SCDNR adult red drum 1/3rd mile longline survey
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Summary

This document details red drum catches from the South Carolina Department of Natural Resources (SCDNR) Adult Red Drum longline survey, conducted in South Carolina's estuarine and nearshore waters.

Catch per unit effort (CPUE) in number of red drum per set are reported for the time series. The SCDNR red drum time series had to be analyzed in two separate time segments (1998-2006 and 2007-2011) due to a change in gear and sampling design. Nominal and standardized CPUE results from the adult red drum survey indicate an increasing trend in red drum abundance during survey years, however, increases in abundance may be due to the changes in bait used as well as addition and removal of stations.

Introduction

In an effort to monitor populations of adult red drum, *Sciaenops ocellatus*, in South Carolina's estuarine waters, the South Carolina Department of Natural Resources (SCDNR) Marine Resources Division began sampling for using longlines in Charleston Harbor in 1994. This survey was modified from a fixed station to a random stratified station survey in 2007 in response to the needs of stock assessment biologists and to increase coverage along the coast. In addition, the mainline and number of hooks used for the 2007-2013 SCDNR Adult Red Drum longline survey were reduced to one third of the original mainline length and hook number per set. For these reasons, the SCDNR red drum longline survey was analyzed as two separate time series (1998-2006 and 2007-2013). Relative abundance indices from the SCDNR red drum survey were previously generated for red drum covering the time period from 1994 to 2006 (SEDAR 18-DW14). In this document, the new time series (2007-2013) is added with data through 2013.

Methods

Sampling consistently occurred during three fixed sampling periods, August 1 to September 15, September 16 to October 31 and November 1 to December 15. From 2007 to 2009 sets were made from March to November sets were made from March to December, however catches were highest during the three sampling periods above, therefore effort was maximized during these periods. Sampling occurs in four strata, Winyah Bay, Charleston Harbor, St. Helena Sound and Port Royal Sound (Figure 1). Thirty sites are randomly selected from a predetermined list of sites (43-80 sites/strata) during each sampling period. Each of four strata is sampled once during each time period. Specific sampling locations within each stratum were identified and chosen based on previous index sampling stations, suggestions from local charter captains, or areas identified as possible red drum habitat based on depth and bottom type. Sites were designated as either inshore or offshore based on location to land and man-made structures (jetties).

Longline gear consisted of a 272 kg test monofilament mainline that was 610 m long with 30.5 m buoy lines attached at each end. The mainline was equipped with stop sleeves at 30.5 m intervals to prevent gangions from sliding together when a large fish was captured. The gangions consisted of a 0.5 m, 91 kg test monofilament leader, size 120 stainless steel longline snap, 4/0 swivel and a 15/0 circle hook. Sets consisted of 40 hooks. Gear was only set during daylight hours, and soak times for longline sets were limited to 45 minutes unless conditions or events dictated otherwise. Longlines were baited with all Atlantic mackerel (*Scomber scombrus)*, half Atlantic mackerel and half striped mullet (*Mugil cephalus*) for a bait study in Charleston Harbor (2011/2012), or all striped mullet. Station location, water and air temperature, wind speed and direction, cloud cover, salinity, depth, dissolved oxygen, and set and pickup times were recorded for all sets.

Red drum captured were measured to fork (FL) and total length (TL), tissue for genetic analysis was taken, and specimens were either tagged and released or sacrificed for age estimation and reproductive assessment. Multiple tag types have been used for tagging red drum throughout the surveys history. Nylon dart tags (Hallprint©) have been used on all tagged fish since the survey began (in the pterygiophores beneath the second dorsal fin). Internal passive integrated transponder tags (PIT) and stainless steel dart tags were added in 2001 as part of a tag shedding study (Hendrix 2010). Stainless steel dart tag use was discontinued in 2007. From 2007 to present, released red drum are double tagged with a nylon dart and PIT tag.

Results

Sampling Intensity

A total of 2,054 collections occurred from 2007 to 2013 across 250 sites from the four strata (Table 1). Of the 250 sites, 226 had positive catches of red drum and 761 of the 2054 sets (37.0%) captured at least one red drum. Not every site was sampled every period or year due to the stratified random design. Sampling occurred from August through December each year.

Catch and Biological sampling

A total of 2,687 red drum were caught from all strata from 2007 to 2013 (Table 2). Measurements (FL and TL) to the nearest mm were taken on 2,672 individuals (Table 3, Figures 2 and 3). Indices of abundance (arithmetic mean) were calculated across sampling periods, strata and site designation (Table 4, Figure 4). Catch per unit effort has increased since the survey was reconfigured in 2007. Sampling sites were reevaluated and additional sites were added after the 2009 season. These changes appear to have a minimal effect on CPUE as percent of positive sets and CPUE were not affected.

Bait type had a significant effect on catch of red drum in the survey (ANOVA, $p<0.001$). From 2007-2009 Atlantic mackerel was the primary bait, and from 2010-2013, striped mullet was the primary bait choice (Table 5). In 2011 the survey conducted a bait study testing these two bait types (Charleston Harbor only), the Atlantic mackerel used in that season was of poor quality, so the study was repeated in 2012. These data were used to produce a correction factor for sets using Atlantic mackerel (striped mullet sets were superior). A 2011 specific correction factor of 0.54 was applied to the 2011 Charleston Harbor sets, and the 2012 correction factor of 0.63 was applied to any remaining sets using Atlantic mackerel (2010-2013) (Table 6, Figure 4).

From 2007 to 2013 a total of 539 red drum were sacrificed for age estimation and reproductive assessment (Table 7). Age estimates ranged from 3 to 40 ($\bar{x}$=17.3) and ages were significantly different between strata (ANOVA, p<0.001) (Figure 5). Differences are driven by a larger frequency of younger drum in the Charleston Harbor. It is unclear whether there is greater escapement of young red drum in the Charleston Harbor System, or a lack of older drum (differential mortality).

Mark and Recapture

From 1994 to 2013 a total of 5,788 red drum were tagged and released. A total of 361 were recaptured by the project as well as recreational angler (Table 8), individual fish were recaptured up to 5 times. Time-at-liberty ranged from 2 days to 4,374 days.

Biases

-Less effort in 2007-2009 sampling seasons as some stations that were sampled during this period were removed.
-Bait type (Atlantic Mackerel 2007-2009, Striped Mullet 2010-2013) has large effect on CPUE.
-Bait study conducted in Charleston Harbor in 2011/2012 may have negatively affected catches during this period (Charleston Harbor only).
-Addition of sites and removal of no catch sites after 2009 likely has negligible effect on CPUE, as removal of sites added beginning in 2010 leads to higher CPUE.

Literature Cited

Hendrix C (2010). Retention of Three Types of Tags Applied to Adult Red Drum in South Carolina Waters**.** Master's Thesis, College of Charleston**.**

SEDAR 18-DW14. Assessment of Adult Red Drum in South Carolina Coastal Waters.

Tables and Figures

Table 1. Effort data by year and strata (sampling period and designation pooled) from the South Carolina Department of Natural Resources Adult Red Drum Longline Survey from 2007-2013.

Year	Charleston Harbor	Port Royal Sound	St. Helena Sound	Winyah Bay	**Total**
2007	46	41	30	67	**184**
2008	81	38	27	63	**209**
2009	79	39	37	78	**233**
2010	87	87	90	90	**354**
2011	92	88	90	90	**360**
2012	91	87	90	90	**358**
2013	89	89	90	88	**356**
	565	**469**	**454**	**566**	**2054**

Table 2. Arithmetic mean (catch per unit effort) of red drum by year in the South Carolina Department of Natural Resources Adult Red Drum Longline Survey. Mean, standard deviation (SD) number of sets, number of positive sets, standard error (SE) and coefficient of variation (CV) by year are presented.

Year	Catch Arith Mean	SD	Sets	Positive Sets	SE	CV
2007	0.62	1.92	184	42	0.14	3.10
2008	0.66	1.59	209	55	0.11	2.41
2009	1.35	3.54	233	79	0.23	2.62
2010	1.21	2.81	354	125	0.15	2.32
2011	1.12	2.29	360	143	0.12	2.04
2012	1.85	3.41	358	157	0.18	1.84
2013	1.76	3.08	356	160	0.16	1.75

Table 3. Size-frequency distribution of red drum in the South Carolina Department of Natural Resources Adult Red Drum longline survey by strata and sampling period (periods 1 and 2 combined).

	Charleston Harbor		Port Royal Sound		St. Helena Sound		Winyah Bay		
Sampling Period	1 & 2	3	1 & 2	3	1 & 2	3	1 & 2	3	
Fork Length (mm)									**Total**
601-650	1	0	0	0	0	0	0	0	**1**
651-700	1	1	2	0	1	0	0	0	**5**
701-750	2	1	2	1	1	1	7	1	**16**
751-800	9	4	2	4	4	3	17	4	**47**
801-850	39	12	4	0	4	10	40	5	**114**
851-900	42	46	8	6	35	15	102	10	**264**
901-950	83	103	33	34	76	28	206	31	**594**
951-1000	72	91	89	110	98	60	213	69	**802**
1001-1050	45	55	74	76	72	32	142	87	**583**
1051-1100	14	14	18	23	27	14	46	44	**200**
1101-1150	2	2	2	3	0	1	12	16	**38**
1151-1200	0	0	0	0	0	0	1	1	**2**
1201-1250	1	0	0	0	0	0	0	0	**1**
Total	**310**	**329**	**234**	**257**	**318**	**164**	**760**	**268**	**2666**

Table 4. Arithmetic mean catch per unit effort (CPUE) of red drum in the South Carolina Department of Natural Resources Adult Red Drum Longline Survey.

Year	CPUE	SD	Sets	Positive Sets	SE	CV
2007	0.62	1.92	184	42	0.14	3.10
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2011	1.12	2.29	360	143	0.12	2.04
2012	1.85	3.41	358	157	0.18	1.84
2013	1.76	3.08	356	160	0.16	1.75

Table 5. Number of sets by bait type by year and strata for the South Carolina Department of Natural Resources Adult Red Drum Longline Survey.

	Charleston Harbor			Port Royal			St. Helena Sound			Winyah Bay		
	Mackerel	Mullet	Both	Mackerel	Mullet	Both	Mackerel	Mullet	Both	Mackerel	Mullet	Both
2007	46	-	-	41	-	-	30	-	-	67	-	-
2008	81	-	-	38	-	-	27	-	-	63	-	-
2009	79	-	-	39	-	-	37	-	-	78	-	-
2010	5	80	2	39	48	-	20	70	-	-	90	-
2011	-	14	78	-	88	-	-	86	4	-	90	-
2012	-	1	90	-	87	-	5	85	-	-	88	2
2013	-	89	-	-	78	11	-	62	28	-	88	-

Table 6. Arithmetic mean catch per unit effort (CPUE) of red drum adjusted for bait type in the South Carolina Department of Natural Resources Adult Red Drum Longline Survey.

Year	CPUE	SD	Sets	Positive Sets	SE	CV
2007	0.99	3.04	184	42	0.22	3.07
2008	1.05	2.53	209	55	0.18	2.41
2009	2.14	5.61	233	79	0.37	2.62
2010	1.24	2.82	354	125	0.15	2.27
2011	1.19	2.43	360	143	0.13	2.04
2012	1.97	3.54	358	157	0.19	1.80
2013	1.81	3.18	356	160	0.17	1.76

Table 7. Number of sacrificed red drum per strata and by year from the South Carolina Department of Natural Resources Adult Red Drum Longline Survey.

Year	Charleston Harbor	Port Royal Sound	St. Helena Sound	Winyah Bay	**Total**
2007	4	9	0	19	**32**
2008	13	12	8	30	**63**
2009	24	14	19	13	**70**
2010	30	20	14	41	**105**
2011	9	12	18	16	**55**
2012	19	25	30	21	**94**
2013	35	34	31	20	**119**
Total	**134**	**126**	**120**	**159**	**539**

Table 8. Matrix of all tagged red drum per year as well as all tag and recapture events from the South Carolina Department of Natural Resources Adult Red Drum Longline Survey (1994-2013). Recapture dates reflect initial tagging and final capture date (multiple recapture dates not presented).

Tag	Total	Year of Recapture																		
Year	**Tagged**	**1995**	**1996**	**1998**	**1999**	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**Total**
1994	182	2	2		1			1												6
1995	293		8			1														9
1996	279		2									1								3
1997	112			1					1											2
1998	198			3		1	1									1				6
1999	245						1		2											3
2000	177					1	5	4	4	2	1		1							18
2001	214						4	15	4	1	2	2	2		1	1			1	33
2002	418							19	9	14	10	7	3			2	2	1	2	69
2003	446								9	17	12	6	3	4	2		2		1	56
2004	268									2	7	5	2	3	4	3		2	1	29
2005	426										7	10	5		2	1	1	1	3	30
2006	353											2	4	3	5	8	3	2	2	29
2007	160												4	3		1	2	4		14
2008	127													1				3		4
2009	216															5		1		6
2010	298															2	3	1	2	8
2011	337																1	9	5	15
2012	550																	3	10	13
2013	489																		8	8
Total	5788	**2**	**12**	**4**	**1**	**3**	**11**	**39**	**29**	**36**	**39**	**33**	**24**	**14**	**14**	**24**	**14**	**27**	**35**	**361**

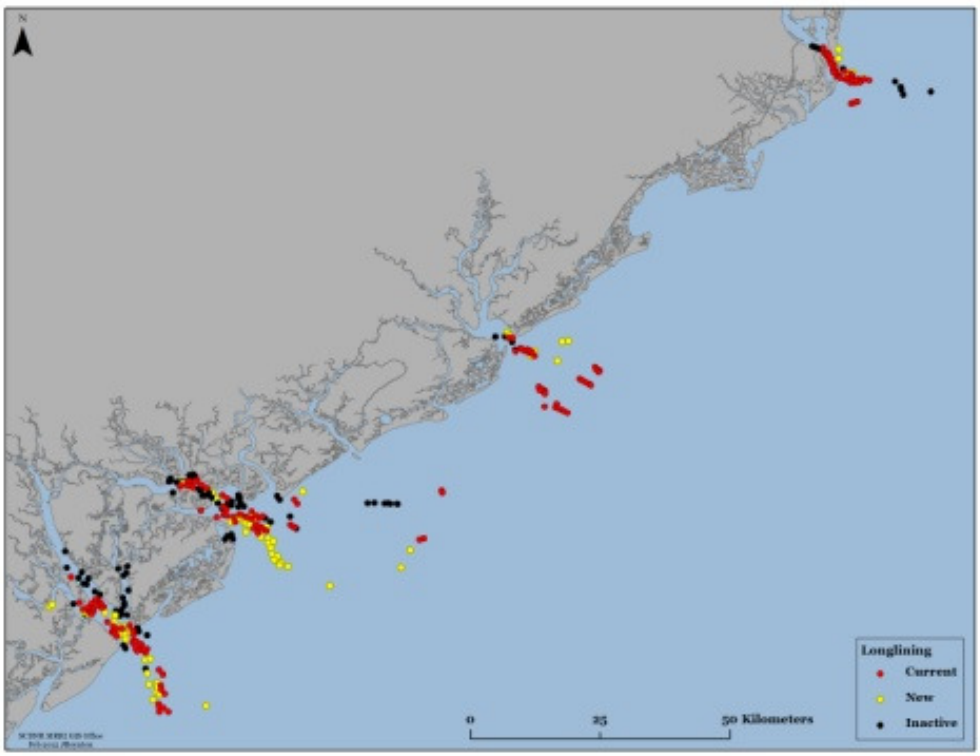

Figure 1. Sampling locations for the South Carolina Department of Natural Resources Adult Red Drum Longline Survey. Red dots indicate sites in continuous use since 2007, yellow sites were added prior to the 2010 sampling season, and black dots were removed after the 2009 sampling season.

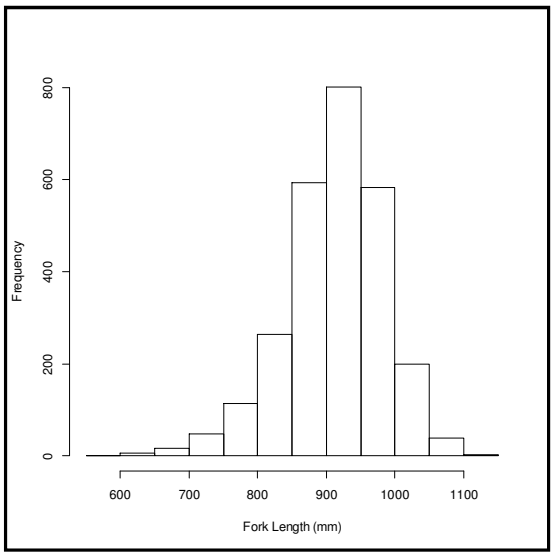

Figure 2. Length frequency of red drum captured in the South Carolina Department of Natural Resources Adult Red Drum Longline Survey.

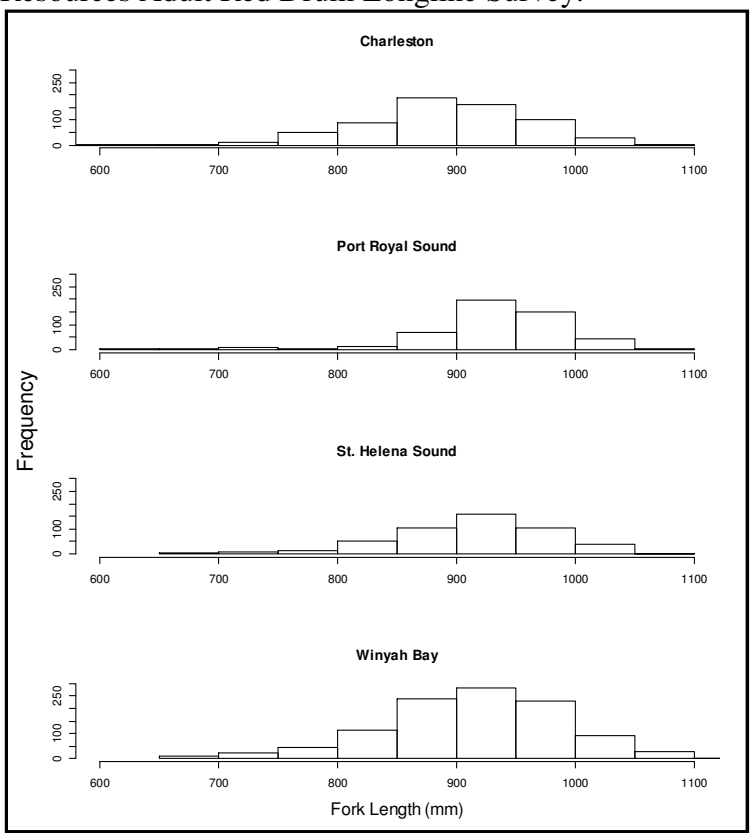

Figure 3. Length frequency of red drum by strata in the South Carolina Department of Natural Resources Adult Red Drum Longline Survey.

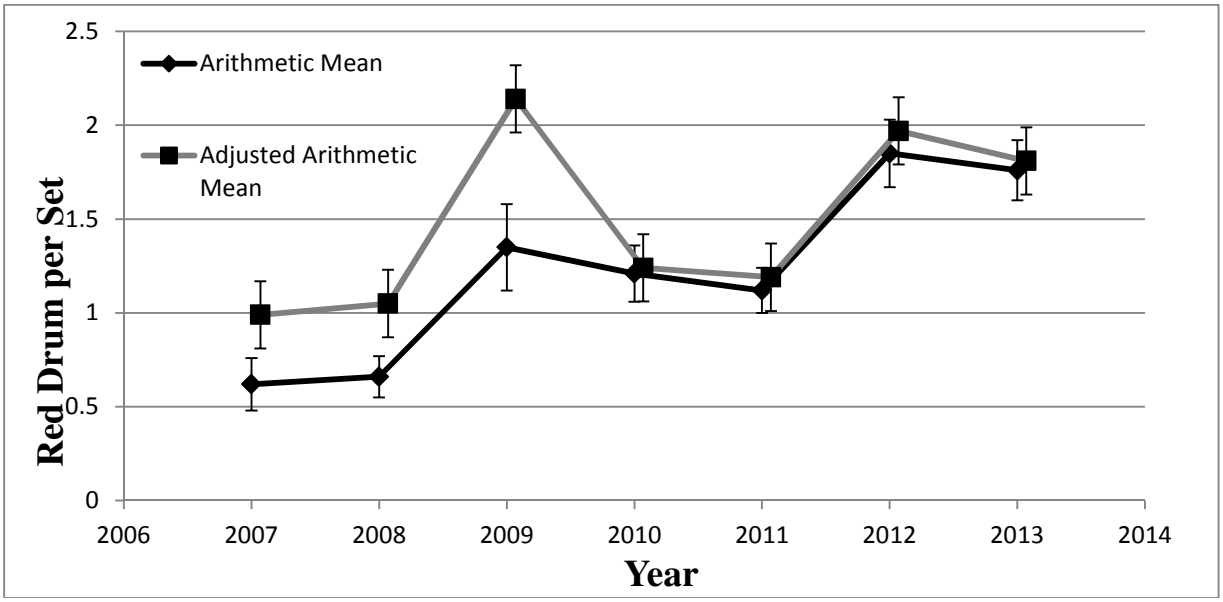

Figure 4. Arithmetic mean CPUE (±SE) of red drum and arithmetic mean adjusted for bait type (±SE) captured in the South Carolina Department of Natural Resources Adult Red Drum Longline Survey, data are pooled across strata, sampling periods and station designations.

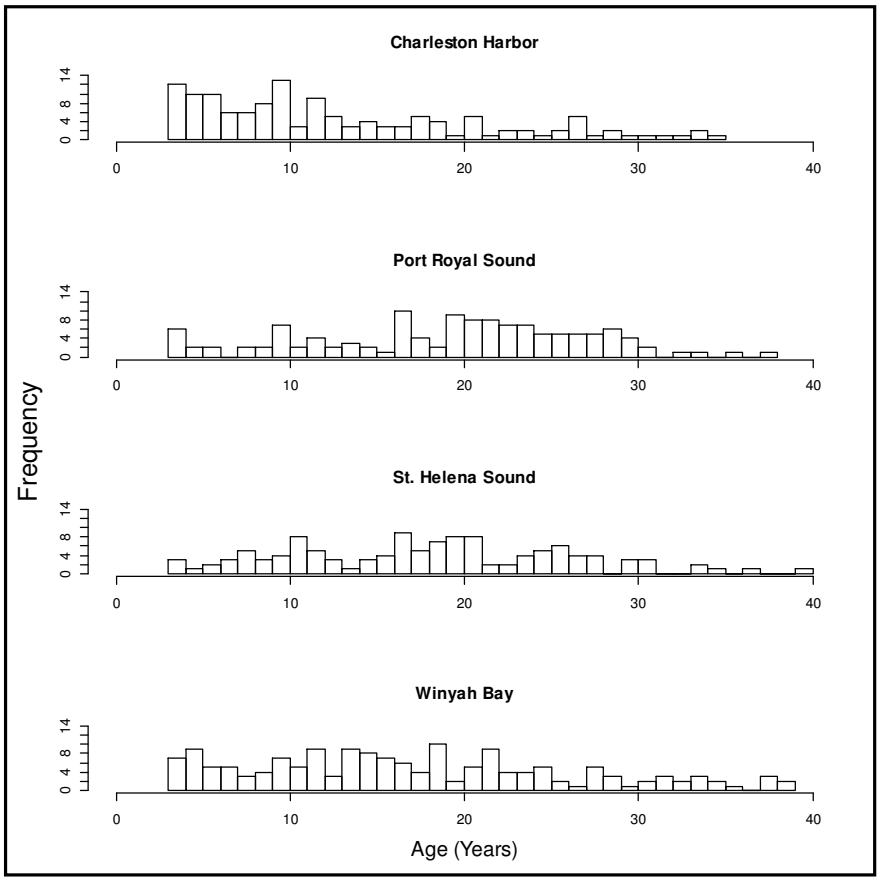

Figure 5. Frequency of age estimates in years by strata for red drum sacrificed by the South Carolina Department of Natural Resources Adult Red Drum Longline Survey.