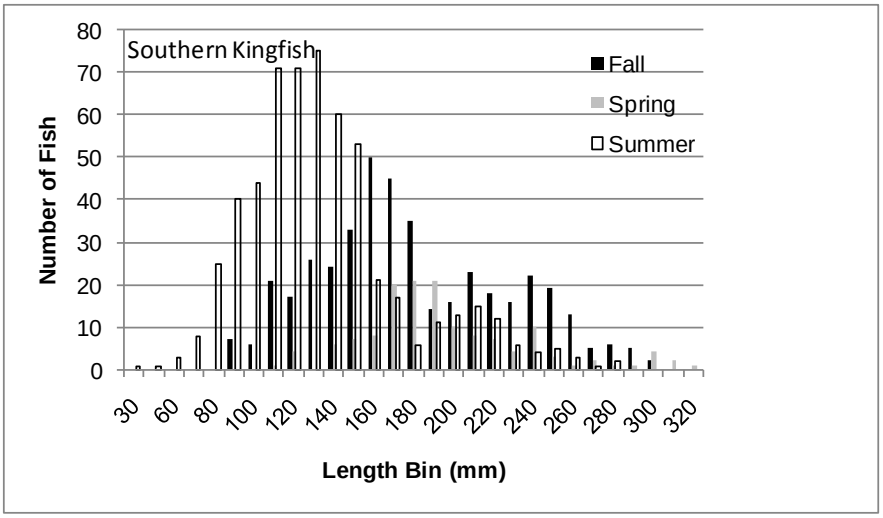

Figure 8. Length frequency of Southern kingfish observed in the commercial shrimp trawl fishery from Carteret County to Brunswick County, North Carolina from 1 July 2007 to 30 June 2008.

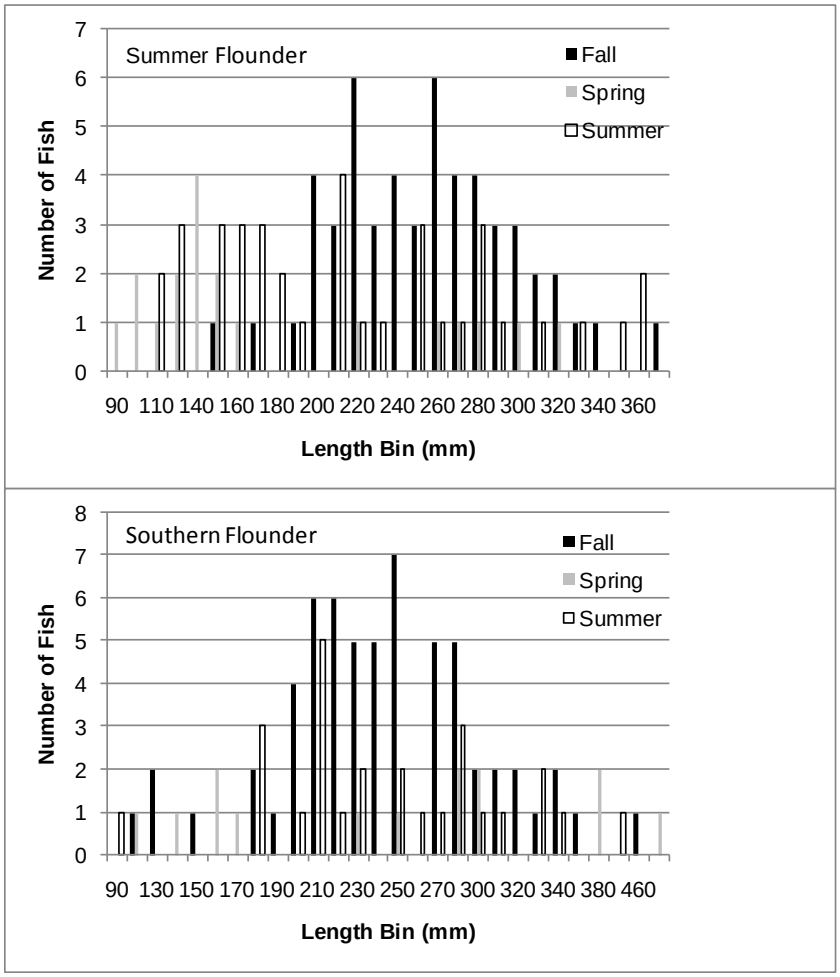

Figure 9. Length frequency of Summer flounder and Southern flounder observed in the commercial shrimp trawl fishery from Carteret County to Brunswick County, North Carolina from 1 July 2007 to 30 June 2008.

Catch Per Unit Effort (CPUE) – Key Species

Catch per unit effort was determined by dividing total weight (kg) by total effort, and was calculated per 60 minutes of tow time. Differences were observed based on net type and season.

Double Seamed Fishery

Seasonally, the CPUE in the double seamed fishery was higher for brown shrimp (the target species of the fishery), during the summer. The CPUE of Atlantic croaker was significantly higher than other commercially important bycatch in this fishery during both the spring and summer. The CPUE of other commercially important finfish bycatch in this fishery was higher in the summer than in the spring, with the exception of Atlantic croaker and flounder spp. (Table 8).

Tongue Net Fishery

The highest CPUE observed in this fishery, was for white shrimp (the target species of this gear type), during the summer, followed closely by the fall. The CPUE of Atlantic croaker was highest in this fishery during the summer and declined during the spring and fall. The CPUE of spot was lowest during the spring and increased thru the summer and fall. The CPUE of weakfish was highest during the summer in this fishery (Table 8).

Table 8. Catch per unit effort (CPUE) defined as: total weight (kg) / (head rope length*number of nets*tow time) per hour by net type in the commercial shrimp trawl fisheries from Carteret County to Brunswick County, North Carolina, 1 July 2007 to 30 June 2008.

Species	Double Seamed			Tongue		
	Spring	Summer	Fall	Spring	Summer	Fall
Brown Shrimp	0.06	0.36	*	0.01	0.09	0.05
Pink Shrimp	0.05	0.00	*	0.06	0.00	0.00
White Shrimp	0.04	0.01	*	0.08	0.32	0.25
Atlantic Croaker	0.59	0.28	*	0.30	0.70	0.27
Spot	0.04	0.10	*	0.04	0.05	0.09
Weakfish	0.01	0.02	*	0.02	0.07	0.03
Kingfish spp.	0.00	0.01	*	0.02	0.02	0.04
Flounder spp.	0.02	0.00	*	0.00	0.01	0.02

* No double seamed nets were observed during the fall

Finfish Bycatch

There were two classifications of discards: regulatory and unmarketable. Regulatory discards were defined as any fish that must be discarded due to size, season, or quota restrictions. Unmarketable discards accounted for all other discards, including discretionary discards.

Atlantic croaker accounted for the largest percentage of the unmarketable discards in both the double seamed and tongue net fisheries by weight. All Atlantic croaker were classified as unmarketable discards. Spot was the second most abundant unmarketable finfish discard in both fisheries. Over 99% of spot by weight were classified as unmarketable in the double seamed nets and 98% of spot by weight were classified as unmarketable in the tongue net fishery (Table 9 and 10).

Weakfish represented the largest regulatory discard in both the double seamed and tongue net fishery. In the double seamed nets 100% of weakfish were classified as regulatory discards and comprised 60% of all regulatory discards by weight. Spanish mackerel, southern flounder, and summer flounder represented 16%, 8%, and 9% of regulatory discards in the double seamed nets, respectively. In the tongue net fishery, 98% of weakfish were regulatory discards and represented 69% of all regulatory discards by weight. Spanish mackerel, southern flounder, and summer flounder represented 15%, 8%, and 8% of the regulatory discards in the tongue net fishery, respectively (Table 9 and 10).

Table 9. Tabulation of sampled catch and discards by weight (kg) and species status (kept, unmarketable, regulatory discards) in double seamed nets in the commercial shrimp trawl fishery from Carteret County to Brunswick County, North Carolina, 1 July 2007 to 30 June 2008.

Species	Fish Kept	Unmarketable	Regulatory Discard	Total
Brown Shrimp	6,418.18	0.00	0.00	6,418.18
Atlantic Croaker	0.00	6,244.09	0.00	6,244.09
Jellyfish	0.00	2,044.17	0.00	2,044.17
Spot	1.54	1,897.13	0.00	1,898.67
Atlantic Cutlassfish	0.00	840.96	0.00	840.96
Banded Drum	0.00	609.78	0.00	609.78
Smooth Butterfly Ray	0.00	591.24	0.00	591.24
Atlantic Brief Squid	135.74	452.95	0.00	588.69
Weakfish	0.00	0.00	443.75	443.75
Rubbish	0.00	403.13	0.00	403.13
Atlantic Sharpnose Shark	0.00	361.30	0.00	361.30
Inshore Lizardfish	0.00	344.96	0.00	344.96
Pinfish	0.00	344.76	0.00	344.76
White Shrimp	321.86	0.55	0.00	322.41
Portunus Crabs	0.00	254.73	0.00	254.73
Silver Seatrout	0.00	234.32	0.00	234.32
Striped Anchovy	0.00	195.68	0.00	195.68
Longspine Porgy	0.76	193.21	0.00	193.98
Cownose Ray	0.00	161.83	0.00	161.83
Southern Kingfish	0.00	141.66	0.00	141.66
Silver Perch	6.25	127.48	0.00	133.74
Atlantic Moonfish	0.00	129.80	0.00	129.80
Searobins	0.00	125.81	0.00	125.81
Pink Shrimp	123.17	0.00	0.00	123.17
Miscellaneous	0.00	121.84	0.00	121.84
Spanish Mackerel	0.00	0.00	117.59	117.59
Blacktip Shark	0.00	102.29	0.00	102.29
Mantis Shrimp	0.00	97.99	0.00	97.99
Windowpane	0.00	87.08	0.00	87.08
Bonnethead Shark	0.00	86.93	0.00	86.93
Bluefish	2.90	77.15	0.00	80.05
Southern Flounder	8.66	10.45	58.92	78.04
Pigfish	0.00	77.55	0.00	77.55
King Mackerel	0.00	2.09	67.96	70.05
Atlantic Stingray	0.00	68.47	0.00	68.47
Blue Crab	0.00	60.66	0.00	60.66
Bay Whiff	0.00	57.56	0.00	57.56
Smooth Dogfish	0.00	55.30	0.00	55.30
Summer Flounder	0.00	0.00	41.88	41.88

Table 9. Continued

Species	Fish Kept	Unmarketable	Regulatory Discard	Total
Butterfish	0.00	36.03	0.00	36.03
Atlantic Bumper	0.00	34.21	0.00	34.21
Lookdown	0.00	29.42	0.00	29.42
Hogchoker	0.00	27.75	0.00	27.75
Bullnose Ray	0.00	27.66	0.00	27.66
Southern Stingray	0.00	25.72	0.00	25.72
Harvestfish	1.38	23.06	0.00	24.44
Atlantic Menhaden	0.00	24.19	0.00	24.19
Atlantic Thread Herring	0.00	22.31	0.00	22.31
Atlantic Silverside	0.00	19.91	0.00	19.91
Cat Sharks	0.00	19.82	0.00	19.82
Ocellated Flounder	0.00	19.39	0.00	19.39
Unidentified Green Algae	0.00	18.39	0.00	18.39
Clearnose Skate	0.00	18.16	0.00	18.16
Atlantic Spadefish	0.00	18.09	0.00	18.09
Butterfly Rays	0.00	16.62	0.00	16.62
Libinia Spider Crabs	0.00	15.04	0.00	15.04
Bar Jack	0.00	13.36	0.00	13.36
Stingrays	0.00	11.26	0.00	11.26
Northern Sennet	0.00	11.03	0.00	11.03
Southern Hake	0.00	9.09	0.00	9.09
Northern Kingfish	0.00	1.15	7.01	8.16
Tonguefishes	0.00	6.07	0.00	6.07
African Pompano	0.00	5.28	0.00	5.28
Cobia	0.00	0.00	5.19	5.19
Aluterus Filefishes	0.00	4.75	0.00	4.75
Atlantic Purple Sea Urchin	0.00	4.34	0.00	4.34
Florida Stone Crab	0.00	4.28	0.00	4.28
Florida Pompano	0.00	3.98	0.00	3.98
Bank Sea Bass	0.00	3.68	0.00	3.68
Smooth Puffer	0.00	3.64	0.00	3.64
Atlantic Seabob	0.00	3.34	0.00	3.34
Striped Searobin	0.00	3.30	0.00	3.30
Inland Silverside	0.00	2.63	0.00	2.63
Gulf Flounder	0.00	0.00	2.21	2.21
Common Octopus	0.00	1.61	0.00	1.61
Hickory Shad	0.82	0.45	0.00	1.27
Gulf Kingfish	0.00	0.00	0.85	0.85
Quahogs	0.00	0.84	0.00	0.84
Broad Flounder	0.00	0.61	0.00	0.61
Balistes Triggerfishes	0.00	0.51	0.00	0.51
Cero	0.00	0.43	0.00	0.43
Bay Anchovy	0.00	0.17	0.00	0.17
Spotfin Mojarra	0.00	0.09	0.00	0.09

Table 10. Tabulation of sampled catch and discards by weight (kg) and species status (kept, unmarketable, regulatory discards) in tongue nets in the commercial shrimp trawl fishery from Carteret County to Brunswick County, North Carolina, 1 July 2007 to 30 June 2008.

Species	Fish Kept	Unmarketable	Regulatory Discard	Total
Atlantic Croaker	0.00	11,789.78	0.00	11,789.78
White Shrimp	6,331.82	0.00	0.00	6,331.82
Spot	64.36	2,900.01	0.00	2,964.37
Jellyfish	0.00	2,407.49	0.00	2,407.49
Atlantic Cutlassfish	0.00	2,085.01	0.00	2,085.01
Brown Shrimp	1,501.00	0.00	0.00	1,501.00
Miscellaneous	0.00	1,421.98	0.00	1,421.98
Pinfish	0.00	1,363.75	0.00	1,363.75
Smooth Butterfly Ray	0.00	1,189.06	0.00	1,189.06
Banded Drum	0.00	1,142.70	0.00	1,142.70
Weakfish	15.01	2.22	1,054.20	1,071.44
Inshore Lizardfish	0.00	936.07	0.00	936.07
Rubbish	0.00	899.67	0.00	899.67
Clearnose Skate	0.00	778.22	0.00	778.22
Atlantic Sharpnose Shark	0.00	753.43	0.00	753.43
Southern Kingfish	144.00	588.97	0.00	732.98
Silver Seatrout	0.00	731.55	0.00	731.55
Portunus Crabs	0.00	725.41	0.00	725.41
Striped Anchovy	0.00	686.79	0.00	686.79
Atlantic Stingray	0.00	641.27	0.00	641.27
Pink Shrimp	580.72	0.00	0.00	580.72
Jelly Bomb	0.00	496.16	0.00	496.16
Silver Perch	0.00	472.88	0.00	472.88
Longspine Porgy	0.00	461.83	0.00	461.83
Cownose Ray	0.00	391.18	0.00	391.18
Harvestfish	16.03	370.29	0.00	386.32
Bluefish	0.00	312.18	0.00	312.18
Atlantic Brief Squid	50.12	242.62	0.00	292.75
Smooth Dogfish	0.00	284.58	0.00	284.58
Pigfish	0.00	260.25	0.00	260.25
Spanish Mackerel	24.85	6.55	228.28	259.68
Atlantic Moonfish	0.00	239.25	0.00	239.25
Atlantic Thread Herring	0.00	226.88	0.00	226.88
Southern Stingray	0.00	218.52	0.00	218.52
Unidentified Green Algae	0.00	214.15	0.00	214.15
Bullnose Ray	0.00	198.19	0.00	198.19
Butterfish	0.00	193.23	0.00	193.23
Mantis Shrimp	0.00	164.95	0.00	164.95
Southern Flounder	40.75	0.00	123.11	163.86
Horseshoe Crab	16.81	128.48	0.00	145.30
Summer Flounder	18.51	0.00	120.96	139.47
Bay Whiff	0.00	130.53	0.00	130.53
Sheepshead	72.69	48.09	0.00	120.78
Butterfly Rays	0.00	110.67	0.00	110.67
Windowpane	0.00	106.55	0.00	106.55
Bonnethead Shark	0.00	95.17	0.00	95.17
Atlantic Bumper	0.00	90.83	0.00	90.83
Searobins	0.00	81.82	0.00	81.82

Table 10. Continued

Species	Fish Kept	Unmarketable	Regulatory Discard	Total
Spotfin Mojarra	0.00	65.61	0.00	65.61
Southern Hake	0.00	57.21	0.00	57.21
Atlantic Spadefish	0.00	52.56	0.00	52.56
Hogchoker	0.00	49.94	0.00	49.94
Bar Jack	0.00	47.12	0.00	47.12
Striped Burrfish	0.00	42.21	0.00	42.21
Lookdown	0.00	39.85	0.00	39.85
Tonguefishes	0.00	39.49	0.00	39.49
Threadfin Shad	0.00	39.37	0.00	39.37
Northern Kingfish	0.00	35.31	0.00	35.31
Florida Pompano	8.72	24.86	0.00	33.59
Sandbar Shark	0.00	29.50	0.00	29.50
Sand Tiger Shark	0.00	29.44	0.00	29.44
Bank Sea Bass	0.00	28.77	0.00	28.77
Spotted Seatrout	0.00	27.76	0.70	28.46
Smooth Puffer	0.00	28.20	0.00	28.20
Spiny Dogfish	0.00	24.07	0.00	24.07
Atlantic Seabob	0.00	22.34	0.00	22.34
Blue Crab	0.00	19.24	0.00	19.24
Libinia Spider Crabs	0.00	17.33	0.00	17.33
Florida Stone Crab	0.00	16.05	0.00	16.05
Peprilus Butterfish	0.00	13.69	0.00	13.69
Spottail Pinfish	0.00	13.49	0.00	13.49
Atlantic Silverside	0.00	13.36	0.00	13.36
Lesser Electric Ray	0.00	11.82	0.00	11.82
Whelks	0.00	10.94	0.00	10.94
Black Drum	0.00	10.48	0.00	10.48
Northern Sennet	0.00	10.23	0.00	10.23
Red Goatfish	0.00	9.32	0.00	9.32
Atlantic Menhaden	0.00	9.12	0.00	9.12
African Pompano	0.00	7.79	0.00	7.79
Ocellated Flounder	0.00	6.57	0.00	6.57
Atlantic Purple Sea Urchin	0.00	6.52	0.00	6.52
Blacktip Shark	0.00	5.02	0.00	5.02
Pea Crabs	0.00	4.96	0.00	4.96
Gulf Flounder	0.00	0.00	4.44	4.44
Starfish	0.00	3.92	0.00	3.92
Northern Puffer	0.00	3.90	0.00	3.90
Aluterus Filefishes	0.00	2.65	0.00	2.65
Black Sea Bass	0.00	0.00	1.69	1.69
Striped Searobin	0.00	1.51	0.00	1.51
Red Drum	0.00	1.50	0.00	1.50
Hermit Crabs	0.00	1.27	0.00	1.27
Conchs	0.00	1.18	0.00	1.18
Parri Rock Shrimp	0.00	0.71	0.00	0.71
Speckled Swimming Crab	0.00	0.70	0.00	0.70
Remora	0.00	0.40	0.00	0.40
Crested Blenny	0.00	0.36	0.00	0.36
Hickory Shad	0.00	0.26	0.00	0.26
King Mackerel	0.00	0.00	0.19	0.19
Irish Pompano	0.00	0.09	0.00	0.09

Sea Bird and Protected Species Bycatch

There was no sea bird bycatch observed in the commercial shrimp trawl fishery throughout the study. However, there were always numerous sea birds of several unrecorded species present. Likewise, no marine mammal takes were observed in the commercial shrimp trawl fishery during the study. Atlantic bottlenose dolphins were observed on 50% of the trips (n=71). The dolphin were observed feeding on discards and on numerous occasions they were observed feeding directly out of the nets on haul back, causing significant damage to the nets on two occasions that ceased fishing operations until the nets could be repaired (Figure 5). There were three observed interactions with loggerhead sea turtles. All three sea turtles were taken in the try net and were released before the animals could be measured and tagged. Try nets are small trawls equipped with small doors, no TEDs or BRDs, and is used to sample areas prior to setting the main trawls and to monitor the catch rates during tows. The try nets had tow times of approximately 10 minutes. All three sea turtles were released in good condition. There were no observed sea turtle interactions observed in the main nets.

Figure 10. Picture showing bottlenose dolphins (*Tursiops truncates*) damaging nets while feeding from them during observations made in the commercial shrimp trawl fisheries from Carteret County to Brunswick County, North Carolina, 1 July 2007 to 30 June 2008.

Discussion

Fishery observers monitor and record catch data on commercial fishing activity, worldwide. The data are used to supplement research and aid in the management of living marine resources. Observers may collect data on species composition of the catch, weights of fish caught, disposition of landed species and protected species interactions. Fishing locations and fishing effort are also important data for managing fisheries. In some fisheries, observers provide valuable assistance to researchers with tagging projects involving sharks, and even some species of sea turtles. Observer programs often are responsible for collecting the largest

part of fisheries management data. The first hand information supplied by observers to fisheries managers on protected species interactions with fishing activities provides excellent information to help sustain and rebuild some populations of protected species (French et. al 1982).

The purpose of this project was to identify and characterize effort, catch, and bycatch in commercial shrimp trawl fisheries in the near shore waters of North Carolina from Carteret County to Brunswick County. This project identified and observed two net types (double seamed and tongue nets) and observed trips during the spring, summer and fall. Double seamed nets are used primarily to target brown shrimp in the spring and early summer. Tongue nets fish higher in the water column and are used primarily to target white shrimp in the late summer and fall.

Bycatch and discard mortality estimates are important issues in fisheries management. There were no discard mortality estimates obtained from this study, however due to tow times and predation from birds, sharks, and dolphins the discard mortality is assumed to be high for finfish.

The three commercially important species of shrimp represented 21% of the catch by weight for all net types combined, compared to 54% seen in a similar study conducted in the estuarine waters of North Carolina (Logothetis and McCuiston 2005). Atlantic croaker accounted for approximately 25% of the catch by weight (Table 4) for all net types combined and represented the largest bycatch. However the stock status of Atlantic croaker is considered viable and the population in the mid-Atlantic region is currently not overfished and overfishing is not occurring on the spawning stock biomass based on the Atlantic States Marine Fisheries Commission assessment (ASMFC 2008). Spot was the second most abundant finfish bycatch by weight in the commercial shrimp trawl fishery, accounting for approximately 7% of the catch by weight for all net types combined. The NCDMF's 2008 Stock Status Report lists the stock status of spot as concerned (NCDMF 2008). The bycatch of other commercially and recreationally important species was relatively low. Weakfish, kingfish, flounder (all three commercially important species combined), and spotted sea trout represented approximately 2%, 1%, 0.5%, and 0.5% of the catch by weight for all net types combined (Table 4). Weakfish also represented the largest regulatory discard in both net types, accounting for approximately 60% of all regulatory discards by weight. Length frequency distributions of these species indicate that the majority of these fish are undersized.

The importance of characterization studies cannot be overstated. The results of this study provide effort, catch, and discard information that can be used in current and future stock assessments and management decisions in trawl fisheries throughout North Carolina.

Conclusion

This study characterized the commercial shrimp trawl fishery in the near shore waters from Carteret County to Brunswick County, North Carolina. This fishery encompasses double seamed nets and tongue nets. The observed targeted species varied seasonally based on the availability of the target species. Specifically, this program quantified species composition, effort, CPUE and bycatch of federally managed species of finfish. Further observations of commercial shrimp trawl effort and other fisheries are needed to accurately quantify effort, catch, and discards throughout commercial fisheries in North Carolina. This information will assist in the development of Fishery Management Plans and maintaining sustainable stocks.

Recommendations

- Expand the scientific observer coverage in commercial shrimp trawl fisheries to encompass all seasons and areas.

- Establish a long-term scientific observer program throughout North Carolina commercial fisheries.

- Require mandatory observer coverage in North Carolina commercial fisheries.

- Generate better lines of communication between fishery managers, and the commercial fishing industry. This will increase understanding, and allow the increased incorporation of commercial knowledge into fishery management.

- Work with the commercial fishing industry and fishery managers to develop gear to reduce bycatch.

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