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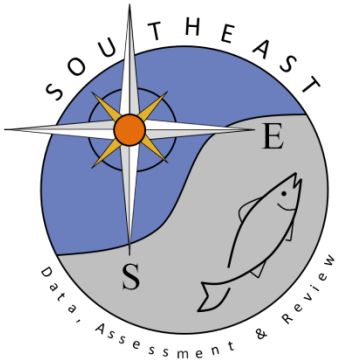

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Overview

The Southeast Gillnet Observer Program has adapted to the changes of the Florida- Georgia shark gillnet fishery since the program began in 1993 (e.g. Mathers et al. 2018 and references therein). The observer program initially focused efforts only on those gillnets vessels targeting shark. However, gillnet effort targeting large coastal and small coastal sharks declined as a result of Amendments 2 and 3 to the Consolidated Atlantic Highly Migratory Species Fishery Management Plan. Shark targeted gillnet effort has continued to decline in the last five years. Fishers have consequently increased effort targeting fish, including Spanish mackerel *Scomberomorus maculatus*, king mackerel *Scomberomorus cavalla*, and bluefish *Pomatomus saltatrix*, with varying types of gillnet gear. Regardless of target, hammerhead sharks are either kept or discarded as bycatch, depending on the time of the year and opening or closure of the fishery. The Southeast Gillnet Observer Program, in its continuing efforts to adapt to the fishery, currently covers anchored (sink and stab), strike, or drift gillnet fishing, regardless of target, by vessels that fish year-round from Florida to North Carolina and the Gulf of Mexico.

Methods

Following the definition of the US south Atlantic from the Highly Migratory Species Office, data were divided between the Gulf of Mexico and US south Atlantic. Due to the nature of the data, we followed the approach of Garrison (2007) by employing a simple ratio estimator to represent bycatch rates;

Catch per unit effort (CPUE) = number of hammerhead sharks discarded / number of sets

An estimate of uncertainty in these estimates was derived from bootstrap resampling of the calculated CPUE data set. A sample was drawn from the data (with replacement) and the procedure was repeated 1,000 times to generate a mean distribution for the estimate and the associated standard deviation. Estimates were derived separately for sharks discarded dead and sharks discards alive as reported by the on-board observer. Total bycatch by year for the fishery were estimated by multiplying the derived bootstrap CPUE estimates by the total number of reported sets for the US South Atlantic, Gulf of Mexico or all areas.

Total effort data reflects all gillnet trip reports received by the Coastal Fisheries Logbook Program (hereafter Logbook Program) in the southeast United States (Figure 1). Four gillnet types are reported to the Coastal Fisheries Logbook: Strike, Drift, Anchor, and Other. These types are coded and reflected in the summary as follows:
Strike – Gear code: ‘475’ - gear name: ‘GILL NETS, DRIFT, RUNAROUND’
Drift – Gear code: ‘470’ - gear name: ‘GILL NETS, DRIFT, OTHER’
Anchor – Gear code:’480’ gear name: ‘GILL NETS, STAKE’
Other – Gear code: ‘425’ gear name: ‘GILL NETS, OTHER’.
However, given the nature of the data and that most gillnet effort is reported as “OTHER”, bycatch estimates were derived for the gillnet fishery regardless of gillnet type.

Results and Discussion

Calculated scalloped hammerhead and great hammerhead shark discards (in numbers of fish, dead or live) from the commercial gillnet fishery are provided in Table 1-Table 8. Also included are discard rates, number of observed trips, discard rate standard errors, and number of logbook trips reporting effort. In all the estimates, data was pooled without considering strata due to the sparse nature of the bycatch events and the fact that logbook data is reported by sampling grid (see Figure 1).

Literature cited

Garrison, L.P. 2007. Estimated Marine Mammal and Turtle Bycatch in Shark Gillnet Fisheries Along the Southeast U.S. Atlantic Coast: 2000-2006. PRD Contribution: #PRD-04/05- 10,

Mathers, A.N., B.M. Deacy, H.E. Moncrief-Cox, J.K. Carlson. 2018. Catch and Bycatch in U.S. Southeast Gillnet Fisheries, 2017. NOAA Technical Memorandum NMFS-SEFSC-728. 13 p.

Table 1. Yearly calculated dead discards of great hammerhead shark from US southeast commercial gillnet fishery. Discards are reported as number of sharks for all areas combined.

YEAR	TOTAL LOGBOOK SETS	NUMBER OF OBSERVER SETS	DEAD DISCARD RATE (SHARKS/SETS)	DISCARD RATE STANDARD DEVIATION	ESTIMATED TOTAL DEAD DISCARDS (NUMBERS)
1998	2515	9	0.000	0.000	0
1999	2077	54	0.019	0.136	38
2000	2097	63	0.063	0.504	133
2001	2034	109	0.000	0.000	0
2002	1953	107	0.449	1.519	876
2003	1633	65	0.000	0.000	0
2004	1602	57	0.070	0.417	112
2005	1879	152	0.013	0.162	25
2006	2471	215	0.000	0.000	0
2007	3748	170	0.000	0.000	0
2008	3756	204	0.000	0.000	0
2009	4422	421	0.017	0.212	74
2010	2801	295	0.000	0.000	0
2011	3825	402	0.000	0.000	0
2012	3773	315	0.003	0.056	12
2013	2173	225	0.000	0.000	0
2014	3932	236	0.004	0.065	17
2015	3871	226	0.000	0.000	0
2016	3221	208	0.000	0.000	0
2017	2351	75	0.000	0.000	0
2018	3227	87	0.000	0.000	0
2019	3635	95	0.000	0.000	0

Table 2. Yearly calculated live discards of great hammerhead shark from US south Atlantic commercial gillnet fishery. Discards are reported as number of sharks for all areas combined

YEAR	TOTAL LOGBOOK SETS	NUMBER OF OBSERVER SETS	LIVE DISCARD RATE (SHARKS/SETS)	DISCARD RATE STANDARD DEVIATION	ESTIMATED TOTAL LIVE DISCARDS (NUMBERS)
1998	2515	9	0.000	0.000	0
1999	2077	54	0.000	0.000	0
2000	2097	63	0.000	0.000	0
2001	2034	109	0.000	0.000	0
2002	1953	107	0.000	0.000	0
2003	1633	65	0.000	0.000	0
2004	1602	57	0.018	0.132	28
2005	1879	152	0.000	0.000	0
2006	2471	215	0.009	0.136	23
2007	3748	170	0.000	0.000	0
2008	3756	204	0.005	0.070	18
2009	4422	421	0.002	0.049	11
2010	2801	295	0.000	0.000	0
2011	3825	402	0.000	0.000	0
2012	3773	315	0.003	0.056	12
2013	2173	225	0.004	0.067	10
2014	3932	236	0.000	0.000	0
2015	3871	226	0.000	0.000	0
2016	3221	208	0.000	0.000	0
2017	2351	75	0.000	0.000	0
2018	3227	87	0.023	0.151	74
2019	3635	95	0.000	0.000	0

Table 3. Yearly calculated dead discards of scalloped hammerhead shark from US southeast commercial gillnet fishery. Discards are reported as number of sharks for all areas combined.

YEAR	TOTAL LOGBOOK SETS	NUMBER OF OBSERVER SETS	DEAD DISCARD RATE (SHARKS/SETS)	DISCARD RATE STANDARD DEVIATION	ESTIMATED TOTAL DEAD DISCARDS (NUMBERS)
1998	2515	9	0.000	0.000	0
1999	2077	54	0.556	1.574	1154
2000	2097	63	0.762	5.541	1598
2001	2034	109	0.101	0.429	205
2002	1953	107	0.327	1.294	639
2003	1633	65	0.923	5.773	1507
2004	1602	57	3.263	11.087	5228
2005	1879	152	0.046	0.210	87
2006	2471	215	0.200	1.438	494
2007	3748	170	0.029	0.276	110
2008	3756	204	0.015	0.121	55
2009	4422	421	0.036	0.269	158
2010	2801	295	0.041	0.450	114
2011	3825	402	0.012	0.165	48
2012	3773	315	0.137	1.453	515
2013	2173	225	0.147	1.550	319
2014	3932	236	0.000	0.000	0
2015	3871	226	0.027	0.229	103
2016	3221	208	0.019	0.169	62
2017	2351	75	0.000	0.000	0
2018	3227	87	0.138	0.718	445
2019	3635	95	0.000	0.000	0

Table 4. Yearly calculated live discards of scalloped hammerhead shark from US southeast commercial gillnet fishery. Discards are reported as number of sharks for all areas combined.

YEAR	TOTAL LOGBOOK SETS	NUMBER OF OBSERVER SETS	DEAD LIVE RATE (SHARKS/SETS)	DISCARD RATE STANDARD DEVIATION	ESTIMATED TOTAL LIVE DISCARDS (NUMBERS)
1998	2515	9	0.000	0.000	0
1999	2077	54	0.056	0.408	115
2000	2097	63	0.000	0.000	0
2001	2034	109	0.000	0.000	0
2002	1953	107	0.019	0.136	37
2003	1633	65	0.000	0.000	0
2004	1602	57	0.070	0.320	112
2005	1879	152	0.059	0.237	111
2006	2471	215	0.135	1.386	333
2007	3748	170	0.012	0.108	44
2008	3756	204	0.059	0.324	221
2009	4422	421	0.019	0.168	84
2010	2801	295	0.044	0.380	123
2011	3825	402	0.030	0.210	114
2012	3773	315	0.067	0.307	252
2013	2173	225	0.107	0.693	232
2014	3932	236	0.021	0.215	83
2015	3871	226	0.062	0.740	240
2016	3221	208	0.043	0.266	139
2017	2351	75	0.013	0.115	31
2018	3227	87	0.207	0.718	668
2019	3635	95	0.084	0.347	306

Table 5. Yearly calculated dead discards of scalloped hammerhead shark from US southeast commercial gillnet fishery. Discards are reported as number of sharks for the Atlantic.

YEAR	TOTAL LOGBOOK SETS	NUMBER OF OBSERVER SETS	DEAD DISCARD RATE (SHARKS/SETS)	DISCARD RATE STANDARD DEVIATION	ESTIMATED TOTAL DEAD DISCARDS (NUMBERS)
1998	2403	9	0.000	0.000	0
1999	1855	54	0.556	1.574	1031
2000	1945	54	0.056	0.231	108
2001	1872	90	0.122	0.470	229
2002	1874	84	0.417	1.450	781
2003	1558	64	0.938	5.817	1461
2004	1547	57	3.263	11.087	5048
2005	1812	152	0.046	0.210	83
2006	2379	205	0.210	1.472	499
2007	3658	170	0.029	0.276	108
2008	3602	201	0.010	0.100	36
2009	4108	393	0.036	0.274	146
2010	2714	295	0.041	0.450	110
2011	3467	398	0.013	0.166	44
2012	3540	300	0.143	1.489	507
2013	1876	209	0.158	1.608	296
2014	3354	225	0.000	0.000	0
2015	3125	191	0.031	0.249	98
2016	2851	199	0.020	0.173	57
2017	2151	66	0.000	0.000	0
2018	3063	78	0.154	0.757	471
2019	3370	94	0.000	0.000	0

Table 6. Yearly calculated live discards of scalloped hammerhead shark from US southeast commercial gillnet fishery. Discards are reported as number of sharks for the Atlantic.

YEAR	TOTAL LOGBOOK SETS	NUMBER OF OBSERVER SETS	DEAD LIVE RATE (SHARKS/SETS)	DISCARD RATE STANDARD DEVIATION	ESTIMATED TOTAL LIVE DISCARDS (NUMBERS)
1998	2403	9	0.000	0.000	0
1999	1855	54	0.056	0.408	103
2000	1945	54	0.000	0.000	0
2001	1872	90	0.000	0.000	0
2002	1874	84	0.024	0.153	45
2003	1558	64	0.000	0.000	0
2004	1547	57	0.070	0.320	109
2005	1812	152	0.059	0.237	107
2006	2379	205	0.141	1.419	337
2007	3658	170	0.012	0.108	43
2008	3602	201	0.060	0.326	215
2009	4108	393	0.015	0.142	63
2010	2714	295	0.044	0.380	120
2011	3467	398	0.030	0.211	105
2012	3540	300	0.070	0.314	248
2013	1876	209	0.115	0.718	215
2014	3354	225	0.022	0.220	75
2015	3125	191	0.073	0.805	229
2016	2851	199	0.045	0.271	129
2017	2151	66	0.000	0.000	0
2018	3063	78	0.231	0.755	707
2019	3370	94	0.085	0.349	287

Table 7. Yearly calculated dead discards of scalloped hammerhead shark from US southeast commercial gillnet fishery. Discards are reported as number of sharks for the Gulf of Mexico. Due to low observer coverage, the discard rate and standard deviation is the grand mean of all years combined.

YEAR	TOTAL LOGBOOK SETS	NUMBER OF OBSERVER SETS	DEAD DISCARD RATE (SHARKS/SETS)	DISCARD RATE STANDARD DEVIATION	ESTIMATED TOTAL DEAD DISCARDS (NUMBERS)
1998	112	0	0.336	1.026	38
1999	222	0	0.336	1.026	74
2000	152	9	0.336	1.026	51
2001	162	13	0.336	1.026	54
2002	79	21	0.336	1.026	27
2003	75	0	0.336	1.026	25
2004	55	0	0.336	1.026	18
2005	67	0	0.336	1.026	22
2006	92	9	0.336	1.026	31
2007	90	0	0.336	1.026	30
2008	154	3	0.336	1.026	52
2009	314	28	0.336	1.026	105
2010	87	0	0.336	1.026	29
2011	358	4	0.336	1.026	120
2012	233	15	0.336	1.026	78
2013	297	16	0.336	1.026	100
2014	578	11	0.336	1.026	194
2015	746	35	0.336	1.026	250
2016	370	9	0.336	1.026	124
2017	200	9	0.336	1.026	67
2018	164	9	0.336	1.026	55
2019	265	1	0.336	1.026	89

Table 8. Yearly calculated live discards of scalloped hammerhead shark from US southeast commercial gillnet fishery. Discards are reported as number of sharks for the Gulf of Mexico. Due to low observer coverage, the discard rate and standard deviation is the grand mean of all years combined.

YEAR	TOTAL LOGBOOK SETS	NUMBER OF OBSERVER SETS	DEAD LIVE RATE (SHARKS/SETS)	DISCARD RATE STANDARD DEVIATION	ESTIMATED TOTAL LIVE DISCARDS (NUMBERS)
1998	112	0	0.012	0.051	1
1999	222	0	0.012	0.051	3
2000	152	9	0.012	0.051	2
2001	162	13	0.012	0.051	2
2002	79	21	0.012	0.051	1
2003	75	0	0.012	0.051	1
2004	55	0	0.012	0.051	1
2005	67	0	0.012	0.051	1
2006	92	9	0.012	0.051	1
2007	90	0	0.012	0.051	1
2008	154	3	0.012	0.051	2
2009	314	28	0.012	0.051	4
2010	87	0	0.012	0.051	1
2011	358	4	0.012	0.051	4
2012	233	15	0.012	0.051	3
2013	297	16	0.012	0.051	4
2014	578	11	0.012	0.051	7
2015	746	35	0.012	0.051	9
2016	370	9	0.012	0.051	5
2017	200	9	0.012	0.051	2
2018	164	9	0.012	0.051	2
2019	265	1	0.012	0.051	3

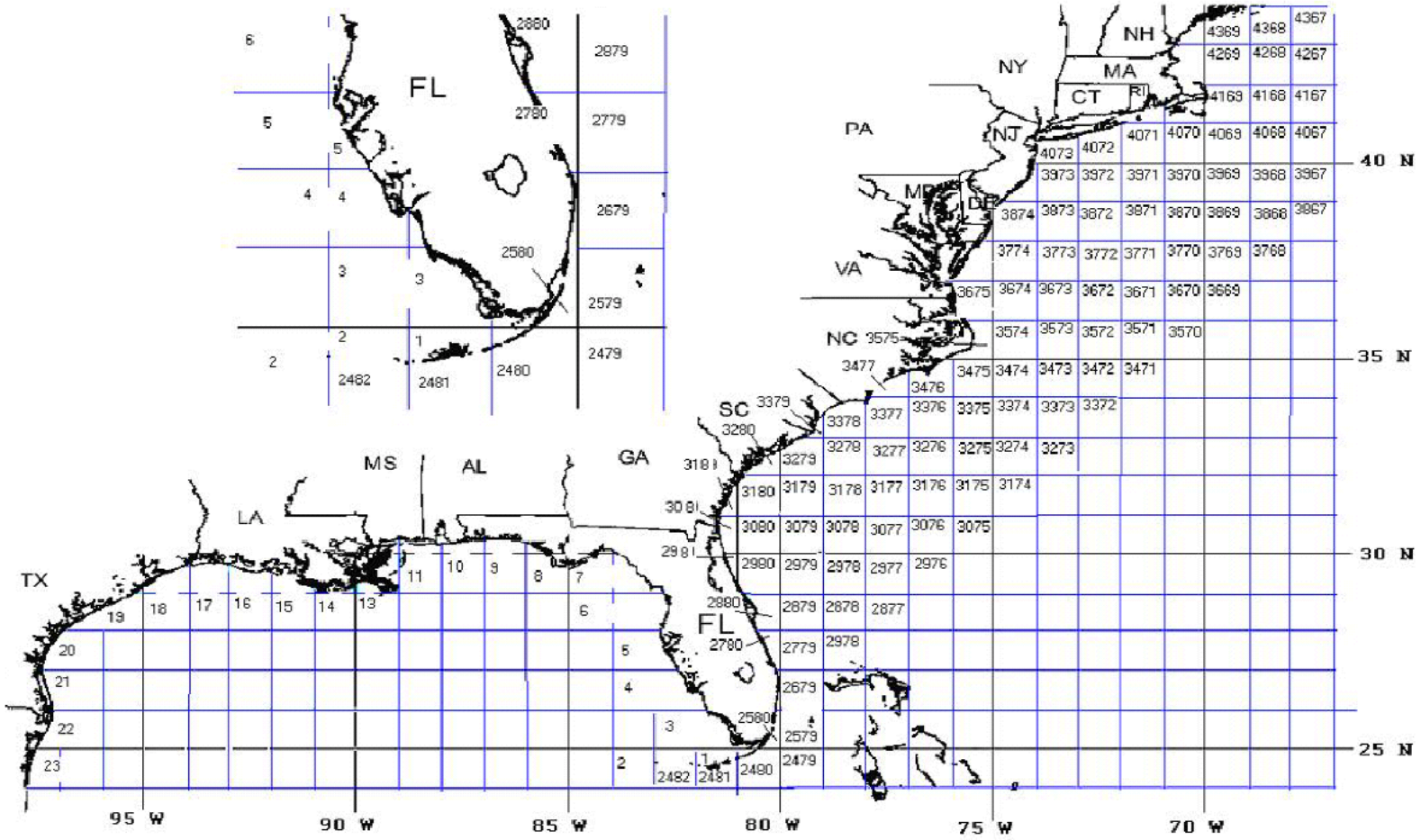

Figure 1. Coastal logbook statistical areas.