SEDAR 18 Working Paper
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An Estimate of Red Drum Removals from the North Carolina Estuarine Gill Net Fishery Occurring from both Recreational Users of Gill Nets and from Regulatory and Unmarketable Discards.

Abstract

Red drum removals, other than harvest, were estimated for estuarine gill nets. Sources of removals included unaccounted for harvest by recreational gill net users and dead red drum discards from both the commercial and recreational estuarine gill net fishery. The recreational harvest was estimated by NCDMF using a survey which targeted recreational commercial gear license holders (RCGL) for the period of 2002 to 2006. Estimated estuarine gill net harvest of red drum by RCGL holders ranged from 4,245 lb in 2003 to 9,893 lb in 2002. Red drum removals associated with unmarketable or regulatory discards were estimated using data provided by the NC Gill Net Observer Program (CPUE=dead discards per trip) and the NC Trip Ticket Program (total trips made) for the period of 2004 to 2006. Estimated discard mortalities in the estuarine gill net fishery were between 22,142 lbs in 2005 and 68,997 lbs in 2006. These additional removals represented 54% of the 2005 and 22% of the 2006 total annual commercial harvest (all gears combined). Results indicate that removals from these sources make up a significant proportion of the total removals from the population on an annual basis and should be accounted for in order to more accurately determine the status of the red drum stock in this region.

Background

Non-harvest loss of red drum occurring from the use of commercial fishing gear is currently not fully known. This lack of information continues to be a major source of bias in accurately assessing the current stock status of red drum in North Carolina. Spawning potential ratio (SPR) and escapement rates estimated by the previous stock assessment carry the caveat that non-harvest losses in the commercial fishery are not known. This lack of information on discards likely results in an overly optimistic estimate of escapement and SPR. Assessing the magnitude of discards in the commercial fishery is listed as high research priority in both the 2007 red drum stock assessment update (Takade and Paramore 2007) and Amendment 2 to the Atlantic States Marine Fisheries Commission (ASMFC) Red Drum Fishery Management Plan (FMP) (ASMFC 2002).

While non-harvest losses likely occur to some extent from various commercial gears, it has been well accepted that the primary loss is likely due to the bycatch of red drum in the estuarine gill net fishery. Measures have been taken in NC to reduce red drum bycatch in the estuarine gill net fishery by requiring the seasonal attendance of small mesh gill nets (<5" stretch mesh). Gill nets of this mesh size select for red drum less than 18" TL and are a significant source of the bycatch mortality, particularly in months when water temperatures are high. Current North Carolina regulations require the attendance of small

mesh gill nets from May 1 through November 30 in areas known to be critical for juvenile red drum. These include all primary and secondary nursery areas, areas within 200 yards of any shoreline, and the extensive area of shallow grass flats located behind the Outer Banks. Additionally, areas in the Pamlico, Pungo and Neuse Rivers now require year round attendance of small mesh gill nets if they are fished within 200 yards of any shoreline. Studies conducted by NCDMF have shown that setting gill nets well off the shoreline is effective at reducing the incidence of juvenile red drum bycatch.

This paper provides available information on the removal of red drum by estuarine gill nets that are not accounted for in the North Carolina Trip Ticket Program. Estimates were generated by 1) collecting information on gill net effort by area/season; 2) conducting at sea samples to estimate red drum discards from commercial gill nets; 3) estimating the release mortality from gill nets; and 4) collecting data on the harvest and releases of red drum captured in gill nets under the Recreational Commercial Gear License.

1) Collect information on estuarine gill net effort by area and season.

Information specific to North Carolina's estuarine gill net fishery can be drawn from three DMF sampling programs briefly described below:

NC Trip Ticket Program

Commercial red drum landings and the red drum commercial cap are monitored through the North Carolina trip ticket program. Under this program licensed fishermen can only sell commercial catches to licensed NCDMF fish dealers. The dealer is required to complete a trip ticket every time a licensed fishermen lands fish. Trip tickets capture data on gears used to harvest fish, area fished, species harvested, and total weights of each individual species. The trip ticket program began in 1994.

Commercial Fish House Sampling

Commercial fishing activity is monitored through fishery dependent (fish house) sampling. Sampling is done dockside as fish are landed. Commercial fishers are interviewed and the catch is sampled. Data collected includes information on location, effort and gear characteristics, as well as information used to determine the size and age distribution of species landed. Over the past decade gill nets have been the dominant gear used for red drum accounting for >70% of the overall harvest. In 2006, 93.5% of the red drum harvest was taken in gill nets, followed by pound nets with 4%.

Commercial Observer Program

Starting in October of 2000, the Pamlico Sound flounder gill net fishery has been restricted, operating under an Incidental Take Permit (ITP) issued by NMFS to reduce interactions with endangered and threatened sea turtles. The restrictions on this fishery are effective from September 15 through December 31. Stipulations of the permit include permitted entry, restricted areas, limited yardage of gill net and mandatory scientific observer coverage. This ITP began the available observer data available for the estuarine gill net

fishery in North Carolina. From 2001 to 2003, coverage was limited to the fall Pamlico Sound flounder gill net fishery. From 2004 to 2006, coverage was expanded by DMF to include other regions and estuarine gill net fisheries. Participation in this expanded coverage by commercial gill netters was voluntary. Information gathered during observer trips includes data on effort and mesh sizes used, as well as, data on the size, weight and ultimate fate of captured species.

Information gathered from these three programs was used to characterize North Carolina's estuarine gill net fishery. North Carolina has a large number of commercially valuable species that are targeted by gill nets throughout the year with no single size gill net (i.e. mesh size) being ideal for all species. The result is gill netters utilize specific mesh size nets depending on the species they intend to target. While multiple species are most often landed for a single trip, a target (key) species most often represents the majority of the catch.

In order to characterize a specific estuarine gill net fishery the species being targeted must first be identified. This information is not readily available and must be inferred from the catch composition. Data collected from 2001 to 2006 was analyzed to determine the target species for each individual trip made. Drift and run-around gill nets were not included in this analysis. Using trip ticket data, the species of highest abundance in landings was considered the target species and was used to define the trip. After initial analysis, 95% of all gill net trips fell into one of sixteen key species. These sixteen species were then each identified as a separate fishery. For those remaining undefined trips, a hierarchy was used where the species of second and then third highest abundance was used to define the trip if it was represented by one of these sixteen species. This defined an additional 4% of the remaining trips. Of the remaining trips (1%) the non-key species of highest abundance in the catch was used to define the trip. Overall, flounder was the primary species targeted by gill netters in estuarine waters of North Carolina (Table 1). Overall landings across all trips for each of the key species are summarized in Table 2.

Table 1. Estuarine gill net trips with the species of highest abundance landed (target species) being used to define a trip.

Species	2001	2002	2003	2004	2005	2006	Combined	(%)	cum%
Flounder	19,390	17,779	16,255	16,208	14,402	16,884	100,918	(47)	47
Striped Bass	5,198	5,041	4,965	4,404	4,377	3,363	27,348	(13)	59
Spot	2,105	2,793	2,861	2,847	2,930	1,686	15,222	(7)	66
Striped Mullet	3,149	3,041	2,720	2,035	1,853	1,659	14,457	(7)	73
American Shad	1,327	1,746	1,865	1,556	1,447	1,325	9,266	(4)	77
Menhaden	1,579	1,512	1,647	1,192	1,226	1,725	8,881	(4)	81
Bluefish	1,895	991	1,484	915	1,240	1,063	7,588	(4)	85
White Perch	882	1,111	1,827	968	879	858	6,525	(3)	88
Catfish	1,040	916	831	743	776	1,112	5,418	(3)	90
Red Drum	2,347	356	556	331	599	883	5,072	(2)	93
Speckled Trout	413	820	621	486	411	948	3,699	(2)	94
Spanish Mackerel	685	668	279	308	553	396	2,889	(1)	96
Hickory Shad	801	219	199	619	550	306	2,694	(1)	97
River Herring	341	488	377	314	413	281	2,214	(1)	98
Weakfish	458	330	218	406	321	275	2,008	(1)	99
Sea Mullet	129	92	99	74	67	147	608	(0)	99
Others (37 species)	463	357	279	220	137	199	1,655	(1)	100
Combined	42,202	38,260	37,083	33,626	32,181	33,110	216,462	(100)	

Table 2. Annual landings of major species in North Carolina's estuarine gill net fishery (lbs).

Species	2001	2002	2003	2004	2005	2006	Combined
Flounder	1,905,276	1,807,364	1,469,218	1,587,289	1,283,917	1,539,360	9,592,425
Menhaden	1,134,509	791,479	980,822	561,149	865,364	602,951	4,936,272
Striped Mullet	778,261	891,357	709,182	512,018	449,901	377,231	3,717,950
Spot	536,123	675,204	652,932	685,989	728,509	325,141	3,603,898
Bluefish	445,555	256,451	488,170	278,599	368,342	231,817	2,068,932
Striped Bass	226,372	226,705	339,056	295,172	235,708	184,266	1,507,279
American Shad	119,925	238,923	356,303	241,001	179,411	161,248	1,296,812
White Perch	175,525	219,077	404,865	176,027	138,723	106,859	1,221,077
Catfish	155,373	157,399	170,153	125,599	118,345	134,689	861,557
Spanish Mackerel	183,834	199,166	74,470	88,931	178,606	97,679	822,686
Hickory Shad	161,234	44,195	63,388	173,352	169,441	48,963	660,573
Red Drum	129,509	66,335	78,805	44,917	103,648	145,833	569,047
Weakfish	106,464	95,321	69,863	89,238	101,191	74,261	536,339
Speckled Trout	55,038	101,934	96,928	67,850	50,757	114,347	486,854
River Herring	86,164	71,636	82,119	75,920	74,727	36,849	427,414
Sea Mullet	45,656	40,184	38,423	28,907	25,755	54,951	233,877

Once trips were defined, each fishery was then further characterized from available fish house sampling and observer data from 2001 to 2006. For each of the sixteen fisheries defined, information specific to mesh sizes used, yards of net fished, soak times and depths fished are included (Tables 3 and 4). Species with similar gear parameters for mesh size are grouped together into large ($\geq$ 5 inch) or small (<5 inch) stretch mesh gill net fisheries. Available information is also separated by region. Regions include: Albemarle Sound, Core Sound to the South Carolina border, Pamlico and Neuse River, and Pamlico Sound.

The availability of various species in North Carolina's estuarine gill net fishery varies by season. Monthly landings by region for each of the sixteen key species are provided in Figures 1 and 2.

Table 3. Large mesh (≥ 5 inch) gill net fishery parameters commonly associated with the targeting of various species, 2001-2006.

FLOUNDERS		Gill Net Stretch Mesh Size						Effort Data (yards fished)			Soak Time (hours)			Depth (ft)		
Region	Source (Program)	N	mode	common range	mean	min	max	mean	min	max	mean	min	max	mean	min	max
All	Dependent	1,686	5.50	5.25 - 6.5	5.66	2.88	7.00	1,534	50	6,000	20	4	96	5	1	20
Albemarle Sound	Dependent (pgm 461)	293	5.75	5.5 - 6	5.74	3.13	6.50	1,737	200	3,700	26	12	72	9	1	20
	Observer (pgm 466)	66	5.50	5.25 - 6	5.59	3.25	6.50	2,109	600	3,000	22	10	48	7	1	20
Core Sound South	Dependent (pgm 461)	349	5.50	5.5 - 6	5.63	3.25	7.00	1,949	200	6,000	17	7	48	3	1	12
	Observer (pgm 466)	101	5.50	5.5 - 6	5.66	5.25	6.50	1,519	500	3,400	18	11	48	3	1	6
Pamlico/Neuse River	Dependent (pgm 461)	543	5.50	5.25 - 5.5	5.46	3.00	7.00	1,176	50	5,333	17	4	72	4	1	18
	Observer (pgm 466)	202	5.50	5.25 - 5.5	5.45	3.00	6.00	935	100	3,200	21	4	144	4	1	18
Pamlico Sound	Dependent (pgm 461)	501	6.00	5.25 - 6.5	5.83	2.88	7.00	1,411	100	6,000	22	8	96	3	1	10
	Observer (pgm 466)	881	6.00	5.5 - 7	5.99	3.00	8.75	1,179	100	3,000	24	2	144	3	<1	13

STRIPED BASS		Gill Net Stretch Mesh Size (inches)						Effort Data (yards fished)			Soak Time (hours)			Depth (ft)		
Region	Source (Program)	N	mode	common range	mean	min	max	mean	min	max	mean	min	max	mean	min	max
All	Dependent	150	5.50	5.5 - 8	5.70	2.50	10.00	657	50	3,000	17	1	36	6	2	15
Albemarle Sound	Dependent (pgm 461)	24	5.75 & 8	5.5 - 8	5.90	2.50	10.00	1,009	100	3,000	20	1	24	8	3	15
	Observer (pgm 466)	7	5.50	5.50	5.50	5.50	5.50	950	400	2,000	31	24	48	11	6	18
Core Sound South	Dependent (pgm 461)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	Observer (pgm 466)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Pamlico/Neuse River	Dependent (pgm 461)	111	5.50	5.5 - 7	5.70	5.50	7.00	555	50	1,800	16	12	36	6	2	12
	Observer (pgm 466)	6	5.50	5.25 - 6	5.45	5.25	6.00	1,033	600	1,600	22	12	24	6	4	12
Pamlico Sound	Dependent (pgm 461)	15	5.75	5.75 - 6	5.30	3.00	6.00	986	400	1,500	21	12	24	6	3	12
	Observer (pgm 466)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

RED DRUM		Gill Net Stretch Mesh Size (inches)						Effort Data (yards fished)			Soak Time (hours)			Depth (ft)		
Region	Source (Program)	N	mode	common range	mean	min	max	mean	min	max	mean	min	max	mean	min	max
All	Dependent	51	5.50	5.5 - 6	5.30	3.00	6.50	838	100	3,200	17	8	48	3	1	7
Albemarle Sound	Dependent (pgm 461)	7	6.00	4.5 - 6	5.63	4.50	6.00	700	100	2,000	16	12	24	3	1	5
	Observer (pgm 466)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Core Sound South	Dependent (pgm 461)	9	5.50	4.5 - 5.75	5.06	3.00	5.75	738	200	3,200	16	12	24	3	2	5
	Observer (pgm 466)	3	5.50	5.5 - 5.75	5.56	5.50	5.75	1,033	600	1,600	16	12	24	2	2	4
Pamlico/Neuse River	Dependent (pgm 461)	12	5.50	5.25 - 6	5.25	3.25	6.00	750	100	1,400	15	12	24	4	2	4
	Observer (pgm 466)	1	5.50	4.5 - 5.5	5.00	4.50	5.50	800	800	800	16	16	16	4	2	7
Pamlico Sound	Dependent (pgm 461)	23	6.00	5.5 - 6.25	5.43	3.25	6.50	968	300	3,000	19	8	48	3	1	7
	Observer (pgm 466)	14	6.00	4.75 - 6.5	5.76	4.75	6.50	1,016	300	1,700	23	12	48	2	1	4

AM SHAD		Gill Net Stretch Mesh Size (inches)						Effort Data (yards fished)			Soak Time (hours)			Depth (ft)		
Region	Source (Program)	N	mode	common range	mean	min	max	mean	min	max	mean	min	max	mean	min	max
All	Dependent	208	5.50	5 - 5.5	5.50	3.00	7.00	759	100	2,500	24	12	96	9	1	14
Albemarle Sound	Dependent (pgm 461)	18	5.50	5.25 - 5.5	5.37	3.00	7.00	892	300	1,400	49	12	96	9	8	10
	Observer (pgm 466)	33	5.50	5.25 - 5.5	5.25	3.00	6.00	786	231	2,400	28	12	96	10	2	21
Core Sound South	Dependent (pgm 461)	2	5.25	5.25	5.25	5.25	5.25	300	300	300	18	12	24	4	4	4
	Observer (pgm 466)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Pamlico/Neuse River	Dependent (pgm 461)	179	5.50	5.25 - 5.5	5.56	3.75	7.00	731	100	2,500	22	12	72	9	1	14
	Observer (pgm 466)	54	5.50	5 - 6	5.55	5.00	7.00	835	198	3,000	26	12	73	6	2	14
Pamlico Sound	Dependent (pgm 461)	9	5.50	5.50	5.29	3.13	6.00	1,217	200	2,000	26	12	48	5	2	6
	Observer (pgm 466)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Table 3. Continued.

HICKORY SHAD*		Gill Net Stretch Mesh Size (inches)						Effort Data (yards fished)			Soak Time (hours)			Depth (ft)		
Region	Source (Program)	N	mode	common range	mean	min	max	mean	min	max	mean	min	max	mean	min	max
All	Dependent	55	5.50	3 - 5.5	4.20	3.00	6.00	1,073	231	3,000	23	12	48	7	1	13
Albemarle Sound	Dependent (pgm 461)	1	5.50	2.5 - 5.5	3.67	2.50	5.50	1,150	1,150	1,150	12	12	12	5	5	5
	Observer (pgm 466)	8	5.25	3 - 5.5	4.98	3.00	5.50	963	400	1,760	22	12	48	11	8	21
Core Sound South	Dependent (pgm 461)	13	3.75	3.25 - 4.0	3.58	3.00	4.00	939	400	1,900	20	12	24	4	2	6
	Observer (pgm 466)	2	3.50	3.25 - 3.75	3.60	3.25	5.50	1,000	500	1,500	36	24	48	5	3	6
Pamlico/Neuse River	Dependent (pgm 461)	19	5.50	3.75 - 5.5	4.70	3.75	5.50	878	231	1,900	26	12	24	10	5	13
	Observer (pgm 466)	9	5.50	4 - 5.5	4.93	4.00	5.50	836	231	1,770	24	12	48	7	3	15
Pamlico Sound	Dependent (pgm 461)	22	4.00	3.0 - 4.0	3.96	2.88	6.00	1,365	400	3,000	23	12	48	5	1	10
	Observer (pgm 466)	4	3.50	3 - 5.75	4.17	3.00	5.75	763	560	1,150	24	24	24	3	1	5

CATFISH		Gill Net Stretch Mesh Size (inches)						Effort Data (yards fished)			Soak Time (hours)			Depth (ft)		
Region	Source (Program)	N	mode	common range	mean	min	max	mean	min	max	mean	min	max	mean	min	max
Albemarle Sound	Observer (pgm 466)	12	5.50	3.25 - 5.5	4.68	3.00	5.75	1,338	400	3,000	20	1	48	8	2	18
Core Sound South	Observer (pgm 466)	2	5.50	3.25 - 5.5	4.30	3.25	5.50	1,100	900	1,300	36	24	48	3	2	6
Pamlico/Neuse River	Observer (pgm 466)	15	5.50	3.25 - 5.5	5.50	5.00	6.00	713	132	2,400	21	10	24	6	3	11
Pamlico Sound	Observer (pgm 466)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Table 4. Small mesh (< 5 inch) gill net fishery parameters commonly associated with the targeting of various species, 2001-2006.

SPOT		Gill Net Stretch Mesh Size (inches)						Effort Data (yards fished)			Soak Time (hours)			Depth (ft)		
Region	Source (Program)	N	mode	common range	mean	min	max	mean	min	max	mean	min	max	mean	min	max
All	Dependent	160	3 - 3.25	3 - 3.5	3.46	2.75	8.00	780	100	3,000	17	1	48	6	2	20
Albemarle Sound	Dependent (pgm 461)	46	3.25	3.13 - 3.25	3.50	3.00	8.00	715	133	1,600	16	2	24	6	3	10
	Observer (pgm 466)	13	3.25	3.0 - 3.25	3.22	3.00	3.75	815	200	1,700	11	1	24	7	2	16
Core Sound South	Dependent (pgm 461)	42	3.00	3 - 3.13	3.32	2.75	5.75	544	100	2,500	12	1	24	5	3	20
	Observer (pgm 466)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Pamlico/Neuse River	Dependent (pgm 461)	12	3.00	3 - 3.25	3.57	3.00	5.50	544	200	800	10	2	24	4	3	4
	Observer (pgm 466)	6	3.00	2.75 - 3.25	3.50	2.75	5.50	791	400	1,025	18	12	24	4	2	6
Pamlico Sound	Dependent (pgm 461)	60	3.00	3 - 3.5	3.54	2.88	6.00	1,091	200	3,000	22	7	48	6	2	13
	Observer (pgm 466)	26	3.50	3 - 3.75	4.25	2.87	7.00	1,020	140	2,630	24	2	72	4	1	12

STRIPED MULLET		Gill Net Stretch Mesh Size (inches)						Effort Data (yards fished)			Soak Time (hours)			Depth (ft)		
Region	Source (Program)	N	mode	common range	mean	min	max	mean	min	max	mean	min	max	mean	min	max
All	Dependent	89	3.75 - 4	3 - 4	4.10	2.88	5.75	818	200	2,600	16	1	48	5	1	17
Albemarle Sound	Dependent (pgm 461)	9	3.25	3.25	4.60	3.00	5.75	1,371	500	2,600	27	10	48	8	3	17
	Observer (pgm 466)	18	3.25	3 - 3.5	3.71	3.00	5.50	537	100	1,200	10	1	24	5	1	11
Core Sound South	Dependent (pgm 461)	10	3.75	3.75 - 4	4.00	3.25	5.50	833	400	1,600	17	12	36	4	3	5
	Observer (pgm 466)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Pamlico/Neuse River	Dependent (pgm 461)	60	4.00	3 - 4	3.70	2.88	6.50	638	200	1,800	11	1	24	4	3	7
	Observer (pgm 466)	1	4.00	4	4.75	4.00	5.50	800	800	800	12	12	12	5	4	6
Pamlico Sound	Dependent (pgm 461)	10	4.00	3.25 - 4	4.60	3.25	6.50	889	400	1,500	19	12	24	3	1	7
	Observer (pgm 466)	44	4.00	3.50 - 4.0	4.02	3.00	6.00	901	55	1,500	26	1	72	3	1	24

Table 4. Continued.

SPOTTED SEATROUT		Gill Net Stretch Mesh Size (inches)						Effort Data (yards fished)			Soak Time (hours)			Depth (ft)		
Region	Source (Program)	N	mode	common range	mean	min	max	mean	min	max	mean	min	max	mean	min	max
All	Dependent	70	4.00	3.5 - 4(+5.5)	4.20	3.00	5.75	1,055	100	2,300	19	3	72	4	3	8
Albemarle Sound	Dependent (pgm 461)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	Observer (pgm 466)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Core Sound South	Dependent (pgm 461)	6	4.00	3.5 - 4	3.90	3.50	4.00	1,180	400	1,600	17	3	24	4	2	5
	Observer (pgm 466)	4	3.75	3.25-3.75(+5.5)	4.00	3.25	5.50	1,175	800	1,500	42	24	48	4	2	6
Pamlico/Neuse River	Dependent (pgm 461)	40	4.00	3.5 - 4(+5.5)	4.20	3.00	5.50	988	400	2,000	13	12	24	4	2	7
	Observer (pgm 466)	3	5.50	3 - 5.5	4.28	3.00	5.50	840	331	1,400	15	1	24	3	1	5
Pamlico Sound	Dependent (pgm 461)	24	4.00	3.75 - 4.75	4.30	3.25	5.76	1,083	100	2,300	27	12	72	4	2	8
	Observer (pgm 466)	14	4.00	3.75 - 4.5	4.21	3.50	6.00	1,030	400	1,700	24	16	48	4	2	8

BLUEFISH		Gill Net Stretch Mesh Size (inches)						Effort Data (yards fished)			Soak Time (hours)			Depth (ft)		
Region	Source (Program)	N	mode	common range	mean	min	max	mean	min	max	mean	min	max	mean	min	max
All	Dependent	161	3.25	2.88 - 3.5	3.70	2.88	6.50	1,036	100	3,900	23	2	48	6	2	17
Albemarle Sound	Dependent (pgm 461)	11	3.25	3.13 - 3.25	3.23	3.12	3.25	950	500	1,200	24	12	48	5	3	10
	Observer (pgm 466)	1	3.00	3.00	3.00	3.00	3.00	2,000	2,000	2,000	2	1	4	4	2	7
Core Sound South	Dependent (pgm 461)	16	3.00	3 - 3.25	3.43	2.88	6.00	1,103	150	2,000	18	12	24	5	3	8
	Observer (pgm 466)	1	5.50	5.50	5.50	5.50	5.50	900	900	900	24	24	24	3	3	4
Pamlico/Neuse River	Dependent (pgm 461)	2	3.25	3.25	4.38	3.25	5.50	1,700	1,700	1,700	12	12	12	3	3	3
	Observer (pgm 466)	3	3.25	3.25	4.25	3.25	6.00	867	200	1,400	11	4	18	5	4	6
Pamlico Sound	Dependent (pgm 461)	132	3.25	2.88 - 3.5	3.76	2.88	6.50	1,026	100	3,900	23	2	48	6	2	17
	Observer (pgm 466)	37	3.50	3.25 - 4	4.89	3.00	7.00	885	200	2,775	24	12	48	4	1	11

WEAKFISH		Gill Net Stretch Mesh Size (inches)						Effort Data (yards fished)			Soak Time (hours)			Depth (ft)		
Region	Source (Program)	N	mode	common range	mean	min	max	mean	min	max	mean	min	max	mean	min	max
All	Dependent	36	3.00	2.88 - 3.25	3.30	2.50	6.25	1,307	200	4,000	21	1	48	8	3	14
Albemarle Sound	Dependent (pgm 461)	2	3.25	3.25	3.25	2.50	3.25	800	800	800	14	14	14	7	7	7
	Observer (pgm 466)	1	3.13	3.13	3.13	3.13	3.13	270	270	270	18	12	24	4	3	5
Core Sound South	Dependent (pgm 461)	2	3.00	3 - 4	3.31	3.00	4.00	650	500	800	18	12	24	4	4	5
	Observer (pgm 466)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Pamlico/Neuse River	Dependent (pgm 461)	1	3.00	3.00	3.00	3.00	3.00	200	200	200	12	12	12	7	7	7
	Observer (pgm 466)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Pamlico Sound	Dependent (pgm 461)	31	3.00	2.88 - 3.25	3.34	2.88	6.25	1,408	250	4,000	22	1	48	8	3	14
	Observer (pgm 466)	18	3.00	2.88 - 3.75	3.37	2.88	5.75	999	300	2,440	22	3	48	7	2	15

MENHADEN		Gill Net Stretch Mesh Size (inches)						Effort Data (yards fished)			Soak Time (hours)			Depth (ft)		
Region	Source (Program)	N	mode	common range	mean	min	max	mean	min	max	mean	min	max	mean	min	max
All	Dependent	37	3.00	3 - 3.25	3.60	2.88	4.00	985	200	2,000	22	9	48	7	3	15
Albemarle Sound	Dependent (pgm 461)	13	3.25	3.13 - 3.75	3.43	3.00	4.00	844	300	1,500	24	12	48	9	6	12
	Observer (pgm 466)	37	5.25	3 - 5.5	4.68	3.00	5.50	829	210	1,965	29	12	72	10	4	22
Core Sound South	Dependent (pgm 461)	2	3.13	3 - 3.13	3.06	3.00	3.12	850	200	1,500	18	12	24	5	3	6
	Observer (pgm 466)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Pamlico/Neuse River	Dependent (pgm 461)	6	3.00	3 - 4	3.50	3.00	4.00	567	200	1,000	12	12	12	6	6	6
	Observer (pgm 466)	28	5.50	3.25 - 5.5	4.65	3.25	8.00	758	248	1,700	20	2	48	6	2	16
Pamlico Sound	Dependent (pgm 461)	16	3.00	3 - 3.25	3.75	2.88	4.00	1,170	200	2,000	23	9	48	7	3	15
	Observer (pgm 466)	41	3.50	2.88 - 3.5	3.72	2.87	7.00	721	200	1,955	24	1	72	6	1	15

Table 4. Continued.

SP MACKEREL		Gill Net Stretch Mesh Size (inches)						Effort Data (yards fished)			Soak Time (hours)			Depth (ft)		
Region	Source (Program)	N	mode	common range	mean	min	max	mean	min	max	mean	min	max	mean	min	max
All	Dependent	48	3.50	3.38 - 3.75	3.55	3.00	4.00	1,291	500	2,700	7	2	12	13	6	17
Albemarle Sound	Dependent (pgm 461)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	Observer (pgm 466)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Core Sound South	Dependent (pgm 461)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	Observer (pgm 466)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Pamlico/Neuse River	Dependent (pgm 461)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	Observer (pgm 466)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Pamlico Sound	Dependent (pgm 461)	48	3.50	3.38 - 3.75	3.55	3.00	4.00	1,291	500	2,700	7	2	12	13	6	17
	Observer (pgm 466)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

WHITE PERCH		Gill Net Stretch Mesh Size (inches)						Effort Data (yards fished)			Soak Time (hours)			Depth (ft)		
Region	Source (Program)	N	mode	common range	mean	min	max	mean	min	max	mean	min	max	mean	min	max
Albemarle Sound	Observer (pgm 466)	17	3.25	3 - 3.25	3.77	2.33	5.50	709	100	1,400	28	2	96	10	2	2
Core Sound South	Observer (pgm 466)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Pamlico/Neuse River	Observer (pgm 466)	7	3.25	3.25 - 3.5	3.29	3.25	3.50	667	300	1,050	18	12	24	4	3	6
Pamlico Sound	Observer (pgm 466)	6	3.50	3 - 3.5	4.00	3.00	5.75	1,012	450	1,650	28	24	48	4	3	7

RIVER HERRING		Gill Net Stretch Mesh Size (inches)						Effort Data (yards fished)			Soak Time (hours)			Depth (ft)		
Region	Source (Program)	N	mode	common range	mean	min	max	mean	min	max	mean	min	max	mean	min	max
Albemarle Sound	Observer (pgm 466)	28	3.00	3 - 3.25	3.59	3.00	5.50	694	280	1,590	32	12	72	9	2	17
Core Sound South	Observer (pgm 466)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Pamlico/Neuse River	Observer (pgm 466)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Pamlico Sound	Observer (pgm 466)	5		3 - 3.5	4.04	3.00	5.50	1,390	750	1,700	24	24	24	4	1	8

SEA MULLET		Gill Net Stretch Mesh Size (inches)						Effort Data (yards fished)			Soak Time (hours)			Depth (ft)		
Region	Source (Program)	N	mode	common range	mean	min	max	mean	min	max	mean	min	max	mean	min	max
All	Dependent	5	2.88	2.88 - 3.5	2.82	3.50	3.50	1,280	200	2,000	13	3	24	11	7	14
Albemarle Sound	Dependent (pgm 461)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Core Sound South	Dependent (pgm 461)	1	3.50	3.50	3.50	3.50	3.50	200	200	200	3	3	3	7	7	7
Pamlico/Neuse River	Dependent (pgm 461)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Pamlico Sound	Dependent (pgm 461)	4		2.62 - 3.5	3.00	2.62	3.50	1,550	1,000	2,000	15	12	24	13	12	14

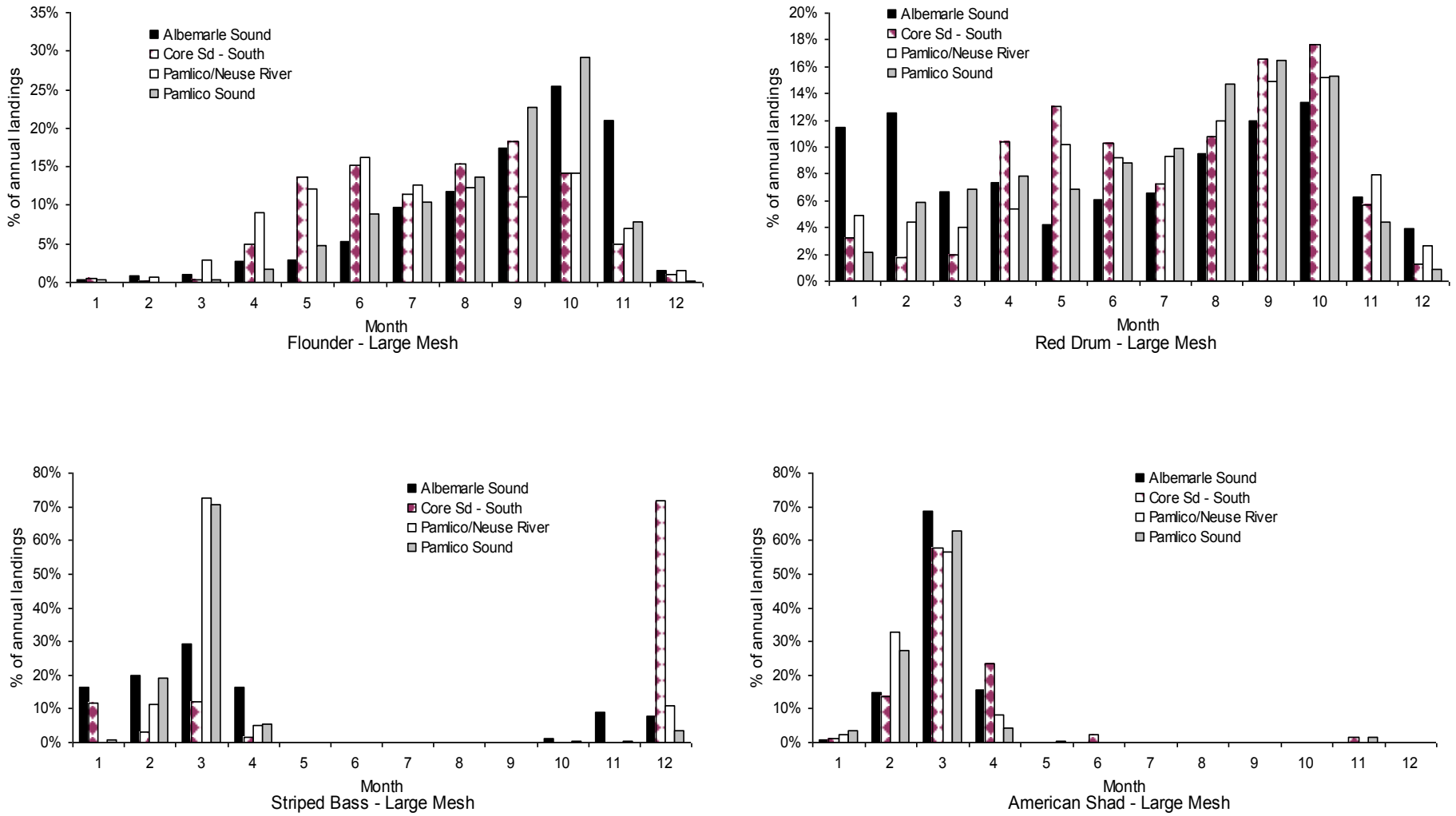
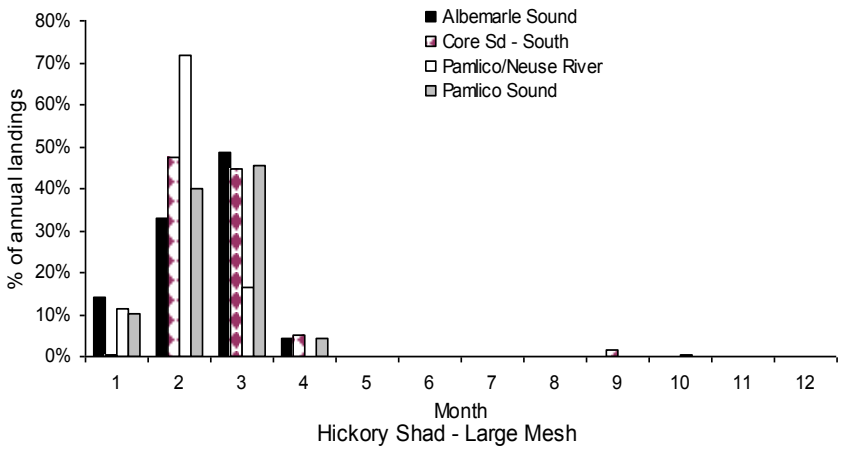


Figure 1. Monthly landings by region for common species targeted in the large mesh estuarine gill net fishery.



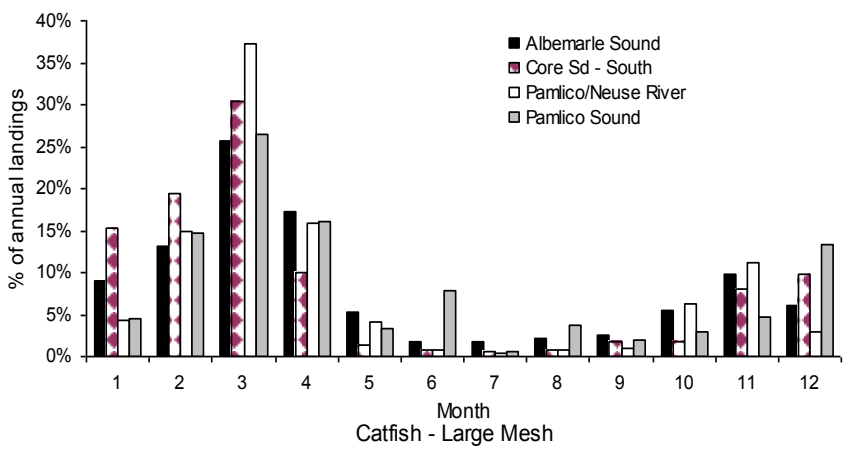
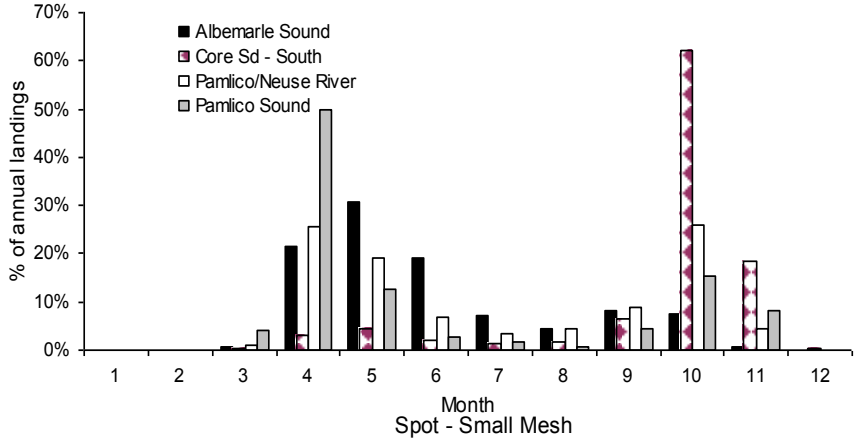


Figure 1. Continued.



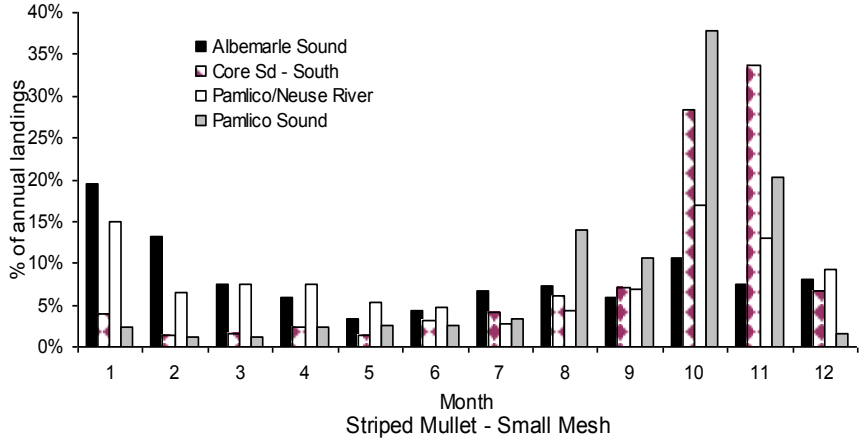
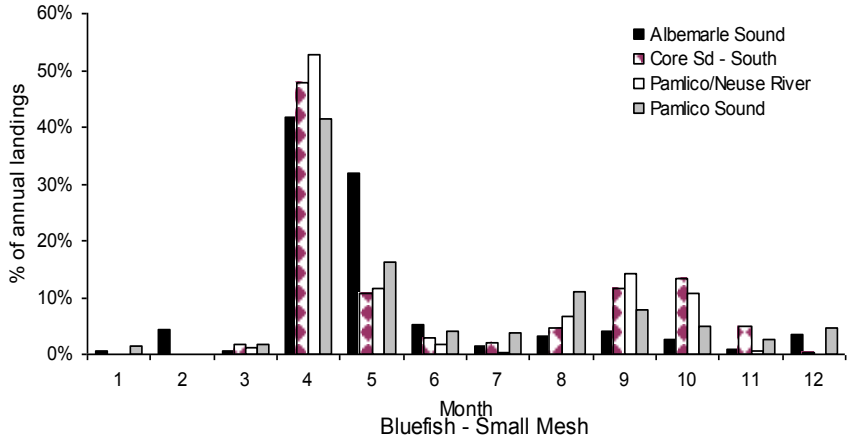
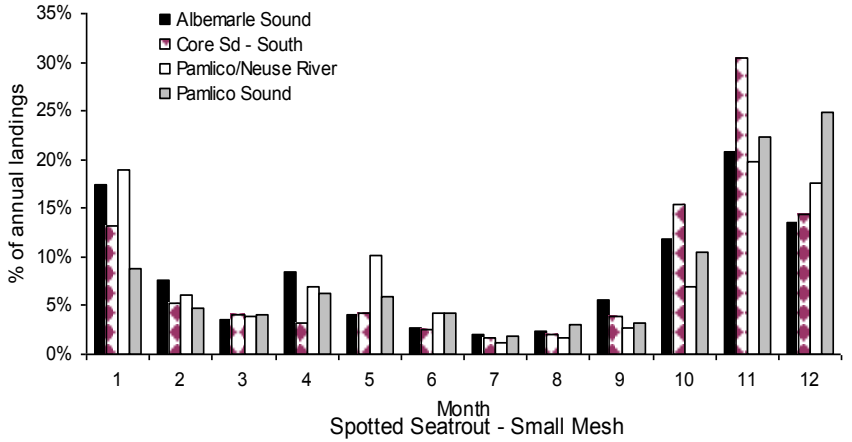
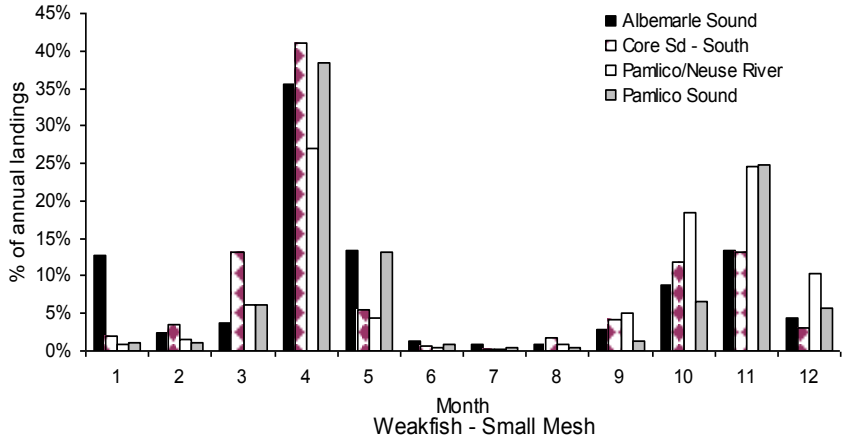


Figure 2. Monthly landings by region for common species targeted in the small mesh estuarine gill net fishery.







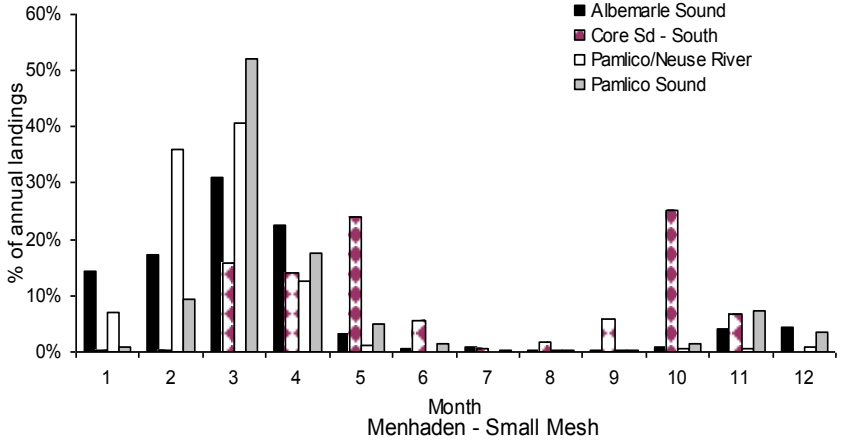
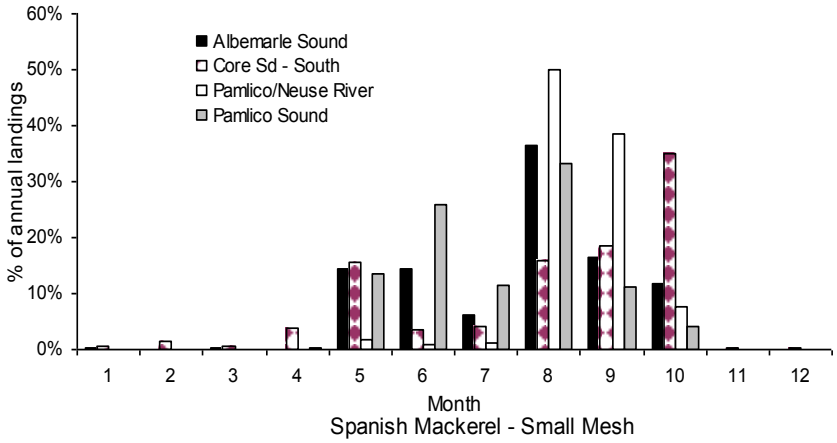
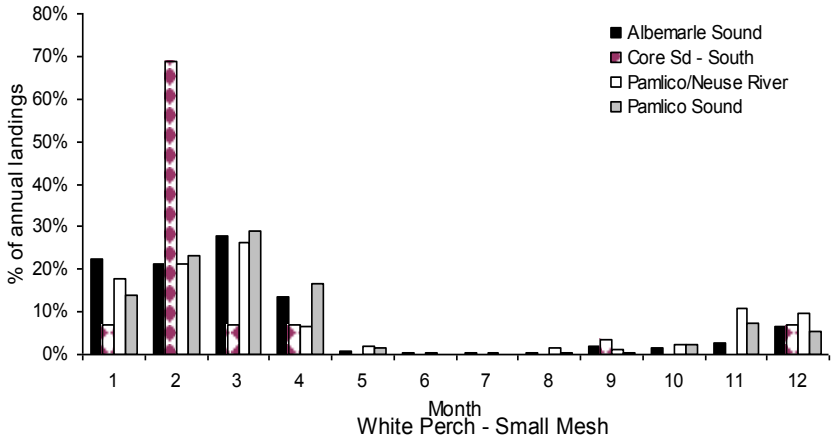
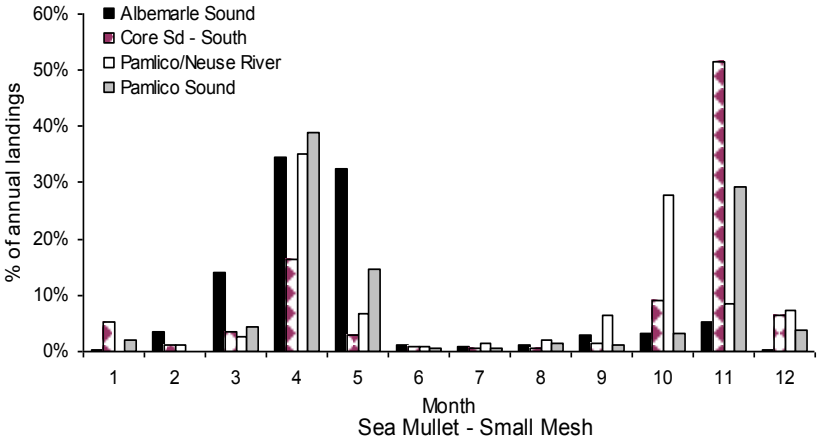


Figure 2. Continued







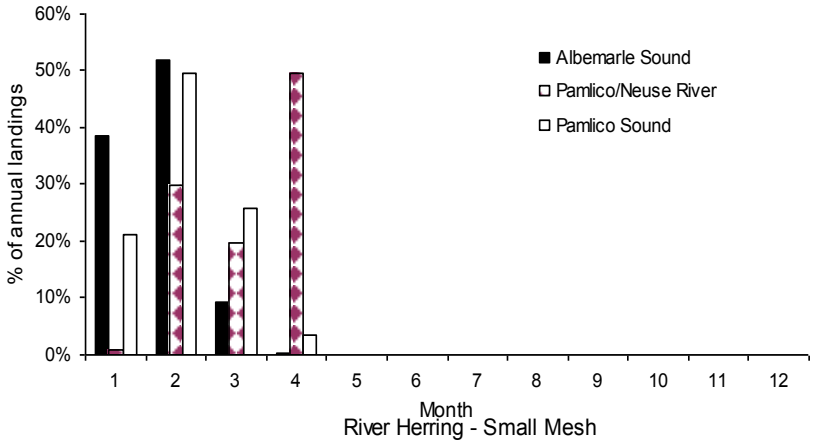


Figure 2. Continued.

2) Conduct at sea samples to estimate dead red drum discards from gill nets

North Carolina observer data were used to estimate discards of dead red drum from the estuarine gill net fishery. Available observer coverage was for the period of 2001 to 2006 (Table 5). Data from 2001 to 2003 were exclusively from the Pamlico Sound gill net fishery in the fall. Due to this limited coverage, annual coast wide estimates for these years were not attempted.

Table 5. Observed estuarine gill net trips by month and year from the North Carolina observer program.

Month	2001	2002	2003	2004	2005	2006
January	0	0	0	5	7	22
February	0	0	0	14	34	40
March	0	0	0	36	45	45
April	0	0	0	28	35	34
May	0	0	0	48	31	26
June	0	0	0	51	27	26
July	0	0	0	30	22	14
August	0	0	0	25	38	12
September	29	69	34	91	56	61
October	70	73	52	96	77	92
November	66	32	25	58	63	30
December	14	5	7	21	6	0
Total	179	179	118	503	441	402

Available data from 2004 to 2006 were separated by region as described in the previous section and included: Albemarle Sound, Pamlico Sound, Pamlico/Neuse River, and Core Sound to the South Carolina border. In addition, available data were further partitioned into seasons. Seasons were selected based on several criteria that included: months with similar mean water temperatures, peak landings for major fisheries, and periods where small mesh gill net attendance was required. The seasons selected were: January through April; May through August; September through October; and November through December.

Observed trips, in the same manner as was done for the trip ticket data, used the species of highest abundance in the catch to define the trip. A catch per unit effort (CPUE) was then generated for discarded dead red drum. The CPUE was defined as the number (or weight) of dead red drum discarded per trip. Estimates of discards were then calculated by multiplying the number of trips taken in a particular fishery by the corresponding CPUE from the observer data. Initial analysis attempted to generate CPUE's by fishery, season and region; however data were not sufficient at this level. Observed trips were then collapsed into large ($\geq$5 inch stretch mesh) or small (<5 inch stretch mesh) mesh gill net fishery groupings in an attempt to fill data gaps. CPUE was generated by year, region and season where at least 10 trips were observed. Collapsing across regions by season then filled remaining data gaps for each year. For the small mesh estimates, low sample sizes required additional collapsing across region and season by year.

Estimates of dead red drum discards from 2004 to 2006 in the large mesh estuarine gill net fishery ranged from 12,393 lbs in 2004 to 54,143 lbs in 2005 (Table 6). Dead discards from small mesh gill nets ranged from 3,042 lbs in 2004 to 5,570 lbs in 2006 (Table 7). Results of this analysis should be viewed with caution as bycatch associated with various fisheries can vary drastically. The number of observed trips for each of the key fisheries was inadequate to allow for estimates by a single fishery. After collapsing across key fisheries, samples in the large mesh fishery were much better represented by region and season than were the samples for the small mesh fishery. Small mesh observer trips were not adequate for analysis by region and season. Most of the data was collapsed across both regions and seasons to provide a single CPUE by year. For this reason, small mesh estimates in particular should be viewed with caution.

Combined estimates from the small and large mesh fishery were as follows: 15,435 lb in 2004; 58,950 lb in 2005; and 32,676 lb in 2006. These values represent 29%, 46% and 19% of the annual commercial harvest in 2004, 2005 and 2006.

3) Estimate the dead red drum discards resulting from the release mortality associated with gill nets

Estimated red drum discards from the commercial estuarine gill net fishery are based on red drum observed to be dead at the time the gear is fished and do not account for any mortality associated with red drum released alive at the net. In the red drum stock assessment a 10 percent mortality is assumed for all red drum released in the recreational fishery (Vaughan and Carmichael, 2000). This estimate is based on hook and line studies where red drum have been captured using techniques common to the recreational fishery and then held for a short period to determine the short-term mortality associated with catch and release. From 1999 to 2000, the NCDMF conducted studies to determine the short-term mortality associated with the release of red drum from estuarine gill nets. During this study, delayed mortality estimates were conducted separately for small ($\leq$ 4 ½ inch) and large ($\geq$ 5 inch) stretch mesh gill nets (Price and Gearhart 2002a; Price and Gearhart 2002b). Red drum were held (72 hours) in pens to determine the short-term mortality. Results varied by mesh size. For small mesh nets the overall delayed mortality averaged 3% while large mesh mortality was significantly higher averaging 33%. Discrepancies in these values were attributed to the low sample size of red drum captured in the large mesh nets (n = 18) relative to the small mesh nets (n = 1,236). Additional work should be conducted in this area to provide more reliable estimates.

The magnitude of mortality associated with release from estuarine gill nets was estimated using an intermediate release mortality of 10%. Estimates were calculated in the same manner as previously used to estimate dead red drum discards occurring at the net. The one exception being that the CPUE was defined as the number of red drum released per trip. This number was then multiplied by 10% to determine the total release mortality. CPUE was generated by year, region and season where at least 10 trips were observed. Collapsing across regions for each season then filled remaining data gaps for each year. For the small mesh estimates low sample sizes required additional collapsing across region and season by year.

Estimated release mortalities from 2004 to 2006 in the large mesh estuarine gill net fishery ranged from 2,613 lb in 2004 to 6,229 lb in 2005 (Table 8). For the small mesh gill net fishery, estimates were lower ranging from 1,005 lb in 2004 to 2,222 lb in 2005 (Table 9).

Table 6. Estimated dead discards (number and weight) of red drum from the large mesh estuarine gill net fishery.

2004	Season	# trips	# trips observed	% coverage	CPUE (#)	CPUE (lbs)	exp_num	exp_wt
Albemarle Sound	Jan-Apr	5,755	30	0.5%	0.00	0.00	-	-
	May-Aug	2,371	41	1.7%	0.00	0.00	-	-
	Sep-Oct	1,838	5	0.3%	0.78	1.30	1,434	2,389
	Nov-Dec	1,037	4	0.4%	0.25	0.28	259	290
Core Sound South	Jan-Apr	504	0	0.0%	0.02	0.04	10	20
	May-Aug	2,273	1	0.0%	0.26	0.38	591	864
	Sep-Oct	1,098	27	2.5%	1.96	3.26	2,152	3,579
	Nov-Dec	230	2	0.9%	0.25	0.28	58	64
Pamlico/Neuse River	Jan-Apr	1,422	21	1.5%	0.05	0.10	68	142
	May-Aug	1,477	67	4.5%	0.27	0.24	399	354
	Sep-Oct	930	22	2.4%	0.00	0.00	-	-
	Nov-Dec	330	17	5.2%	0.00	0.00	-	-
Pamlico Sound	Jan-Apr	503	0	0.0%	0.02	0.04	10	20
	May-Aug	2,220	36	1.6%	0.39	1.15	866	2,553
	Sep-Oct	1,646	110	6.7%	0.69	1.18	1,136	1,942
	Nov-Dec	354	27	7.6%	0.44	0.49	156	173
Combined		23,988	410	1.7%			**7,138**	**12,393**

2005	Season	# trips	# trips observed	% coverage	CPUE (#)	CPUE (lbs)	exp_num	exp_wt
Albemarle Sound	Jan-Apr	4,640	11	0.2%	0.00	0.00	-	-
	May-Aug	1,654	7	0.4%	0.48	1.06	794	1,753
	Sep-Oct	2,216	0	0.0%	1.82	6.53	4,033	14,470
	Nov-Dec	1,458	0	0.0%	0.54	1.46	787	2,129
Core Sound South	Jan-Apr	458	0	0.0%	0.44	0.72	202	330
	May-Aug	2,008	14	0.7%	1.50	2.50	3,012	5,020
	Sep-Oct	1,225	2	0.2%	1.82	6.53	2,230	7,999
	Nov-Dec	226	2	0.9%	0.54	1.46	122	330
Pamlico/Neuse River	Jan-Apr	1,410	41	2.9%	0.22	0.61	310	860
	May-Aug	1,671	57	3.4%	0.25	0.63	418	1,053
	Sep-Oct	810	2	0.2%	1.82	6.53	1,474	5,289
	Nov-Dec	172	3	1.7%	0.54	1.46	93	251
Pamlico Sound	Jan-Apr	483	3	0.6%	0.44	0.72	213	348
	May-Aug	1,771	18	1.0%	0.61	1.73	1,080	3,064
	Sep-Oct	1,721	125	7.3%	1.74	6.29	2,995	10,825
	Nov-Dec	327	46	14.1%	0.50	1.29	164	422
Combined		22,250	331	1.5%			**17,925**	**54,143**

2006	Season	# trips	# trips observed	% coverage	CPUE (#)	CPUE (lbs)	exp_num	exp_wt
Albemarle Sound	Jan-Apr	4,631	26	0.6%	0.23	0.22	1,065	1,019
	May-Aug	2,582	0	0.0%	0.30	0.76	775	1,962
	Sep-Oct	2,625	0	0.0%	0.72	2.42	1,890	6,353
	Nov-Dec	1,100	0	0.0%	0.19	0.56	209	616
Core Sound South	Jan-Apr	396	0	0.0%	0.12	0.12	48	48
	May-Aug	2,466	27	1.1%	0.33	0.99	814	2,441
	Sep-Oct	1,390	1	0.1%	0.72	2.42	1,001	3,364
	Nov-Dec	156	0	0.0%	0.19	0.56	30	87
Pamlico/Neuse River	Jan-Apr	1,214	24	2.0%	0.00	0.00	-	-
	May-Aug	1,574	23	1.5%	0.00	0.00	-	-
	Sep-Oct	904	0	0.0%	0.72	2.42	651	2,188
	Nov-Dec	160	0	0.0%	0.19	0.56	30	90
Pamlico Sound	Jan-Apr	588	2	0.3%	0.12	0.12	71	71
	May-Aug	2,065	13	0.6%	0.92	1.98	1,900	4,089
	Sep-Oct	1,915	144	7.5%	0.73	2.43	1,396	4,653
	Nov-Dec	217	25	11.5%	0.20	0.58	43	126
Combined		23,983	285	1.2%			**9,922**	**27,106**

Collapsed across region by season where n<10

Table 7. Estimated dead discards (number and weight) of red drum from the small mesh estuarine gill net fishery.

2004	Season	# trips	# trips observed	% coverage	CPUE (#)	CPUE (lbs)	exp_num	exp_wt
Albemarle Sound	Jan-Apr	2,175	19	0.9%	0.00	0.00	-	-
	May-Aug	647	5	0.8%	**0.09**	**0.23**	**58**	**149**
	Sep-Oct	288	3	1.0%	0.26	0.86	75	248
	Nov-Dec	187	2	1.1%	0.13	0.18	23	34
Core Sound South	Jan-Apr	418	0	0.0%	**0.09**	**0.23**	**38**	**96**
	May-Aug	454	0	0.0%	**0.09**	**0.23**	**41**	**104**
	Sep-Oct	962	0	0.0%	0.26	0.86	250	827
	Nov-Dec	427	0	0.0%	0.13	0.18	53	77
Pamlico/Neuse River	Jan-Apr	475	5	1.1%	**0.09**	**0.23**	**43**	**109**
	May-Aug	185	1	0.5%	**0.09**	**0.23**	**17**	**43**
	Sep-Oct	72	1	1.4%	0.26	0.86	19	62
	Nov-Dec	164	2	1.2%	0.13	0.18	21	30
Pamlico Sound	Jan-Apr	1,199	5	0.4%	**0.09**	**0.23**	**108**	**276**
	May-Aug	797	2	0.3%	**0.09**	**0.23**	**72**	**183**
	Sep-Oct	584	12	2.1%	0.35	1.15	204	672
	Nov-Dec	604	20	3.3%	0.15	0.22	91	133
Combined	All	9,638	77	0.8%			**1,112**	**3,042**

2005	Season	# trips	# trips observed	% coverage	CPUE (#)	CPUE (lbs)	exp_num	exp_wt
Albemarle Sound	Jan-Apr	2,068	31	1.5%	0.10	0.11	207	227
	May-Aug	1,013	9	0.9%	0.32	0.55	324	557
	Sep-Oct	240	0	0.0%	**0.22**	**0.32**	**53**	**77**
	Nov-Dec	193	1	0.5%	0.40	0.53	77	102
Core Sound South	Jan-Apr	224	0	0.0%	0.14	0.20	31	44
	May-Aug	306	0	0.0%	0.32	0.55	98	168
	Sep-Oct	607	0	0.0%	**0.22**	**0.32**	**134**	**194**
	Nov-Dec	423	1	0.2%	0.40	0.53	169	224
Pamlico/Neuse River	Jan-Apr	609	18	3.0%	0.06	0.05	37	30
	May-Aug	172	3	1.7%	0.32	0.55	55	95
	Sep-Oct	108	0	0.0%	**0.22**	**0.32**	**24**	**35**
	Nov-Dec	171	0	0.0%	0.40	0.53	68	91
Pamlico Sound	Jan-Apr	1,421	16	1.1%	0.31	0.52	441	739
	May-Aug	1,444	10	0.7%	0.70	1.22	1,011	1,762
	Sep-Oct	327	4	1.2%	**0.22**	**0.32**	**72**	**105**
	Nov-Dec	605	18	3.0%	0.44	0.59	266	357
Combined	All	9,931	111	1.1%			**3,066**	**4,807**

2006	Season	# trips	# trips observed	% coverage	CPUE (#)	CPUE (lbs)	exp_num	exp_wt
Albemarle Sound	Jan-Apr	1,325	44	3.3%	0.18	0.21	239	278
	May-Aug	638	2	0.3%	**0.20**	**0.33**	**126**	**211**
	Sep-Oct	292	0	0.0%	0.57	1.69	166	493
	Nov-Dec	256	0	0.0%	0.25	0.28	64	72
Core Sound South	Jan-Apr	169	2	1.2%	0.18	0.24	30	41
	May-Aug	196	2	1.0%	**0.20**	**0.33**	**39**	**65**
	Sep-Oct	950	0	0.0%	0.57	1.69	542	1,606
	Nov-Dec	508	0	0.0%	0.25	0.28	127	142
Pamlico/Neuse River	Jan-Apr	691	15	2.2%	0.00	0.00	-	-
	May-Aug	221	1	0.5%	**0.20**	**0.33**	**44**	**73**
	Sep-Oct	222	1	0.5%	0.57	1.69	127	375
	Nov-Dec	288	0	0.0%	0.25	0.28	72	81
Pamlico Sound	Jan-Apr	1,200	16	1.3%	0.38	0.59	456	708
	May-Aug	1,053	1	0.1%	**0.20**	**0.33**	**211**	**347**
	Sep-Oct	543	6	1.1%	0.57	1.69	310	918
	Nov-Dec	575	4	0.7%	0.25	0.28	144	161
Combined	All	9,127	94	1.0%			**2,694**	**5,570**

Collapsed across region by season where n<10
Collapsed across region and season by year

Table 8. Estimated release mortalities (number and weight) of red drum from the large mesh estuarine gill net fishery.

2004	Season	# trips	# trips observed	% coverage	CPUE (#)	CPUE (lbs)	(10%) exp_num	(10%) exp_wt
Albemarle Sound	Jan-Apr	5,755	30	0.5%	0.00	0.00	-	-
	May-Aug	2,371	41	1.7%	0.00	0.00	-	-
	Sep-Oct	1,838	5	0.3%	1.64	2.93	301	539
	Nov-Dec	1,037	4	0.4%	1.59	3.04	165	315
Core Sound South	Jan-Apr	504	0	0.0%	0.99	1.66	50	84
	May-Aug	2,273	1	0.0%	0.37	0.28	84	64
	Sep-Oct	1,098	27	2.5%	2.85	4.49	313	493
	Nov-Dec	230	2	0.9%	1.59	3.04	37	70
Pamlico/Neuse River	Jan-Apr	1,422	21	1.5%	0.00	0.00	-	-
	May-Aug	1,477	67	4.5%	0.46	0.32	68	47
	Sep-Oct	930	22	2.4%	0.64	0.96	60	89
	Nov-Dec	330	17	5.2%	0.47	0.70	16	23
Pamlico Sound	Jan-Apr	503	0	0.0%	0.99	1.66	50	83
	May-Aug	2,220	36	1.6%	0.56	0.48	124	107
	Sep-Oct	1,646	110	6.7%	1.68	3.20	277	526
	Nov-Dec	354	27	7.6%	2.44	4.89	86	173
Combined		23,988	410	1.7%			1,630	2,613

2005	Season	# trips	# trips observed	% coverage	CPUE (#)	CPUE (lbs)	(10%) exp_num	(10%) exp_wt
Albemarle Sound	Jan-Apr	4,640	11	0.2%	0.14	0.40	65	185
	May-Aug	1,654	7	0.4%	0.73	1.22	121	202
	Sep-Oct	2,216	0	0.0%	2.15	5.55	476	1,230
	Nov-Dec	1,458	0	0.0%	1.65	4.01	241	585
Core Sound South	Jan-Apr	458	0	0.0%	1.69	2.20	77	101
	May-Aug	2,008	14	0.7%	3.14	5.49	631	1,102
	Sep-Oct	1,225	2	0.2%	2.15	5.55	263	680
	Nov-Dec	226	2	0.9%	1.65	4.02	37	91
Pamlico/Neuse River	Jan-Apr	1,410	41	2.9%	0.80	1.39	113	196
	May-Aug	1,671	57	3.4%	0.32	0.44	53	74
	Sep-Oct	810	2	0.2%	2.15	5.55	174	450
	Nov-Dec	172	3	1.7%	1.65	4.02	28	69
Pamlico Sound	Jan-Apr	483	3	0.6%	1.69	2.20	82	106
	May-Aug	1,771	18	1.0%	0.39	0.72	69	128
	Sep-Oct	1,721	125	7.3%	2.18	5.68	375	978
	Nov-Dec	327	46	14.1%	1.15	1.66	38	54
Combined		22,250	331	1.5%			2,844	6,229

2006	Season	# trips	# trips observed	% coverage	CPUE (#)	CPUE (lbs)	(10%) exp_num	(10%) exp_wt
Albemarle Sound	Jan-Apr	4,631	26	0.6%	0.23	0.27	107	125
	May-Aug	2,582	0	0.0%	0.38	0.52	98	134
	Sep-Oct	2,625	0	0.0%	1.43	2.76	375	725
	Nov-Dec	1,100	0	0.0%	1.23	1.83	135	201
Core Sound South	Jan-Apr	396	0	0.0%	0.20	0.32	8	13
	May-Aug	2,466	27	1.1%	0.19	0.28	47	69
	Sep-Oct	1,390	1	0.1%	1.43	2.76	199	384
	Nov-Dec	156	0	0.0%	1.23	1.83	19	29
Pamlico/Neuse River	Jan-Apr	1,214	24	2.0%	0.17	0.40	21	49
	May-Aug	1,574	23	1.5%	0.26	0.23	41	36
	Sep-Oct	904	0	0.0%	1.43	2.76	129	250
	Nov-Dec	160	0	0.0%	1.23	1.83	20	29
Pamlico Sound	Jan-Apr	588	2	0.3%	0.20	0.32	12	19
	May-Aug	2,065	13	0.6%	1.15	1.78	237	368
	Sep-Oct	1,915	144	7.5%	1.42	2.77	272	530
	Nov-Dec	217	25	11.5%	1.28	1.90	28	41
Combined		23,983	285	1.2%			1,747	3,001

Collapsed across region by season where n<10

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Table 9. Estimated release mortalities (number and weight) of red drum from the small mesh estuarine gill net fishery.

2004	Season	# trips	# trips observed	% coverage	CPUE (#)	CPUE (lbs)	(10%) exp_num	(10%) exp_wt
Albemarle Sound	Jan-Apr	2,175	19	0.9%	0.00	0.00	-	-
	May-Aug	647	5	0.8%	0.25	0.19	16	12
	Sep-Oct	288	3	1.0%	1.72	2.12	50	61
	Nov-Dec	187	2	1.1%	2.08	3.05	39	57
Core Sound South	Jan-Apr	418	0	0.0%	0.03	0.31	1	13
	May-Aug	454	0	0.0%	0.25	0.19	11	9
	Sep-Oct	962	0	0.0%	1.72	2.12	165	204
	Nov-Dec	427	0	0.0%	2.08	3.05	89	130
Pamlico/Neuse River	Jan-Apr	475	5	1.1%	0.03	0.31	1	15
	May-Aug	185	1	0.5%	0.25	0.19	5	4
	Sep-Oct	72	1	1.4%	1.72	2.12	12	15
	Nov-Dec	164	2	1.2%	2.08	3.05	34	50
Pamlico Sound	Jan-Apr	1,199	5	0.4%	0.03	0.31	4	37
	May-Aug	797	2	0.3%	0.25	0.19	20	15
	Sep-Oct	584	12	2.1%	2.29	2.83	134	165
	Nov-Dec	604	20	3.3%	2.45	3.61	148	218
Combined		9,638	77	0.8%			729	1,005

2005	Season	# trips	# trips observed	% coverage	CPUE (#)	CPUE (lbs)	(10%) exp_num	(10%) exp_wt
Albemarle Sound	Jan-Apr	2,068	31	1.5%	0.16	0.11	33	23
	May-Aug	1,013	9	0.9%	0.41	0.72	42	73
	Sep-Oct	240	0	0.0%	0.25	0.25	6	6
	Nov-Dec	193	1	0.5%	1.10	1.71	21	33
Core Sound South	Jan-Apr	224	0	0.0%	0.82	1.01	18	23
	May-Aug	306	0	0.0%	0.41	0.72	13	22
	Sep-Oct	607	0	0.0%	0.25	0.25	15	15
	Nov-Dec	423	1	0.2%	1.10	1.71	47	72
Pamlico/Neuse River	Jan-Apr	609	18	3.0%	0.22	0.28	13	17
	May-Aug	172	3	1.7%	0.41	0.72	7	12
	Sep-Oct	108	0	0.0%	0.25	0.25	3	3
	Nov-Dec	171	0	0.0%	1.10	1.71	19	29
Pamlico Sound	Jan-Apr	1,421	16	1.1%	2.75	3.58	391	509
	May-Aug	1,444	10	0.7%	0.90	1.59	130	230
	Sep-Oct	327	4	1.2%	0.25	0.25	8	8
	Nov-Dec	605	18	3.0%	1.22	1.90	738	1,147
Combined		9,931	111	1.1%			1,503	2,222

2006	Season	# trips	# trips observed	% coverage	CPUE (#)	CPUE (lbs)	(10%) exp_num	(10%) exp_wt
Albemarle Sound	Jan-Apr	1,325	44	3.3%	0.59	0.80	78	106
	May-Aug	638	2	0.3%	0.73	1.05	47	67
	Sep-Oct	292	0	0.0%	0.71	0.69	21	20
	Nov-Dec	256	0	0.0%	1.25	2.59	32	66
Core Sound South	Jan-Apr	169	2	1.2%	0.76	1.09	13	18
	May-Aug	196	2	1.0%	0.73	1.05	14	21
	Sep-Oct	950	0	0.0%	0.71	0.69	67	66
	Nov-Dec	508	0	0.0%	1.25	2.59	64	132
Pamlico/Neuse River	Jan-Apr	691	15	2.2%	0.40	0.49	28	34
	May-Aug	221	1	0.5%	0.73	1.05	16	23
	Sep-Oct	222	1	0.5%	0.71	0.69	16	15
	Nov-Dec	288	0	0.0%	1.25	2.59	36	75
Pamlico Sound	Jan-Apr	1,200	16	1.3%	1.75	2.74	210	329
	May-Aug	1,053	1	0.1%	0.73	1.05	77	111
	Sep-Oct	543	6	1.1%	0.71	0.69	39	37
	Nov-Dec	575	4	0.7%	1.25	2.59	72	149
Combined		9,127	94	1.0%			828	1,268

Collapsed across region by season where n<10

4) Collect data on the harvest and releases of red drum captured in gill nets under the Recreational Commercial Gear License.

Commercial fishing gears such as gill nets, crab pots and shrimp trawls have been used for recreational purposes in the coastal waters of North Carolina for many years. To participate in these activities the user must possess a Recreational Commercial Gear License (RCGL) that entitles the individual to use limited amounts of commercial gear to catch fish for personal consumption but does not allow for the sale of the catch.

The North Carolina Division of Marine Fisheries License and Statistics Section initiated a survey project in March 2002 to collect catch and effort data from RCGL holders. Questionnaires are mailed to 30% of all RCGL holders each month requesting that they indicate waterbodies commonly fished, types and amounts of gear used, number and weight of individual species kept, and number of individual species discarded at sea.

Survey Design

The monthly and bimonthly survey questionnaires were designed to determine the number of trips taken and quantities of gear used. Participants are also requested to provide estimates for the numbers and pounds of each species caught and retained as well as the number of each species discarded.

The sampling universe of RCGL holders for the monthly surveys includes all individuals who purchased a license within a year prior of each month sampled. SAS® PROC SURVEYSELECT is used to randomly select a sample of the population at a 30.0% coverage rate by county of residence, resulting in a mailing of 1,200 to 2,000 questionnaires, depending on the number of active licenses during each sample period.

Effort and Catch Extrapolation Methods

To estimate the total number of trips taken by all RCGL holders, the monthly survey data are extrapolated for each sample period and gear combination by:

1) Calculating the level of participation by dividing the total number of participants actively using a specific gear by the total number of returned questionnaires,
2) Calculating the mean number of trips taken by the participants indicating actively using a specific gear and
3) Estimating the effort using the mean number of trips, level of participation, and the total number of RCGL holders for the given sample period.

Determination of the estimated catch for each species is also calculated for each sample period and gear level by:

1) Summing the total catch by species, sample period and gear combination,
2) Summing the total number of trips taken by sample period and gear combination,
3) Dividing total catch by the total number of trips to determine the mean catch for each species for every sample period and gear combination and
4) Calculating the catch estimate using the product of the mean catch and the estimated effort.

Red drum discards from RCGL gill nets were estimated for both small and large mesh gill nets separately from 2002 to 2006. Information on the disposition of the red drum released from RCGL gill nets was not available. Small mesh gill nets used under the RCGL require full time attendance. Large mesh gill nets used under the RCGL can be left unattended from one hour before sunset to one hour after sunrise north of the Emerald Isle Bridge (HWY 58) in Carteret County but must be attended at all times south of this bridge to the South Carolina line. A maximum of 100 yards of gill net per license holder up to 200 yards of gill net per vessel can be fished. Although the mortality associated with the use of this gear is unknown, the limited yardage and attendance requirements should reduce the potential for excessive discard mortality.

Table 10. Estimated number and pounds of red drum harvested and the number of red drum discarded using the Recreational Commercial Gear License in North Carolina.

Year	Gear	Expanded Trips	Actual Number Observations	Kept (number)	Kept (pound)	Discard* (number)
2002	Large Mesh Gill Nets	4,599	98	2,598	8,413	2,791
	Small Mesh Gill Nets	789	26	441	1,480	1,252
	All	5,388	124	3,039	9,893	4,043
2003	Large Mesh Gill Nets	1,645	47	738	2,746	818
	Small Mesh Gill Nets	976	28	386	1,499	777
	All	2,621	75	1,124	4,245	1,595
2004	Large Mesh Gill Nets	2,389	47	538	1,927	1,897
	Small Mesh Gill Nets	1,304	40	791	2,605	1,735
	All	3,693	87	1,329	4,532	3,632
2005	Large Mesh Gill Nets	2,647	85	1,166	4,879	1,601
	Small Mesh Gill Nets	1,572	54	672	2,748	1,777
	All	4,219	139	1,838	7,627	3,378
2006	Large Mesh Gill Nets	1,783	70	843	3,619	979
	Small Mesh Gill Nets	1,719	72	1,000	3,941	6,655
	All	3,502	142	1,843	7,560	7,634

*discard estimates include both live and dead red drum

In order to estimate the potential dead discards from the RCGL large mesh gill net fishery, the ratio of dead to live releases was calculated from the commercial observer data from 2004 to 2006. Only trips with a soak time of less than 12 hours were used to correspond with the attendance requirement during the day. Of all red drum discarded, 33% were discarded dead. The mean weight of individual red drum discarded dead was also calculated from the commercial observer data to allow for annual discard estimates by weight to be calculated. The mean weight of an individual discarded dead red drum by year was 1.74 lb in 2004; 3.02 lb in 2005; and 2.73 lb in 2006. Based on this analysis, dead discards from the large mesh RCGL gill nets accounted for between 882 lb and 1,596 lb of red drum discards per year (Table 11).

Table 11. Estimated dead discards from large mesh RCGL gill nets.

Year	Dead Discards (number)	Dead Discards (weight)
2004	626	1,089
2005	528	1,596
2006	323	882

Estimates of dead red drum discards from attended small mesh RCGL gill nets were not calculated due to the lack of information on the fate of discarded red drum in this fishery. Commercial observer data had zero mortalities from small mesh trips where the soak time was less than two hours. Low gillnet mortality in attended nets is consistent with the findings of Thorpe et al. (2001). This study characterized the mortality associated with various types of estuarine gill net fisheries in southeastern North Carolina. They reported a 0% acute mortality for red drum discarded in the run-around spotted seatrout fishery, as well as in the small mesh RCGL gill net fishery and a 2.2% acute mortality for red drum taken in the run-around gill net striped mullet fishery. Short soak times, actively fishing gear, and limited yardage appear to be an effective way of minimizing discard mortality.

Summary of Discard Estimates

Available data on red drum discard mortality are summarized below in both pounds and numbers. The summary includes estimates from both commercial and RCGL gill nets. Estimated pounds of dead discards from the estuarine gill net fishery represented between 22% and 54% of the total annual commercial harvest (all gears combined) between 2004 and 2006 (Table 12). Expressed as the number of fish removed from the population, dead discards in the estuarine gill net fishery were approximately equal to the number of red drum harvested commercially during 2004 and 2005 (Table 13). This comparison was made by using the total commercial harvest in numbers derived from the catch at age in the latest NC stock assessment (Takade and Paramore, 2007). Values were not available for 2006 from this assessment. Discard (release) mortality represents a large portion of the overall annual removals from the red drum population in both the recreational and commercial fishery. Currently, the assessment only accounts for the recreational removals and no estimates have been available from the commercial fishery. In 2004 and 2005, dead discards from the gill net fishery represented between 46% and 51% of the total commercial removals (harvest + dead discards) by number. For this same period, recreational release mortality accounted for 39% of the total recreational removals (harvest + release mortality) by number (Table 14). Based on this analysis, the stock assessment failed to account for between 14% and 18% of all annual removals from the population in 2004 and 2005.

Table 12. Summary of all estimated mortalities in pounds associated with the estuarine gill net fishery.

	Estuarine Gill Net Dead Discards (lb)			Estuarine Gill Net Mortality from Releases (lb)			RCGL Mortalities (lb)*	Total Discard Mortality (lb)	Combined Commercial Harvest (lb)	% of Commercial Landings
Year	Small Mesh	Large Mesh	Combined	Small Mesh	Large Mesh	Combined	Large Mesh	All		
2004	3,042	12,393	15,435	1,005	2,613	3,618	1,089	20,142	54,086	37%
2005	4,807	54,143	58,950	2,222	6,229	8,451	1,596	68,997	128,770	54%
2006	5,570	27,106	32,676	1,268	3,001	4,269	882	37,827	169,206	22%

*no estimates for RCGL releases or for RCGL small mesh gill nets

Table 13. Summary of all estimated mortalities in numbers associated with the estuarine gill net fishery.

	Estuarine Gill Net Dead Discards (number)			Estuarine Gill Net Mortality from Releases (number)			RCGL Mortalities (number)*	Total Discard Mortality (number)	Combined Commercial Harvest** (number)	% of Commercial Landings
Year	Small Mesh	Large Mesh	Combined	Small Mesh	Large Mesh	Combined	Large Mesh	All		
2004	1,112	7,138	8,250	729	1,630	2,359	626	11,235	10,900	103%
2005	3,066	17,925	20,991	1,503	2,844	4,347	528	25,866	30,000	86%

*no estimates for RCGL releases or for RCGL small mesh gill nets

**all gears combined (number generated from stock assessment catch at age analysis)

Table 14. Estimated total takes from the red drum population by year. Partitioned into those harvested and discarded by sector (recreational and commercial).

Year	Fishery	Harvested	Discard Mortalities	Combined	% of Mortalities Resulting from Discards
2004	Commercial	10,900	11,325	22,225	51%
	Recreational	35,100	22,500	57,600	39%
	Total	46,000	33,825	79,825	42%
2005	Commercial	30,000	25,866	55,866	46%
	Recreational	55,800	35,900	91,700	39%
	Total	85,800	61,766	147,566	42%

Note: all values reported are in numbers of fish.

Information on size of discards not yet determined…..

Research Recommendations

- Continue and expand estuarine gill net observer program to collect data across various key fisheries by season and area.
- Collect data from observer program or through other sources on the catch rates of red drum and targeted species with regard to distance from shore.
- Conduct a comprehensive survey of gill net fishers including information on species targeted, gear characteristics, areas fished.
- Conduct studies that explore ways to reduce red drum interactions while allowing for retention of targeted species.
- Conduct additional research to determine the release mortality of red drum captured in gill nets.
- Continue and enhance collection of fishery dependent data.

Literature Cited

ASMFC. 2002. Amendment 2 to the Interstate fishery management plan for red drum. Fisheries Management Report No. 38. Atlantic States Marine Fisheries Commission, Washington, DC. 142 p.

Price, A. B. and J.L. Gearhart. 2002a. Small Mesh (< 4.5-inch) Gillnet Discard Mortality of spotted seatrout (*Cynoscion nebulosus*), weakfish (*Cynoscion regalis*), southern flounder (*Paralichthys lethostigma*), and red drum (*Sciaenops ocellata*) in Roanoke Sound, Core Sound, and the Neuse River, North Carolina. North Carolina Division of Marine Fisheries, Morehead City, North Carolina.

Price, A. B. and J.L. Gearhart. 2002b. Large Mesh (≥ 5-inch) Gillnet Discard Mortality of Spotted Seatrout (*Cynoscion nebulosus*), Weakfish (*Cynoscion regalis*), Southern Flounder (*Paralichthys lethostigma*), and Red Drum (*Sciaenops ocellata*) in Roanoke Sound, Core Sound, and the Neuse River, North Carolina. North Carolina Division of Marine Fisheries, Morehead City, North Carolina.

Takade, H. and L.M. Paramore. 2007. Draft stock status of the northern red drum stock. North Carolina Division of Marine Fisheries, Morehead City, NC. 47 p. + appendices.

Thorpe, T., D. Beresoff, and K. Cannady. 2001. Gillnet bycatch potential, discard mortality, and condition of red drum (*Sciaenops ocellatus*) in southeastern North Carolina. Final Report to the Marine Fisheries Commission, Fishery Resource Grant Program. 00-FEG-14. 72 p.