Compare catch rates of shrimp and bycatch of other species in standard (control) and modified (experimental) otter trawls in the Neuse River and Pamlico Sound, North Carolina

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JOB 1: Compare catch rates of shrimp and bycatch of other species in standard (control) and modified (experimental) otter trawls in the Neuse River and Pamlico Sound, North Carolina.

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ABSTRACT

The purpose of this project was to identify potential gear modifications that can be implemented by the commercial shrimp trawl fishery to reduce bycatch in the fishery. Gear comparisons were made using five modified shrimp trawl tail bags in the Neuse River and Pamlico Sound, North Carolina from 1 July 2008 to 30 June 2009 to determine methods of reducing bycatch while maintaining shrimp harvest. Five experimental otter trawls were tested against a standard (1 ½" stretch mesh, hung on the diamond) tail bag. The experimental nets had 1 ¾ inch stretch mesh (hung on the diamond, 1 ¾ inch stretch mesh (hung on the square), 2 inch stretch mesh (hung on the square) mesh tail bags. Otter trawls equipped with the Jones-Davis BRD (bycatch reduction device) and a skylight panel were also tested. The shrimp catch of all five tests nets was not significantly different from the standard net; however with the exception of the 1 ¾ inch stretch mesh (hung on the diamond) all the test nets caught significantly less bycatch. The results of this study offer insights for fishery managers developing Fishery Management Plans and may assist in gear regulations in North Carolina's commercial shrimp trawl fishery. Recommendations include continued experimentation of gear modifications in inshore and nearshore areas of North Carolina, potentially implementing gear regulations based on experimental designs, and continuing and improving collaboration and outreach to the industry to develop and implement gear to reduce bycatch in the shrimp trawl fishery of North Carolina.

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INTRODUCTION

North Carolina's shrimp fishery targets three species of shrimp; brown (*Farfantepenaeus aztecus*), pink (*Litopenaeus setiferus*), and white (*F. duorarum*). All three species are considered annual crops implying that environmental conditions rather than fishery pressure regulates population size. All three commercially important shrimp in North Carolina are considered viable (NCDMF 2006; NCDMF 2008). Shrimp harvest in the Neuse River and Pamlico Sound accounted for 67% of the state's shrimp harvest in 2008. 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 Pamlico Sound the commercial shrimp trawl fishery is conducted primarily on a multi-day trip basis.

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. 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). NCDMF has conducted research on various bycatch reduction devices to reduce bycatch in trawl fisheries (McKenna 1993, McKenna 1996) and this project builds on the data gathered from these previous projects.

The purpose of this project was to identify potential gear modifications that can be implemented by the commercial shrimp trawl fishery to reduce bycatch in the fishery. 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*) in standard and experimental shrimp trawls. These data will assist

managers in sustaining coastal stocks, which are an important resource for both commercial and recreational fishermen.

METHODS

This study was conducted from 1 July 2008 to 30 June 2009 in the Neuse River and Pamlico Sound, North Carolina (Figure 1). Sampling sites were determined based on knowledge of shrimp presence by season. Testing was conducted using the NCDMF R/V Carolina Coast. This vessel is 44 feet in length and double rigged. Each experimental otter trawl was tested against a standard otter trawl. Three types of otter trawls (two seam, four seam, and tongue nets) were fished based on season.

Each tow consisted of a standard and experimental otter trawl towed side by side. All otter trawls had a 30 foot head rope and ¾ inch bar mesh body. All were equipped with standard Turtle Excluder Devices (TEDs). They were heavily chained with 13 links of 3/16 inch chain per each 10 inches of lead line and had a tickler chain approximately 20 inches ahead of the lead line. The standard net had a 1 ½ inch stretch mesh tail bag. The experimental nets had 1 ¾ inch stretch mesh (hung on the diamond), 1 ¾ inch stretch mesh (hung on the square), 2 inch stretch mesh (hung on the square) mesh tail bags, additionally otter trawls equipped with the Jones-Davis BRD (bycatch reduction device) and a skylight panel were tested. The sky light panel was 18 inches by 50 inches of 4 inch stretch mesh, hung on the square. Prior to testing, the nets were calibrated to ensure that they were fishing similarly (within 10% of each other). For calibration tows catches were separated into five categories: finfish, blue crabs, shrimp, miscellaneous invertebrates, and miscellaneous material (shells, tunicates, etc) and the percent difference [(test-control)/control*100] between the two nets calculated. The tail bags were changed out by the use of zippers. Tows were standardized by tow time, tow speed, and net locations. Specifically, all tows were one hour in duration and pulled at a vessel speed of 2.5 knots. Nets were alternated between sides to minimize any bias. This was a fishery independent study; however normal commercial fishing operations and locations were replicated. Gear testing was conducted for 26 days.

Tests were conducted with three different net types (double seamed, four seamed and tongue nets). Double seamed nets, four seamed nets, and tongue nets are 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 and four 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.

Data was collected on each tow and sampled following NCDMF protocols. Each tail bag (standard, experimental) was sampled separately. Total weight (kg) and number of each species was collected. Each species of commercial and recreational importance was sub-sampled for lengths of individuals. 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 standard and experimental nets and each trial consisted of 30 tows was analyzed separately. The results were analyzed to determine trends and potential gear modifications that could be used in the commercial shrimp trawl fishery to provide adequate catch of the target species and reduced bycatch.

GEAR PARAMETERS

There were five configurations of experimental otter trawls that were tested throughout this study. The head rope length was 30 feet on both the standard and experimental nets. The footrope and net bodies were identical as well. All nets were equipped with TEDs and were not equipped with fish excluders, except for two experimental configurations. The only variable regarding the gear configurations was modifications to the tail bags. Tow speed was standardized at 2.5 knots and tow time was standardized at 60 minutes (Table 1). The standard otter trawl tail bag is hung on the diamond, meaning that as the net is hanging vertically the meshes will form diamond shapes. Experimental configurations included tail bags that were hung on the square, meaning that as the net is hung vertically the meshes will form squares. The Jones-Davis BRD was one of the configurations tested and was donated by Robert D. Stevens and Daniel G. Foster with the Harvesting Systems and Engineering Branch of NOAA Fisheries in Pascagoula, MS. The skylight panel was constructed of 4 inch stretch mesh and measured 18 inches by 50 inches (9 meshes wide and 25 meshes long) and was hung on the square 22 meshes from the tie rings.

Table 1. Characteristics of otter trawls, including the standard and experimental configurations tested in the Neuse River and Pamlico Sound, North Carolina, 1 July 2008 to 30 June 2009.

Net Characteristics	Control	Configuration 1	Configuration 2	Configuration 3	Configuration 4	Configuration 5
Headrope	30 ft.	30 ft.	30 ft.	30 ft.	30 ft.	30 ft.
Footrope	standard *	standard *	standard *	standard *	standard *	standard *
Net Body	3/4 in. bar	3/4 in. bar	3/4 in. bar	3/4 in. bar	3/4 in. bar	3/4 in. bar
Tail Bag	1 1/2 in. stretch	1 3/4 in. stretch hung on the diamond	1 3/4 in. square hung on the square	2 in. stretch hung on the square	1 1/2 in. stretch equipped with a Jones-Davis BRD	1 1/2 in. stretch equipped with a skylight panel

* The footrope had 13 links of 3/16 in chain per each 10 in of leadline

RESULTS

The results provide varying trends among the gear types tested. The following sections discuss findings ranging from gear types tested to species composition of standard and experimental nets during each trial and length frequencies of the target species during gear testing in the Neuse River and Pamlico Sound, North Carolina, from 1 July 2008 to 30 June 2009 (Figure 1).

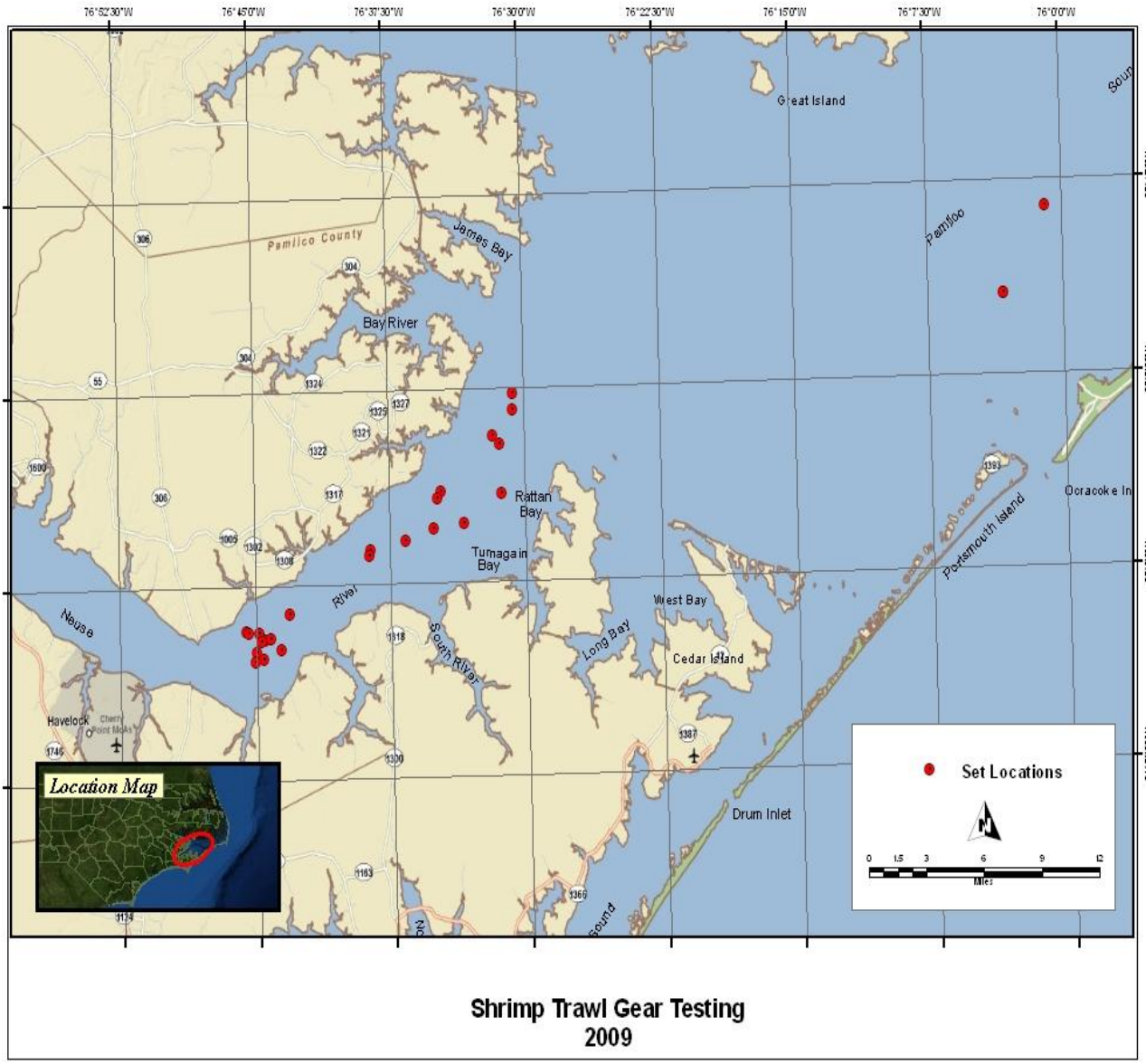

Figure 1. Study areas for shrimp trawl gear testing in the Neuse River and Pamlico Sound, North Carolina from 1 July 2008 through 30 June 2009.

SPECIES COMPOSITION

The composition of species was tabulated by net configuration and comparisons were made between the standard net (1 ½" stretch hung on the diamond) and each experimental net. Miscellaneous includes invertebrates not identified to genus level.

Standard vs. 1 ¾" stretch mesh hung on the diamond

There were 44 species observed in the standard net and 43 species observed in the experimental net during tests of the 1 ¾" stretch mesh hung on the diamond. The experimental net caught 75% by weight of all species combined compared to the standard net. The three commercially important species of shrimp (brown, white, pink) combined represented 16.35% of the catch by weight in the standard net and 21.76% of the catch by weight in the experimental net, however the total catch of shrimp by weight was virtually identical in both gears. Atlantic croaker accounted for 23.92% of the catch by weight in the standard net and 26.77% by weight in the experimental net, which represents a 16% reduction in the total weight of croaker in the experimental net. Spot represented 25.14% of the catch by weight in the control net and 16.8% of the catch by weight in the experimental net, which represents a 50% reduction in the total weight of spot in the experimental net. The commercially important species of flounder combined to represent 0.80% of the catch by weight in the standard net and 0.81% of the catch by weight in the experimental net, which represents a 13% reduction in the total weight of flounder species in the experimental net. Weakfish represented 3.25% of the catch by weight in the standard net and 4.21% of the catch by weight in the experimental net, which represents a 2% decrease in the total weight of weakfish in the experimental net (Tables 2 and 3).

Table 2. Relative biomass (kg) and number of individuals observed in the standard net during gear tests of the 1 ¾" stretch mesh, hung on the diamond in the Neuse River and Pamlico Sound, North Carolina, 1 July 2008 to 30 June 2009.

Scientific Name	Common Name	Total Number	% Number	Total Weight (kg)	% Biomass
Leiostomus xanthurus	Spot	18,083	28.84	187.96	25.14
Micropogonias undulatus	Atlantic Croaker	10,003	15.96	178.90	23.92
Penaeus aztecus	Brown Shrimp	6,801	10.85	120.25	16.08
Lolliguncula brevis	Atlantic Brief Squid	5,814	9.27	48.79	6.52
Brevoortia tyrannus	Atlantic Menhaden	1,680	2.68	24.50	3.28
Cynoscion regalis	Weakfish	1,588	2.53	24.28	3.25
Peprilus paru	Harvestfish	2,297	3.66	22.39	2.99
Lagodon rhomboides	Pinfish	1,851	2.95	22.37	2.99
Peprilus triacanthus	Butterfish	320	0.51	19.44	2.60
Anchoa spp.	Anchovies	4,308	6.87	14.85	1.99
Portunus spp.	Portunus Crabs	471	0.75	13.08	1.75
Pomatomus saltatrix	Bluefish	116	0.19	11.46	1.53
Scomberomorus maculatus	Spanish Mackerel	141	0.22	10.25	1.37
Cynoscion spp.	Seatrouts	8,269	13.19	7.80	1.04
Menticirrhus americanus	Southern Kingfish	24	0.04	4.45	0.60
Callinectes sapidus	Blue Crab	63	0.10	3.96	0.53
Miscellaneous	Miscellaneous	*	*	3.52	0.47
Gymnura micrura	Smooth Butterfly Ray	8	0.01	3.48	0.47
Synodus foetens	Inshore Lizardfish	53	0.08	3.44	0.46
Paralichthys dentatus	Summer Flounder	63	0.10	3.33	0.45
Paralichthys lethostigma	Southern Flounder	24	0.04	2.64	0.35
Penaeus duorarum	Pink Shrimp	125	0.20	1.89	0.25
Dasyatis sabina	Atlantic Stingray	4	0.01	1.80	0.24
Bairdiella chrysoura	Silver Perch	23	0.04	1.71	0.23
Scomberomorus cavalla	King Mackerel	12	0.02	1.50	0.20
Rhizoprionodon terraenovae	Atlantic Sharpnose Shark	2	0.00	1.40	0.19
Triglidae	Searobins	39	0.06	1.37	0.18
Cnidaria	Jellyfish	152	0.24	1.32	0.18
Aluterus spp.	Aluterus Filefishes	65	0.10	1.21	0.16
Squilla empusa	Mantis Shrimp	38	0.06	0.78	0.10
Chaetodipterus faber	Atlantic Spadefish	6	0.01	0.68	0.09
Citharichthys spilopterus	Bay Whiff	29	0.05	0.66	0.09
Opisthonema oglinum	Atlantic Thread Herring	17	0.03	0.54	0.07
Trichiurus lepturus	Atlantic Cutlassfish	3	0.00	0.38	0.05
Selene setapinnis	Atlantic Moonfish	24	0.04	0.34	0.05
Dorosoma petenense	Threadfin Shad	21	0.03	0.21	0.03
Elops saurus	Ladyfish	4	0.01	0.18	0.02
Penaeus setiferus	White Shrimp	28	0.04	0.17	0.02
Alosa sapidissima	American Shad	2	0.00	0.15	0.02
Lagocephalus laevigatus	Smooth Puffer	4	0.01	0.12	0.02
Anchoa hepsetus	Striped Anchovy	97	0.15	0.07	0.01
Symphurus spp.	Tonguefishes	5	0.01	0.07	0.01
Chloroscombrus chrysurus	Atlantic Bumper	14	0.02	0.06	0.01
Selene vomer	Lookdown	2	0.00	0.02	0.00
Totals		62,693	100.00	747.77	100.00

* Numbers not collected

Table 3. Relative biomass (kg) and number of individuals observed in the experimental net (1 ¾" stretch mesh, hung on the diamond) in the Neuse River and Pamlico Sound, North Carolina, 1 July 2008 to 30 June 2009.

Scientific Name	Common Name	Total Number	% Number	Total Weight (kg)	% Biomass
Micropogonias undulatus	Atlantic Croaker	6,400	20.51	150.80	26.77
Penaeus aztecus	Brown Shrimp	8,039	25.77	121.60	21.59
Leiostomus xanthurus	Spot	5,926	19.00	94.61	16.80
Lolliguncula brevis	Atlantic Brief Squid	4,095	13.13	37.87	6.72
Cynoscion regalis	Weakfish	883	2.83	23.74	4.21
Peprilus triacanthus	Butterfish	402	1.29	21.15	3.75
Peprilus paru	Harvestfish	1,829	5.86	18.42	3.27
Brevoortia tyrannus	Atlantic Menhaden	854	2.74	15.00	2.66
Lagodon rhomboides	Pinfish	1,070	3.43	14.60	2.59
Portunus spp.	Portunus Crabs	373	1.20	11.20	1.99
Scomberomorus maculatus	Spanish Mackerel	113	0.36	11.01	1.95
Pomatomus saltatrix	Bluefish	75	0.24	8.52	1.51
Miscellaneous	Miscellaneous	*	*	5.20	0.92
Callinectes sapidus	Blue Crab	80	0.26	4.58	0.81
Gymnura micrura	Smooth Butterfly Ray	3	0.01	3.60	0.64
Paralichthys dentatus	Summer Flounder	52	0.17	3.10	0.55
Aluterus spp.	Aluterus Filefishes	74	0.24	1.95	0.35
Paralichthys lethostigma	Southern Flounder	10	0.03	1.49	0.26
Bairdiella chrysoura	Silver Perch	25	0.08	1.44	0.26
Anchoa spp.	Anchovies	471	1.51	1.33	0.24
Synodus foetens	Inshore Lizardfish	18	0.06	1.33	0.24
Myliobatis freminvillei	Bullnose Ray	1	0.00	1.25	0.22
Cnidaria	Jellyfish	85	0.27	1.18	0.21
Citharichthys spilopterus	Bay Whiff	33	0.11	1.09	0.19
Triglidae	Searobins	32	0.10	1.03	0.18
Menticirrhus americanus	Southern Kingfish	7	0.02	0.90	0.16
Penaeus duorarum	Pink Shrimp	43	0.14	0.72	0.13
Squilla empusa	Mantis Shrimp	29	0.09	0.67	0.12
Selene setapinnis	Atlantic Moonfish	42	0.13	0.60	0.11
Trichiurus lepturus	Atlantic Cutlassfish	3	0.01	0.59	0.10
Scomberomorus cavalla	King Mackerel	15	0.05	0.54	0.10
Selene vomer	Lookdown	6	0.02	0.48	0.09
Opisthonema oglinum	Atlantic Thread Herring	4	0.01	0.28	0.05
Chaetodipterus faber	Atlantic Spadefish	2	0.01	0.27	0.05
Symphurus spp.	Tonguefishes	5	0.02	0.27	0.05
Penaeus setiferus	White Shrimp	31	0.10	0.22	0.04
Dorosoma petenense	Threadfin Shad	19	0.06	0.20	0.04
Caranx ruber	Bar Jack	1	0.00	0.20	0.04
Anchoa hepsetus	Striped Anchovy	42	0.13	0.10	0.02
Trinectes maculatus	Hogchoker	1	0.00	0.06	0.01
Elops saurus	Ladyfish	1	0.00	0.04	0.01
Chloroscombrus chrysurus	Atlantic Bumper	1	0.00	0.01	0.00
Lobotes surinamensis	Atlantic Tripletail	2	0.01	0.01	0.00
Totals		31,197	100.00	563.25	100.00

* Numbers not collected

Standard vs. 1 ¾" stretch hung on the square

There were 43 species observed in the standard net and 38 species observed in the experimental net during tests of the 1 ¾" stretch mesh hung on the square. The experimental net caught 43% by weight of all species combined compared to the standard net. The three commercially important species of shrimp (brown, white, pink) combined represented 5.31% of the catch by weight in the standard net and 9.61% of the catch by weight in the experimental net, which represents a 22% reduction in shrimp caught in the experimental net compared to the control net. Atlantic croaker accounted for 22.82% of the catch by weight in the standard net and 17.99% by weight in the experimental net, which represents a 76% reduction in the total weight of croaker in the experimental net. Spot represented 39.42% of the catch by weight in the control net and 20.62% of the catch by weight in the experimental net, which represents a 77% reduction in the total weight of spot in the experimental net. The commercially important species of flounder combined to represent 1.30% of the catch by weight in the standard net and 3.09% of the catch by weight in the experimental net, which represents a 3% increase in the total weight of flounder species in the experimental net compared to the control net. Weakfish represented 3.53% of the catch by weight in the standard net and 4.41% of the catch by weight in the experimental net, which represents a 46% decrease in the total weight of weakfish in the experimental net (Tables 4 and 5).

Table 4. Relative biomass (kg) and number of individuals observed in the standard net during gear tests of the 1 ¾" stretch mesh, hung on the square in the Neuse River and Pamlico Sound, North Carolina, 1 July 2008 to 30 June 2009.

Scientific Name	Common Name	Total Number	% Number	Total Weight (kg)	% Biomass
Leiostomus xanthurus	Spot	37,122	51.83	324.90	39.42
Micropogonias undulatus	Atlantic Croaker	15,128	21.12	188.06	22.82
Lolliguncula brevis	Atlantic Brief Squid	6,112	8.53	56.07	6.80
Lagodon rhomboides	Pinfish	3,749	5.23	55.34	6.71
Peprilus paru	Harvestfish	2,948	4.12	55.17	6.69
Penaeus aztecus	Brown Shrimp	2,168	3.03	42.16	5.12
Cynoscion regalis	Weakfish	723	1.01	29.09	3.53
Bairdiella chrysoura	Silver Perch	591	0.83	14.94	1.81
Anchoa spp.	Anchovies	1,439	2.01	10.82	1.31
Brevoortia tyrannus	Atlantic Menhaden	549	0.77	10.02	1.22
Paralichthys lethostigma	Southern Flounder	45	0.06	7.61	0.92
Opisthonema oglinum	Atlantic Thread Herring	589	0.82	7.11	0.86
Pomatomus saltatrix	Bluefish	61	0.09	5.38	0.65
Scomberomorus maculatus	Spanish Mackerel	34	0.05	4.11	0.50
Paralichthys dentatus	Summer Flounder	40	0.06	3.13	0.38
Miscellaneous	Miscellaneous	*	*	2.86	0.35
Penaeus setiferus	White Shrimp	114	0.16	1.53	0.19
Rhinoptera bonasus	Cownose Ray	1	0.00	1.34	0.16
Peprilus triacanthus	Butterfish	3	0.00	0.87	0.11
Dorosoma petenense	Threadfin Shad	77	0.11	0.76	0.09
Portunus spp.	Portunus Crabs	31	0.04	0.40	0.05
Trichiurus lepturus	Atlantic Cutlassfish	3	0.00	0.34	0.04
Citharichthys spilopterus	Bay Whiff	14	0.02	0.33	0.04
Dasyatis sabina	Atlantic Stingray	2	0.00	0.32	0.04
Lobotes surinamensis	Atlantic Tripletail	2	0.00	0.32	0.04
Aluterus spp.	Aluterus Filefishes	15	0.02	0.18	0.02
Menticirrhus americanus	Southern Kingfish	1	0.00	0.14	0.02
Selene vomer	Lookdown	6	0.01	0.12	0.01
Anchoa hepsetus	Striped Anchovy	25	0.03	0.10	0.01
Chaetodipterus faber	Atlantic Spadefish	4	0.01	0.09	0.01
Squilla empusa	Mantis Shrimp	3	0.00	0.08	0.01
Synodus foetens	Inshore Lizardfish	1	0.00	0.08	0.01
Symphurus spp.	Tonguefishes	3	0.00	0.07	0.01
Callinectes sapidus	Blue Crab	2	0.00	0.06	0.01
Elops saurus	Ladyfish	1	0.00	0.06	0.01
Triglidae	Searobins	1	0.00	0.04	0.00
Chloroscombrus chrysurus	Atlantic Bumper	8	0.01	0.04	0.00
Selene setapinnis	Atlantic Moonfish	2	0.00	0.04	0.00
Anchoa mitchilli	Bay Anchovy	4	0.01	0.02	0.00
Caranx ruber	Bar Jack	1	0.00	0.02	0.00
Penaeus duorarum	Pink Shrimp	1	0.00	0.01	0.00
Trachypenaeus constrictus	Roughneck Shrimp	1	0.00	0.01	0.00
Caranx hippos	Crevalle Jack	1	0.00	0.01	0.00
Totals		71,625	100.00	824.15	100.00

*Numbers not collected

Table 5. Relative biomass (kg) and number of individuals observed in the experimental net (1 ¾" stretch mesh, hung on the square) in the Neuse River and Pamlico Sound, North Carolina, 1 July 2008 to 30 June 2009.

Scientific Name	Common Name	Total Number	% Number	Total Weight (kg)	% Biomass
Leiostomus xanthurus	Spot	6,743	29.85	73.55	20.62
Micropogonias undulatus	Atlantic Croaker	4,645	20.56	64.17	17.99
Peprilus paru	Harvestfish	2,878	12.74	55.67	15.61
Penaeus aztecus	Brown Shrimp	1,710	7.57	32.94	9.24
Lolliguncula brevis	Atlantic Brief Squid	3,387	14.99	31.88	8.94
Lagodon rhomboides	Pinfish	1,489	6.59	26.33	7.38
Cynoscion regalis	Weakfish	336	1.49	15.73	4.41
Bairdiella chrysoura	Silver Perch	368	1.63	13.23	3.71
Paralichthys lethostigma	Southern Flounder	49	0.22	8.55	2.40
Brevoortia tyrannus	Atlantic Menhaden	335	1.48	6.27	1.76
Pomatomus saltatrix	Bluefish	70	0.31	5.48	1.54
Scomberomorus maculatus	Spanish Mackerel	42	0.19	4.28	1.20
Rhinoptera bonasus	Cownose Ray	3	0.01	4.26	1.19
Miscellaneous	Miscellaneous	*	*	2.49	0.70
Paralichthys dentatus	Summer Flounder	28	0.12	2.47	0.69
Opisthonema oglinum	Atlantic Thread Herring	207	0.92	2.26	0.63
Penaeus setiferus	White Shrimp	95	0.42	1.32	0.37
Menticirrhus americanus	Southern Kingfish	5	0.02	0.82	0.23
Pogonias cromis	Black Drum	1	0.00	0.74	0.21
Cnidaria	Jellyfish	1	0.00	0.72	0.20
Aluterus spp.	Aluterus Filefishes	11	0.05	0.58	0.16
Dasyatis sabina	Atlantic Stingray	3	0.01	0.51	0.14
Trichiurus lepturus	Atlantic Cutlassfish	2	0.01	0.42	0.12
Portunus spp.	Portunus Crabs	28	0.12	0.25	0.07
Dorosoma petenense	Threadfin Shad	27	0.12	0.25	0.07
Selene vomer	Lookdown	7	0.03	0.24	0.07
Callinectes sapidus	Blue Crab	4	0.02	0.22	0.06
Synodus foetens	Inshore Lizardfish	3	0.01	0.22	0.06
Anchoa spp.	Anchovies	89	0.39	0.19	0.05
Scophthalmus aquosus	Windowpane	5	0.02	0.16	0.04
Peprilus triacanthus	Butterfish	4	0.02	0.14	0.04
Caranx hippos	Crevalle Jack	1	0.00	0.08	0.02
Orthopristis chrysoptera	Pigfish	1	0.00	0.08	0.02
Citharichthys spilopterus	Bay Whiff	5	0.02	0.04	0.01
Chloroscombrus chrysurus	Atlantic Bumper	7	0.03	0.03	0.01
Squilla empusa	Mantis Shrimp	1	0.00	0.02	0.01
Symphurus spp.	Tonguefishes	1	0.00	0.02	0.01
Selene setapinnis	Atlantic Moonfish	1	0.00	0.01	0.00
Totals		22,592	100.00	356.62	100.00

* Numbers not collected

Standard vs. 2" stretch mesh hung on the square

There were 38 species observed in the standard net and 34 species observed in the experimental net during tests of the 2" stretch mesh hung on the square. The experimental net caught 48% by weight of all species combined compared to the standard net. The three commercially important species of shrimp (brown, white, pink) combined represented 10.51% of the catch by weight in the standard net and 19.11% of the catch by weight in the experimental net, which represents a 13% reduction in the total weight of shrimp in the

experimental net. Atlantic croaker accounted for 15.55% of the catch by weight in the standard net and 10.33% by weight in the experimental net, which represents a 69% reduction in the total weight of croaker in the experimental net. Spot represented 18.52% of the catch by weight in the control net and 7.27% of the catch by weight in the experimental net, which represents an 82% reduction in the total weight of spot in the experimental net. The commercially important flounder species combined represented 0.52% of the catch by weight in the standard net and 1.17% of the catch by weight in the experimental net, which represents a 7% increase in the total weight of flounder species in the experimental net. Weakfish represented 5.01% of the catch by weight in the standard net and 10.30% of the catch by weight in the experimental net, which represents a 2% decrease in the total weight of weakfish in the experimental net (Tables 6 and 7).

Table 6. Relative biomass (kg) and number of individuals observed in the standard net during gear tests of the 2" stretch mesh, hung on the square in the Neuse River and Pamlico Sound, North Carolina, 1 July 2008 to 30 June 2009.

Scientific Name	Common Name	Total Number	% Number	Total Weight (kg)	% Biomass
Lagodon rhomboides	Pinfish	4,756	16.41	113.69	20.95
Leiostomus xanthurus	Spot	8,169	28.19	100.52	18.52
Micropogonias undulatus	Atlantic Croaker	3,899	13.46	84.39	15.55
Anchoa hepsetus	Striped Anchovy	5,031	17.36	51.77	9.54
Penaeus setiferus	White Shrimp	2,723	9.40	50.39	9.29
Bairdiella chrysoura	Silver Perch	1,080	3.73	32.57	6.00
Cynoscion regalis	Weakfish	398	1.37	27.20	5.01
Pomatomus saltatrix	Bluefish	141	0.49	21.92	4.04
Lolliguncula brevis	Atlantic Brief Squid	1,108	3.82	12.50	2.30
Opisthonema oglinum	Atlantic Thread Herring	808	2.79	12.10	2.23
Peprilus paru	Harvestfish	168	0.58	8.98	1.65
Penaeus aztecus	Brown Shrimp	228	0.79	5.53	1.02
Menticirrhus americanus	Southern Kingfish	16	0.06	3.14	0.58
Synodus foetens	Inshore Lizardfish	16	0.06	2.56	0.47
Brevoortia tyrannus	Atlantic Menhaden	60	0.21	2.42	0.45
Paralichthys lethostigma	Southern Flounder	9	0.03	2.08	0.38
Scomberomorus maculatus	Spanish Mackerel	93	0.32	1.93	0.36
Miscellaneous	Miscellaneous	*	*	1.15	0.21
Penaeus duorarum	Pink Shrimp	128	0.44	1.09	0.20
Cnidaria	Jellyfish	0	0.00	1.02	0.19
Orthopristis chrysoptera	Pigfish	15	0.05	0.82	0.15
Caranx hippos	Crevalle Jack	13	0.04	0.79	0.15
Paralichthys dentatus	Summer Flounder	20	0.07	0.75	0.14
Dorosoma petenense	Threadfin Shad	7	0.02	0.63	0.12
Alosa aestivalis	Blueback Herring	14	0.05	0.55	0.10
Stomolophus meleagris	Jelly Bomb	1	0.00	0.42	0.08
Peprilus triacanthus	Butterfish	3	0.01	0.40	0.07
Chloroscombrus chrysurus	Atlantic Bumper	37	0.13	0.28	0.05
Archosargus probatocephalus	Sheepshead	1	0.00	0.25	0.05
Gymnura micrura	Smooth Butterfly Ray	1	0.00	0.24	0.04
Chaetodipterus faber	Atlantic Spadefish	14	0.05	0.17	0.03
Trinectes maculatus	Hogchoker	6	0.02	0.16	0.03
Sphyraena borealis	Northern Sennet	2	0.01	0.09	0.02
Citharichthys spilopterus	Bay Whiff	5	0.02	0.07	0.01
Symphurus spp.	Tonguefishes	3	0.01	0.03	0.01
Scophthalmus aquosus	Windowpane	2	0.01	0.02	0.00
Selene vomer	Lookdown	1	0.00	0.01	0.00
Eucinostomus argenteus	Spotfin Mojarra	1	0.00	0.01	0.00
Totals		28,977	100.00	542.64	100.00

*Numbers not collected

Table 7. Relative biomass (kg) and number of individuals observed in the experimental net (2" stretch mesh, hung on the square) in the Neuse River and Pamlico Sound, North Carolina, 1 July 2008 to 30 June 2009.

Scientific Name	Common Name	Total Number	% Number	Total Weight (kg)	% Biomass
Lagodon rhomboides	Pinfish	3,036	33.74	81.13	31.18
Penaeus setiferus	White Shrimp	2,379	26.44	44.63	17.15
Micropogonias undulatus	Atlantic Croaker	982	10.91	26.88	10.33
Cynoscion regalis	Weakfish	366	4.07	26.80	10.30
Leiostomus xanthurus	Spot	713	7.92	18.92	7.27
Pomatomus saltatrix	Bluefish	81	0.90	12.77	4.91
Peprilus paru	Harvestfish	231	2.57	12.72	4.89
Bairdiella chrysoura	Silver Perch	209	2.32	5.86	2.25
Penaeus aztecus	Brown Shrimp	190	2.11	4.63	1.78
Opisthonema oglinum	Atlantic Thread Herring	308	3.42	4.52	1.74
Synodus foetens	Inshore Lizardfish	24	0.27	4.04	1.55
Brevoortia tyrannus	Atlantic Menhaden	75	0.83	2.65	1.02
Orthopristis chrysoptera	Pigfish	32	0.36	1.84	0.71
Paralichthys dentatus	Summer Flounder	39	0.43	1.77	0.68
Menticirrhus americanus	Southern Kingfish	9	0.10	1.58	0.61
Lolliguncula brevis	Atlantic Brief Squid	141	1.57	1.41	0.54
Cnidaria	Jellyfish	*	*	1.28	0.49
Paralichthys lethostigma	Southern Flounder	9	0.10	1.27	0.49
Scomberomorus maculatus	Spanish Mackerel	10	0.11	1.06	0.41
Caranx hippos	Crevalle Jack	19	0.21	0.98	0.38
Stomolophus meleagris	Jelly Bomb	2	0.02	0.80	0.31
Miscellaneous	Miscellaneous	*	*	0.74	0.28
Penaeus duorarum	Pink Shrimp	52	0.58	0.48	0.18
Peprilus triacanthus	Butterfish	3	0.03	0.39	0.15
Anchoa hepsetus	Striped Anchovy	27	0.30	0.26	0.10
Chloroscombrus chrysurus	Atlantic Bumper	29	0.32	0.22	0.08
Selene vomer	Lookdown	5	0.06	0.12	0.05
Chaetodipterus faber	Atlantic Spadefish	8	0.09	0.11	0.04
Ancylopsetta quadrocellata	Ocellated Flounder	1	0.01	0.10	0.04
Citharichthys spilopterus	Bay Whiff	7	0.08	0.09	0.03
Aluterus spp.	Aluterus Filefishes	4	0.04	0.08	0.03
Trinectes maculatus	Hogchoker	4	0.04	0.04	0.02
Squilla empusa	Mantis Shrimp	1	0.01	0.03	0.01
Dorosoma petenense	Threadfin Shad	2	0.02	0.02	0.01
		8,998	100.00	260.22	100.00

*Numbers not collected

Standard vs. Jones Davis BRD

There were 32 species observed in the standard net and 29 species observed in the experimental net during tests of the Jones-Davis BRD. The experimental net caught 69% by weight of all species combined compared to the standard net. The three commercially important species of shrimp (brown, white, pink) combined represented 1.45% of the catch by weight in the standard net and 0.80% of the catch by weight in the experimental net, which represents a 62% reduction in the total weight of shrimp caught in the experimental net compared to the control net. Atlantic croaker accounted for 1.66% of the catch by weight in the standard net and 2.74% by weight in the experimental net, which represents a 12% increase in

the total weight of croaker in the experimental net compared to the control net. Spot represented 21.17% of the catch by weight in the control net and 14.85% of the catch by weight in the experimental net, which represents a 52% reduction in the total weight of spot in the experimental net. The commercially important flounder species combined represented 0.30% of the catch by weight in the standard net and 0.68% of the catch by weight in the experimental net, which represents a 37% increase in the total weight of flounder species in the experimental net. Weakfish represented 0.14% of the catch by weight in the standard net and 0.24% of the catch by weight in the experimental net, which represents a 17% increase in the total weight of weakfish in the experimental net (Tables 8 and 9).

Table 8. Relative biomass (kg) and number of individuals observed in the standard net during gear tests of the Jones Davis BRD in the Neuse River and Pamlico Sound, North Carolina, 1 July 2008 to 30 June 2009.

Scientific Name	Common Name	Total Number	% Number	Total Weight (kg)	% Biomass
Lagodon rhomboides	Pinfish	6,154	52.60	167.57	52.73
Leiostomus xanthurus	Spot	4,170	35.64	67.26	21.17
Cnidaria	Jellyfish	181	1.55	40.21	12.65
Brevoortia tyrannus	Atlantic Menhaden	354	3.03	9.80	3.08
Rhinoptera bonasus	Cownose Ray	4	0.03	7.34	2.31
Bairdiella chrysoura	Silver Perch	145	1.24	6.26	1.97
Micropogonias undulatus	Atlantic Croaker	255	2.18	5.26	1.66
Penaeus duorarum	Pink Shrimp	93	0.79	4.45	1.40
Peprilus paru	Harvestfish	48	0.41	2.43	0.76
Pomatomus saltatrix	Bluefish	19	0.16	1.60	0.50
Paralichthys dentatus	Summer Flounder	6	0.05	0.78	0.25
Anchoa spp.	Anchovies	169	1.44	0.68	0.21
Peprilus triacanthus	Butterfish	16	0.14	0.60	0.19
Callinectes sapidus	Blue Crab	3	0.03	0.55	0.17
Trichiurus lepturus	Atlantic Cutlassfish	20	0.17	0.50	0.16
Cynoscion regalis	Weakfish	7	0.06	0.44	0.14
Menticirrhus americanus	Southern Kingfish	1	0.01	0.40	0.13
Dorosoma petenense	Threadfin Shad	18	0.15	0.38	0.12
Miscellaneous	Miscellaneous	*	*	0.27	0.08
Paralichthys lethostigma	Southern Flounder	2	0.02	0.17	0.05
Selene setapinnis	Atlantic Moonfish	4	0.03	0.14	0.04
Mollusca cephalopoda	Squids	4	0.03	0.12	0.04
Penaeus setiferus	White Shrimp	2	0.02	0.12	0.04
Chloroscombrus chrysurus	Atlantic Bumper	6	0.05	0.11	0.03
Squilla empusa	Mantis Shrimp	3	0.03	0.09	0.03
Opisthonema oglinum	Atlantic Thread Herring	5	0.04	0.08	0.03
Penaeus aztecus	Brown Shrimp	2	0.02	0.04	0.01
Portunus spp.	Portunus Crabs	2	0.02	0.04	0.01
Chaetodipterus faber	Atlantic Spadefish	1	0.01	0.03	0.01
Urophycis floridana	Southern Hake	1	0.01	0.02	0.01
Trinectes maculatus	Hogchoker	1	0.01	0.02	0.01
Anchoa hepsetus	Striped Anchovy	4	0.03	0.01	0.00
Totals		11,700	100.00	317.77	100.00

*Numbers not collected

Table 9. Relative biomass (kg) and number of individuals observed in the experimental net (Jones Davis BRD) in the Neuse River and Pamlico Sound, North Carolina, 1 July 2008 to 30 June 2009.

Scientific Name	Common Name	Total Number	% Number	Total Weight (kg)	% Biomass
Lagodon rhomboides	Pinfish	4,199	50.34	120.38	55.24
Cnidaria	Jellyfish	165	1.98	33.80	15.51
Leiostomus xanthurus	Spot	3,092	37.07	32.35	14.85
Brevoortia tyrannus	Atlantic Menhaden	249	2.99	6.07	2.79
Micropogonias undulatus	Atlantic Croaker	202	2.42	5.96	2.74
Bairdiella chrysoura	Silver Perch	118	1.41	5.31	2.44
Rhinoptera bonasus	Cownose Ray	2	0.02	3.90	1.79
Peprilus paru	Harvestfish	63	0.76	3.15	1.45
Penaeus duorarum	Pink Shrimp	103	1.23	1.71	0.78
Paralichthys dentatus	Summer Flounder	8	0.10	1.09	0.50
Pomatomus saltatrix	Bluefish	12	0.14	0.88	0.40
Cynoscion regalis	Weakfish	9	0.11	0.53	0.24
Dasyatis sabina	Atlantic Stingray	1	0.01	0.50	0.23
Paralichthys lethostigma	Southern Flounder	2	0.02	0.40	0.18
Miscellaneous	Miscellaneous	*	*	0.35	0.16
Trichiurus lepturus	Atlantic Cutlassfish	14	0.17	0.34	0.16
Anchoa spp.	Anchovies	66	0.79	0.31	0.14
Peprilus triacanthus	Butterfish	9	0.11	0.23	0.11
Dorosoma petenense	Threadfin Shad	6	0.07	0.12	0.06
Opisthonema oglinum	Atlantic Thread Herring	7	0.08	0.12	0.06
Urophycis floridana	Southern Hake	2	0.02	0.10	0.05
Selene setapinnis	Atlantic Moonfish	3	0.04	0.08	0.04
Chloroscombrus chrysurus	Atlantic Bumper	2	0.02	0.05	0.02
Trinectes maculatus	Hogchoker	2	0.02	0.05	0.02
Penaeus setiferus	White Shrimp	1	0.01	0.04	0.02
Callinectes sapidus	Blue Crab	1	0.01	0.04	0.02
Squilla empusa	Mantis Shrimp	1	0.01	0.02	0.01
Triglidae	Searobins	1	0.01	0.02	0.01
Penaeus aztecus	Brown Shrimp	1	0.01	0.01	0.00
Totals		8,341	100.00	217.91	100.00

*Numbers not collected

Standard vs. skylight panel

There were 22 species observed in the standard net and 25 species observed in the experimental net during tests of the skylight panel. The experimental net caught 65% by weight of all species combined compared to the standard net. The three commercially important species of shrimp (brown, white, pink) combined represented 0.46% of the catch by weight in the standard net and 0.72% of the catch by weight in the experimental net, which represents a 2% increase in the total weight of shrimp caught in the experimental net compared to the control net. Atlantic croaker accounted for 1.11% of the catch by weight in the standard net and 1.79% by weight in the experimental net, which represents a 5% increase in the total weight of croaker in the experimental net. Spot represented 10.03% of the catch by weight in the control net and 13.67% of the catch by weight in the experimental net, which represents a 12% reduction in the total weight of spot in the experimental net. The

commercially important species of flounder combined to represent 0.79% of the catch by weight in the standard net and 0.65% of the catch by weight in the experimental net, which represents a 46% reduction in the total weight of flounder species in the experimental net. Weakfish represented 0.13% of the catch by weight in the standard net and 0.23% of the catch by weight in the experimental net, which represents a 15% increase in the total weight of weakfish in the experimental net (Tables 10 and 11).

Table 10. Relative biomass (kg) and number of individuals observed in the standard net during gear tests of the skylight panel in the Neuse River and Pamlico Sound, North Carolina, 1 July 2008 to 30 June 2009.

Scientific Name	Common Name	Total Number	% Number	Total Weight (kg)	% Biomass
Lagodon rhomboides	Pinfish	3,665	56.31	112.65	42.58
Cnidaria	Jellyfish	652	10.02	106.43	40.23
Leiostomus xanthurus	Spot	1,654	25.41	26.54	10.03
Bairdiella chrysoura	Silver Perch	110	1.69	5.62	2.12
Brevoortia tyrannus	Atlantic Menhaden	100	1.54	3.38	1.28
Micropogonias undulatus	Atlantic Croaker	91	1.40	2.93	1.11
Miscellaneous	Miscellaneous	*	*	2.43	0.92
Paralichthys lethostigma	Southern Flounder	7	0.11	1.06	0.40
Paralichthys dentatus	Summer Flounder	9	0.14	1.03	0.39
Penaeus duorarum	Pink Shrimp	41	0.63	0.67	0.25
Penaeus aztecus	Brown Shrimp	91	1.40	0.55	0.21
Cynoscion regalis	Weakfish	4	0.06	0.34	0.13
Anchoa spp.	Anchovies	67	1.03	0.31	0.12
Callinectes sapidus	Blue Crab	3	0.05	0.27	0.10
Trichiurus lepturus	Atlantic Cutlassfish	4	0.06	0.14	0.05
Lolliguncula brevis	Atlantic Brief Squid	3	0.05	0.10	0.04
Urophycis floridana	Southern Hake	1	0.02	0.04	0.02
Opisthonema oglinum	Atlantic Thread Herring	1	0.02	0.02	0.01
Pomatomus saltatrix	Bluefish	1	0.02	0.02	0.01
Peprilus triacanthus	Butterfish	1	0.02	0.02	0.01
Trinectes maculatus	Hogchoker	1	0.02	0.02	0.01
Noturus spp.	Madtom Catfish	3	0.05	0.01	0.00
Totals		6,509	100.00	264.58	100.00

*Numbers not collected

Table 11. Relative biomass (kg) and number of individuals observed in the experimental net (skylight panel) in the Neuse River and Pamlico Sound, North Carolina, 1 July 2008 to 30 June 2009.

Scientific Name	Common Name	Total Number	% Number	Total Weight (kg)	% Biomass
Cnidaria	Jellyfish	691.00	14.75	100.13	58.33
Lagodon rhomboides	Pinfish	1517.00	32.38	36.54	21.29
Leiostomus xanthurus	Spot	2100.00	44.82	23.47	13.67
Micropogonias undulatus	Atlantic Croaker	82.00	1.75	3.08	1.79
Bairdiella chrysoura	Silver Perch	44.00	0.94	1.78	1.04
Rhinoptera bonasus	Cownose Ray	1.00	0.02	1.15	0.67
Paralichthys dentatus	Summer Flounder	8.00	0.17	1.09	0.63
Penaeus duorarum	Pink Shrimp	55.00	1.17	0.90	0.52
Miscellaneous	Miscellaneous	*	*	0.63	0.37
Brevoortia tyrannus	Atlantic Menhaden	21.00	0.45	0.53	0.31
Callinectes sapidus	Blue Crab	4.00	0.09	0.50	0.29
Cynoscion regalis	Weakfish	6.00	0.13	0.40	0.23
Penaeus aztecus	Brown Shrimp	69.00	1.47	0.35	0.20
Anchoa spp.	Anchovies	64.00	1.37	0.34	0.20
Larimus fasciatus	Banded Drum	1.00	0.02	0.16	0.09
Peprilus paru	Harvestfish	2.00	0.04	0.16	0.09
Peprilus triacanthus	Butterfish	4.00	0.09	0.13	0.08
Trichiurus lepturus	Atlantic Cutlassfish	3.00	0.06	0.07	0.04
Orthopristis chrysoptera	Pigfish	1.00	0.02	0.06	0.03
Trinectes maculatus	Hogchoker	3.00	0.06	0.06	0.03
Opisthonema oglinum	Atlantic Thread Herring	1.00	0.02	0.04	0.02
Paralichthys lethostigma	Southern Flounder	2.00	0.04	0.04	0.02
Anchoa hepsetus	Striped Anchovy	4.00	0.09	0.02	0.01
Urophycis floridana	Southern Hake	1.00	0.02	0.02	0.01
Aluterus spp.	Aluterus Filefishes	1.00	0.02	0.01	0.01
Totals		4685.00	100.00	171.66	100.00

*Numbers not collected

Length Frequencies

Length frequency data of a given population is important information used in the assessment of that population. Length frequency of commercially important species of shrimp in this study was stratified by net type and binned into 10 mm groups. The three commercially important species of shrimp were combined to provide length frequency data.

The length frequency distribution of the three commercially important species of shrimp show similar patterns in each of the five gear types tested compared to the standard net. The majority of individuals measured in both the standard and experimental nets during tests of the 1 ¾" stretch mesh, hung on the diamond were between 110 and 160 mm (Figure 2). The majority of individuals measured in both the standard and experimental nets during tests of the 1 ¾" stretch mesh, hung on the square were between 110 and 160 mm (Figure 3). The majority of individuals measured in both the standard and experimental nets during tests of the 2" stretch mesh, hung on the square were between 110 and 140 mm (Figure 4). The majority of individuals measured in both the standard and experimental nets during test of the Jones

Davis BRD were between 110 and 160 mm, with the Jones Davis BRD showing more individuals in the upper ranges (Figure 5). The standard and experimental nets during testing of the skylight panel showed less discernable trends than the other gears tested; however this gear was tested near the end of the season and had limited catch (Figure 6).

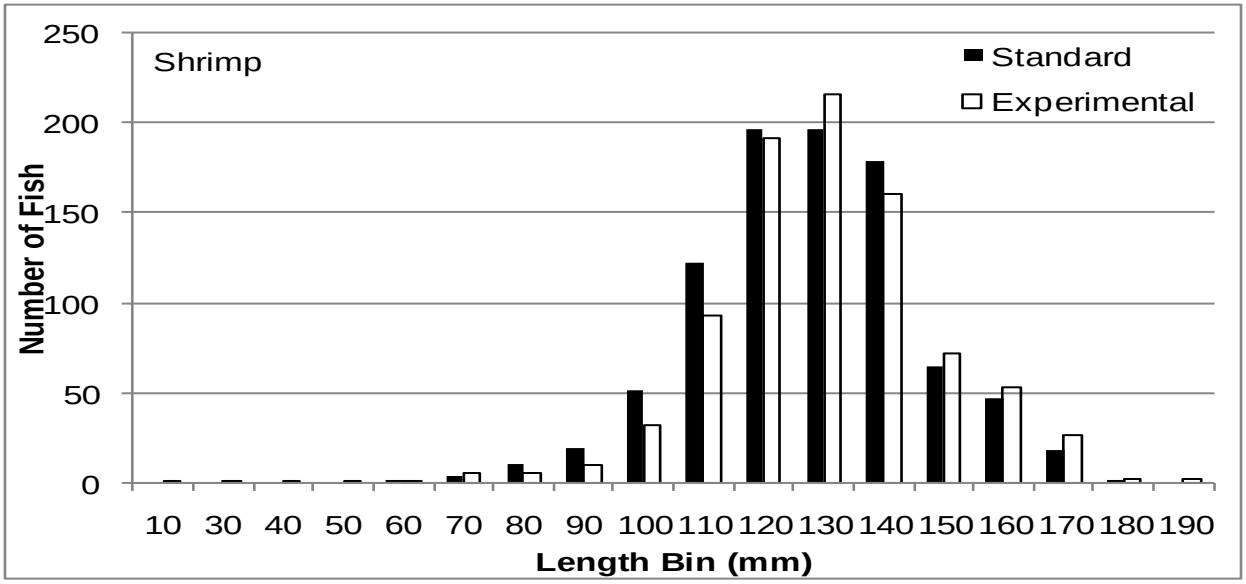

Figure 2. Length frequency of shrimp observed during gear tests of the 1 ¾" stretch mesh, hung on the diamond in the Neuse River and Pamlico Sound, North Carolina 1 July 2008 to 30 June 2009.

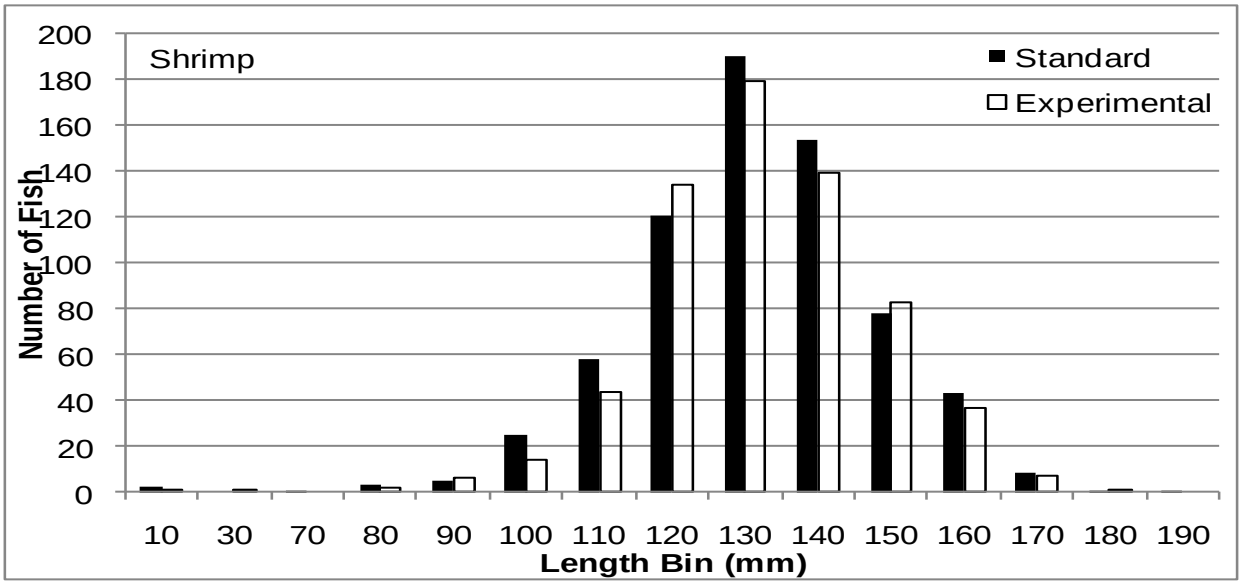

Figure 3. Length frequency of shrimp observed during gear tests of the 1 ¾" stretch mesh, hung on the square in the Neuse River and Pamlico Sound, North Carolina, 1 July 2008 to 30 June 2009.

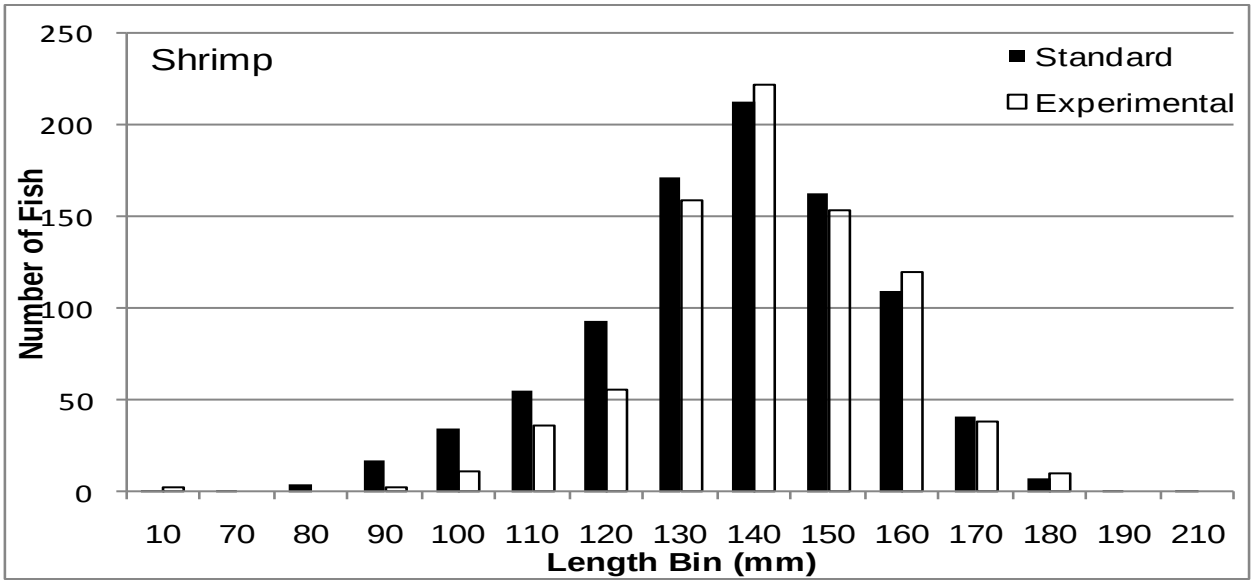

Figure 4. Length frequency of shrimp observed during gear tests of the 2" stretch mesh, hung on the square in the Neuse River and Pamlico Sound, North Carolina, 1 July 2008 to 30 June 2009.

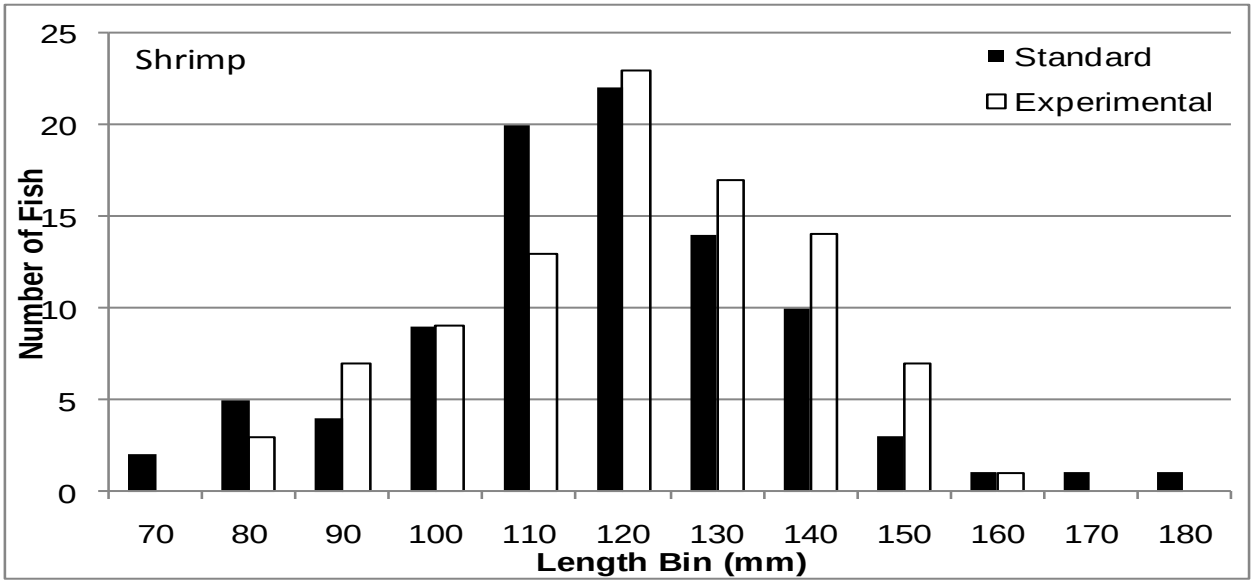

Figure 5. Length frequency of shrimp observed during gear tests of the Jones Davis BRD in the Neuse River and Pamlico Sound, North Carolina, 1 July 2008 to 30 June 2009.

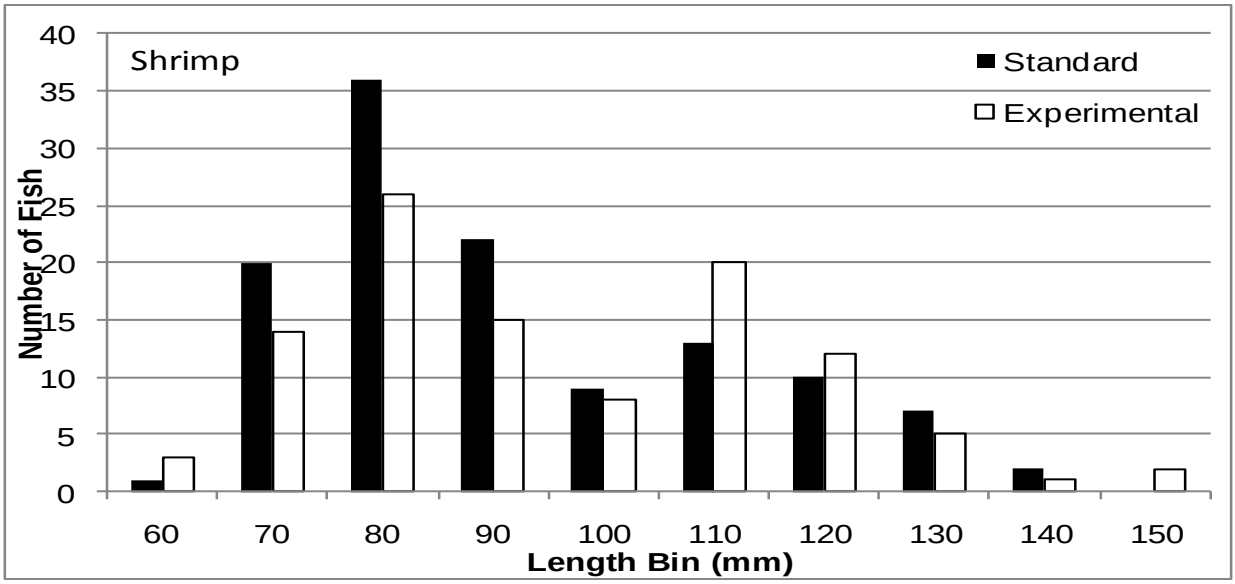

Figure 6. Length frequency of shrimp observed during gear tests of the skylight panel in the Neuse River and Pamlico Sound, North Carolina, 1 July 2008 to 30 June 2009.

Statistical Analysis

T-tests were conducted between the standard net and each of the experimental nets to determine any statistical significance between the target (shrimp) and bycatch (all other species) mean weights (kg) between net types. The alpha level was set at 0.05 to determine significance.

Standard vs. 1 ¾" stretch mesh hung on the diamond

The mean weight (kg) of the target species (shrimp) in the experimental net was not significantly different from the standard net (two sided t-test, dF=58, p=0.9905). The mean weight (kg) of bycatch in the experimental net was not significantly different from the standard net (two sided t-test, dF=58, p=0.2285).

Standard vs. 1 ¾" stretch hung on the square

The mean weight (kg) of the target species (shrimp) in the experimental net was not significantly different from the standard net (two sided t-test, dF=58, p=0.2721). The mean weight (kg) of bycatch in the experimental net was significantly different from the standard net (two sided t-test, dF=39.6, p<0.0001). The experimental net caught significantly less bycatch compared to the standard net during this trial.

Standard vs. 2" stretch hung on the square

The mean weight (kg) of the target species (shrimp) in the experimental net was not significantly different from the standard net (two sided t-test, dF=56, p=0.5837). The mean

weight (kg) of bycatch in the experimental net was significantly different from the standard net (two sided t-test, dF=44.4, p=0.0085). The experimental net caught significantly less bycatch compared to the standard net during this trial.

Standard vs. Jones Davis BRD

The mean weight (kg) of the target species (shrimp) in the experimental net was not significantly different from the standard net (two sided t-test, dF=29.3, p=0.1271). The mean weight (kg) of bycatch in the experimental net was significantly different from the standard net (two sided t-test, dF=46.3, p=0.0353). The experimental net caught significantly less bycatch compared to the standard net during this trial.

Standard vs. skylight panel

The mean weight (kg) of the target species (shrimp) in the experimental net was not significantly different from the standard net (two sided t-test, dF=58, p=0.9182). The mean weight (kg) of bycatch in the experimental net was significantly different from the standard net (two sided t-test, dF=51.2, p=0.0269). The experimental net caught significantly less bycatch compared to the standard net during this trial.

Sea Bird and Protected Species Bycatch

There was no sea bird, marine mammal, or protected species bycatch observed this study. However, there were always numerous sea birds of several unrecorded species present.

DISCUSSION

Fishery managers continue to confront the issues associated with the bycatch and discards in commercial and recreational fisheries. The commercial shrimp trawl fishery is allowed to operate in the estuarine and oceanic waters of North Carolina, which is controversial because of the bycatch and discards associated with trawls.

The purpose of this project was to identify potential gear modifications that can be implemented by the commercial shrimp trawl fishery to reduce bycatch in the fishery. The goal of any gear modification that is used to reduce bycatch must also maintain the target catch or risk the industry resisting the adoption of the modification into commercial practices. This study quantified the target and bycatch in standard and experimental shrimp trawls in the Neuse River and Pamlico Sound, North Carolina. A total of five experimental nets were tested against standard shrimp trawls.

The first gear that was tested was a 1 ¾" stretch mesh tail bag (hung on the diamond). This gear is the most similar to standard 1 ½" stretch mesh tail bag (hung on the diamond) that was tested during this study. No statistical significance was found between the mean weights of the target species or bycatch in the 1 ¾" stretch mesh (hung on the diamond) and the standard net. The shrimp catches between the two nets were almost identical and the test net reduced the catch of Atlantic croaker by 16% and spot by 50%.

The next modification that was tested was a 1 ¾" stretch mesh tail bag (hung on the square). There was no significant statistical difference in the mean weights of the shrimp catch between this net and the standard net. There was a significant difference in the mean weight of bycatch. The experimental net caught significantly less bycatch compared to the standard net. The experimental net reduced the catch of Atlantic croaker by 76%, spot by 77%, and weakfish by 46%.

The third gear tested was a 2" stretch mesh tail bag (hung on the square). There was no significant statistical difference in the mean weights of the shrimp catch between this net and the standard net. There was a significant difference in the mean weight of bycatch between the two nets, with the experimental net significantly reducing the mean weight of bycatch compared to the standard net. The experimental net reduced the catch of Atlantic croaker by 69% and spot by 82%.

The Jones Davis BRD was hung in a standard (1 ½" stretch mesh) tail bag and was tested against a standard tail bag. There was no significant statistical difference in the mean weights of the shrimp catch between the two nets. There was a significant difference in the mean weight of bycatch between the two nets, with the experimental net significantly reducing the mean weight of bycatch compared to the standard net. The experimental net reduced the catch of spot by 52%.

The final gear tested was a skylight panel that was sewn into a standard (1 ½" stretch mesh) tail bag. There was no significant statistical difference in the mean weights of the shrimp catch between the experimental and standard nets. There was a significant difference in the mean weight of bycatch between the two nets, with the experimental net significantly reducing the mean weight of bycatch compared to the standard net. The experimental net reduced the catch of spot by 12% and flounder (all commercial species combined) by 46%.

When conducting gear research it is important to reduce unwanted bycatch but maintain target catch. Each gear modification that was tested showed no statistical difference in the mean weights of shrimp compared to the standard net. All but one test net also showed a statistical significant reduction in the mean weight of bycatch compared to the standard net.

The importance of gear studies designed to reduce bycatch 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.

RECOMMENDATIONS

- Continue to experiment with gear modifications in the commercial shrimp trawl fishery to reduce bycatch and maintain shrimp catch. This should be conducted in various areas of the state to determine any difference associated with area.

- Managers should consider implementing some of the gear modifications into the commercial shrimp trawl fishery.

- 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.

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

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