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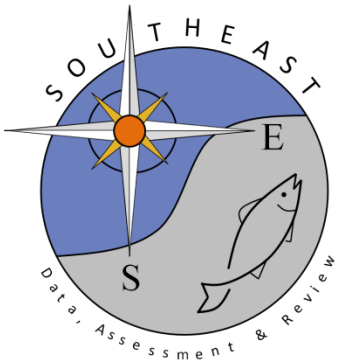
SEDAR77-DW37

Received: 1/31/2022



Please cite this document as:

Zhang, Xinsheng, John Carlson, Enric Cortés, Elizabeth Babcock, Robert Latour. 2022. Revised bycatch estimates of scalloped and great hammerhead shark in the shark bottom longline fishery. SEDAR77-DW37. SEDAR, North Charleston, SC. 24 pp.

Revised bycatch estimates of scalloped and great hammerhead shark in the shark bottom longline fishery

Xinsheng Zhang[1], John Carlson[1], Enric Cortés[1], Elizabeth Babcock[2], Robert Latour[3]

[1]NOAA Fisheries
Southeast Fisheries Science Center
3500 Delwood Beach Road
Panama City, FL

[2]University of Miami Rosenstiel School of Marine and Atmospheric Sciences
Department of Marine Biology and Ecology
4600 Rickenbacker Cswy
Miami, FL 33149

[3]Virginia Institute of Marine Science
William & Mary
Gloucester Point, VA 23062

Summary

This document details the use of the delta-lognormal method (Pennington, 1983) to calculate discard rates to produce discard estimates and associated uncertainty to use in the SEDAR 77 assessment of hammerhead sharks. The ratio method was used in SEDAR77-DW-20 (Carlson et al., 2021) to calculate discard estimates and associated uncertainty. However, the estimated standard deviations (or CVs) obtained through bootstrap resampling reported in SEDAR77-DW-20 are extremely high. The panel recommended to use the delta-lognormal method as an alternative method to estimate dead discards and live discards with the same data sets. The discard estimates from the delta-lognormal are similar to those of the ratio method, but the estimated standard deviations (or CVs) from the delta-lognormal method are much smaller than the ratio method and are within a very reasonable range. Consequently, the panel recommended to use discard estimates and associated uncertainty estimates from the delta-lognormal method in the SEDAR 77 stock assessment. Given the very small number of sets in which a non-zero bycatch was observed (positive sets), the panel recommended to use the grand mean of discard rates based on the pooled observed sets for all years and the annual logbook effort to produce annual discard estimates. With this recommendation, the trend of the discard estimates is solely driven by the logbook effort. The estimated discard estimates, upper 95% CI and lower 95% CI were recommended to be used in the base, and high and low catch scenarios, respectively.

Introduction

The discard estimates produced using the ratio method in SEDAR77-DW-20 were not recommended for use in the SEDAR 77 assessment of hammerhead sharks. This document details the use of the delta-lognormal method (Pennington, 1983) to calculate discard rates to produce discard estimates and associated uncertainty with the same data sets. To facilitate the readers' understanding, this paper reuses the "Introduction" of SEDAR77-DW-20 which provides the background information about the data sets.

Currently about 200 United States (US) fishers are permitted to target sharks (excluding dogfish) in the Atlantic Ocean and Gulf of Mexico, with an additional number of fishers (<250) permitted to land sharks incidentally. Amendments to the Consolidated Atlantic Highly Migratory Species Fishery Management Plan based on stock assessments have eliminated the major directed shark fishery in the US South Atlantic (NMFS 2007). These amendments also implemented a shark research fishery, which allows the National Marine Fisheries Service (NMFS) to select a limited number of commercial shark vessels on an annual basis to collect life history data and catch data for future stock assessments. Since 2008, only commercial shark fishers participating in the shark research fishery are allowed to land sandbar sharks, *Carcharhinus plumbeus*, and must carry an observer on 100% of all trips (compared to a coverage level of 4-6% outside the research fishery). Fishers not participating in the research fishery are permitted to land 45 non-sandbar large coastal sharks (including blacktip shark, *Carcharhinus limbatus*, bull shark, *Carcharhinus leucas*, lemon shark, *Negaprion brevirostris*, nurse shark, *Ginglymostoma cirratum*, silky shark, *Carcharhinus falciformis*, spinner shark, *Carcharhinus brevipinna*, tiger shark, *Galeocerdo cuvier*, great hammerhead, *Sphyrna mokarran*, and scalloped hammerhead, *Sphyrna lewini*) per trip in the South Atlantic region.

Bottom longline landings and fishing effort of commercial vessels operating in the South Atlantic are reported to NMFS through the Coastal Fisheries Logbook Program (CFLP, conducted by the NMFS Southeast Fisheries Science Center). The program collects landings and effort data by fishing trip from vessels that are federally permitted to fish in a number of fisheries managed by NMFS and South Atlantic Fishery Management Council. The coastal logbook program began in 1990 with the objective of a complete census of coastal fisheries permitted vessel activity, with the exception of Florida, where a 20% sample of vessels was selected to report. Beginning in 1993, reporting in Florida was increased to include all vessels permitted for federally managed coastal fisheries.

Commercial shark longline vessels operating in the US South Atlantic are also required to carry fishery observers to monitor catch and bycatch. Fishery observers are trained in fishery and biological data collection, biological sampling, and teleost and elasmobranch species identification. Observers are required to record and measure all species captured, their disposition (e.g. kept, discarded dead, used for bait) and effort (e.g. number of hooks, gear characteristics, set and haul times).

Methods

Dead and live discards were reported separately for the shark research fishery and the shark bottom longline fishery. As vessels in the shark research fishery are monitored 100%, no extrapolations of the dead and live discards were needed. Therefore, dead and live discards for the shark research fishery are not affected by changing from the ratio method to the delta method. To facilitate the readers' understanding, this paper includes dead and live discards for the shark research fishery reported in SEDAR77-DW-20.

For vessels outside the shark research fishery (i.e. shark bottom longline fishery), observer-reported hammerhead shark discard rates from 2005-2019, along with self reported commercial fishing effort data, were used to calculate hammerhead shark discards for the shark bottom longline fishery in the US South Atlantic. Following the definition of the South Atlantic from the Highly Migratory Species Office, bycatch was estimated for the "US south Atlantic", Gulf of Mexico, and areas combined.

The mean and variance of discard rates were calculated using the delta-lognormal method (Pennington, 1983). The method assumes a lognormal distribution of the positive bycatch rate observations. Effectively, the estimates are constructed as a product of the proportion of successful occurrences of an event and the average rate at which the event occurs for those successful events. The variance is a function of the variability of the positive bycatch rates as well the number of successful and unsuccessful sets. The delta estimator is more appropriate than the simple ratio estimate because catch rates are generally log-normally distributed and bycatch events (i.e., positive sets) are rare. The unit of effort in this analysis is the number of hooks, consistent with the method used to estimate the dead discards of Atlantic highly migratory species by the US Atlantic pelagic longline fleet for ICCAT (Brown, 2001). Due to small number of sets in which a non-zero bycatch of the species group was observed (positive sets), observed sets are pooled by each observed year and all observed years, respectively. The annual mean discard rate is based on the pooled observed sets for each observed year. The grand mean discard rate is based on the pooled observed sets for all observed years.

When number of sets in which a non-zero bycatch was observed (positive sets) is greater than 1, the mean discard rate, *C*, is calculated as:

$$C = \frac{m}{n} e^{L} G_m(\frac{s^2}{2}) \quad (1)$$

m is number of sets in which a non-zero bycatch was observed (positive sets),
n is total number of sets observed,
L is the mean of the log-transformed number of animals taken per 1000 hooks for the positive sets,
s^2 is the variance of the log-transformed number of animals taken per 1000 hooks for the positive sets, and
$G_m(\frac{1}{2}s^2)$ is the cumulative probability function from the Poisson distribution given as:

$$G_m(\frac{1}{2}s^2) = 1 + \frac{m-1}{m}(\frac{1}{2}s^2) + \sum_{j=2}^{\infty} \frac{(m-1)^{2j-1}}{m^j(m+1)(m+3)...(m+2j-3)} \text{x} \frac{(\frac{1}{2}s^2)^j}{j!} \quad (2)$$

The series was computed numerically over *j* terms until meeting a convergence criterion of a change in the function value of < 0.001 with additional terms (j). The variance of the delta estimator is:

$$\text{var}(C) = \frac{m}{n}(e^{2L})\left[\frac{m}{n}G_m^2(\frac{s^2}{2}) - \frac{m-1}{n-1}G_m(\frac{m-2}{m-1}s^2)\right] \quad (3)$$

When number of sets in which a non-zero bycatch was observed (positive sets) is equal to 1, the mean discard rate reduces to the simple mean rate where:

$$C = \frac{e^L}{n} \quad (4)$$

and the variance of the delta estimator is:

$$\text{var}(C) = (\frac{e^L}{n})^2 \quad (5)$$

When number of sets in which a non-zero bycatch was observed (positive sets) is equal to 0, the mean discard is:

$$C = 0 \quad (6)$$

and the variance of the delta estimator is:

$$\text{var}(C) = 0 \quad (7)$$

When number of sets in which a non-zero bycatch was observed (positive sets) is greater than or equal to 1, the coefficient of variation for the mean discard rate is taken as:

$$CV = \frac{\sqrt{\text{var}(C)}}{C} \quad (8)$$

The *C* calculated above gives either the annual mean or the grand mean number of animals caught per 1000 hooks for the observed sets. To estimate annual discards, *N*, these rates are multiplied by the annual total number of logbook hooks (in thousands). With an assumption of effort (*number of logbook hooks*) being a known constant, the coefficient of variation for the annual (or grand) mean discard rate is the same as the coefficient of variation for the annual discards. Approximate 95% confidence intervals (95% CI) were calculated assuming a log-normal distribution of annual discards as *Nk* and *N/k* for the upper and lower confidence bounds respectively where:

$$k = e^{\left[1.96\sqrt{\ln(1+CV^2)}\right]} \quad (9)$$

Fishing effort data were available from the coastal logbook program for the years 1993-2019 (Figure 1). Beginning in 1993 all commercial vessels with Federal fishing permits (other than those for swordfish, tunas, and shrimp) was required to report landings and effort to the coastal logbook program. Available coastal logbook data were filtered to include only bottom longline data and to remove records missing effort information (number of sets, number of hooks per set). Data reported from individual trips with fishing effort in both the South Atlantic and Gulf of Mexico were excluded from the analyses because fishing effort cannot be reliably apportioned within single trips. Coastal logbook data were additionally filtered to remove likely erroneous records; for example, data from trips that reported fishing more than 24 sets per 24 hours. Those data that exceeded the 99.5 percentile of the data for any variable used to calculate effort (number of sets, number of hooks) were also excluded. Such outliers in the data set usually resulted from data entry errors. After data filtering, effort data from only those trips that targeted sharks (defined as trips with reported landings of 2/3 shark by weight) were included in the analysis. Effort was defined as hooks fished because hook hours fished could not be reliably calculated from the coastal logbook data.

Results and Discussion

Scalloped hammerhead and great hammerhead shark dead and live discards (in numbers of sharks) from the commercial shark bottom longline fishery and the shark research fishery are provided in Tables 1-16. In all the estimates, data were pooled by either each observed year (tables denoted with an "a") or all observed years (tables denoted with a "b") without considering strata due to the sparse nature of the bycatch events and the fact that logbook data are reported by sampling grid (see Figure 1).

Pooling observed sets for all areas by either each observed year or all observed years without considering variance of areas and seasons, along with an assumption of effort (*number of logbook hooks*) being a known constant, may cause the actual variance of discard estimates to be underestimated. This in turn will produce a narrower confidence interval, which may have a confidence level lower than desired. In addition, assuming the grand mean of discard rate based on all the pooled observed sets is a constant for the entire time series, and the trend of the discard estimates is solely driven by the logbook effort, which may need to be further evaluated in the future. The discard estimates and associated uncertainty estimates using the delta-lognormal

method presented in this report, however, are regarded as an improvement over the discard estimates and associated uncertainty estimates using the ratio method reported in SEDAR77-DW-20. Given the very small number of sets in which a non-zero bycatch was observed (positive sets), the panel recommended to use the grand mean of discard rates based on the pooled observed sets for all years and the annual logbook effort to produce annual discard estimates (tables denoted with a "b").

Acknowledgments

The authors thank Guillermo Diaz and Craig Brown for sharing the code used for estimating dead discards of Atlantic highly migratory species by the US Atlantic pelagic longline fleet for ICCAT.

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Table 1a. Yearly calculated dead discards of great hammerhead sharks for the shark bottom longline fishery for the areas combined. Discards are reported as number.

Observed Year	Observed Sets	Positive Sets	Observed Hooks	Positive Hooks	Observed Animals	Mean CPUE (Per 1000 Hooks)	Standard Deviation	CV	Logbook Year	Logbook Hooks	Estimated Discards	Upper 95% CI	Lower 95% CI
1993									1993	1101380			
1994									1994	1941435			
1995									1995	2417653			
1996									1996	3435583			
1997									1997	1471463			
1998									1998	1579283			
1999									1999	1529138			
2000									2000	1387950			
2001									2001	1358879			
2002									2002	1662874			
2003									2003	1652615			
2004									2004	1227075			
2005	93	0	50394	0	0	0.000	0.000		2005	1388406	0		
2006	89	0	48652	0	0	0.000	0.000		2006	1579548	0		
2007	94	0	67645	0	0	0.000	0.000		2007	495758	0		
2008	5	0	2325	0	0	0.000	0.000		2008	258546	0		
2009	9	0	3305	0	0	0.000	0.000		2009	290442	0		
2010	13	0	5467	0	0	0.000	0.000		2010	230152	0		
2011	13	0	5035	0	0	0.000	0.000		2011	209477	0		
2012	97	0	11119	0	0	0.000	0.000		2012	193178	0		
2013	20	0	1996	0	0	0.000	0.000		2013	231876	0		
2014	22	0	6354	0	0	0.000	0.000		2014	329424	0		
2015	17	0	3652	0	0	0.000	0.000		2015	300820	0		
2016	38	0	9910	0	0	0.000	0.000		2016	187493	0		
2017	48	0	14346	0	0	0.000	0.000		2017	210155	0		
2018	52	4	10888	907	10	0.879	0.496	0.560	2018	196449	173	485	62
2019	39	2	8217	420	2	0.363	0.293	0.810	2019	130975	47	189	12

Table 1b. Yearly calculated dead discards of great hammerhead sharks for the shark bottom longline fishery for the areas combined. Discards are reported as number. Due to small number of observed positive sets, all years of observed data are combined.

Observed Year	Observed Sets	Positive Sets	Observed Hooks	Positive Hooks	Observed Animals	Mean CPUE (Per 1000 Hooks)	Standard Deviation	CV	Logbook Year	Logbook Hooks	Estimated Discards	Upper 95% CI	Lower 95% CI
2005-2019	649	6	249305	1327	12	0.093	0.045	0.490	1993	1101380	102	252	41
2005-2019	649	6	249305	1327	12	0.093	0.045	0.490	1994	1941435	180	444	73
2005-2019	649	6	249305	1327	12	0.093	0.045	0.490	1995	2417653	224	553	91
2005-2019	649	6	249305	1327	12	0.093	0.045	0.490	1996	3435583	319	787	129
2005-2019	649	6	249305	1327	12	0.093	0.045	0.490	1997	1471463	137	338	56
2005-2019	649	6	249305	1327	12	0.093	0.045	0.490	1998	1579283	147	363	60
2005-2019	649	6	249305	1327	12	0.093	0.045	0.490	1999	1529138	142	350	58
2005-2019	649	6	249305	1327	12	0.093	0.045	0.490	2000	1387950	129	318	52
2005-2019	649	6	249305	1327	12	0.093	0.045	0.490	2001	1358879	126	311	51
2005-2019	649	6	249305	1327	12	0.093	0.045	0.490	2002	1662874	154	380	62
2005-2019	649	6	249305	1327	12	0.093	0.045	0.490	2003	1652615	153	378	62
2005-2019	649	6	249305	1327	12	0.093	0.045	0.490	2004	1227075	114	281	46
2005-2019	649	6	249305	1327	12	0.093	0.045	0.490	2005	1388406	129	318	52
2005-2019	649	6	249305	1327	12	0.093	0.045	0.490	2006	1579548	147	363	60
2005-2019	649	6	249305	1327	12	0.093	0.045	0.490	2007	495758	46	114	19
2005-2019	649	6	249305	1327	12	0.093	0.045	0.490	2008	258546	24	59	10
2005-2019	649	6	249305	1327	12	0.093	0.045	0.490	2009	290442	27	67	11
2005-2019	649	6	249305	1327	12	0.093	0.045	0.490	2010	230152	21	52	9
2005-2019	649	6	249305	1327	12	0.093	0.045	0.490	2011	209477	19	47	8
2005-2019	649	6	249305	1327	12	0.093	0.045	0.490	2012	193178	18	44	7
2005-2019	649	6	249305	1327	12	0.093	0.045	0.490	2013	231876	22	54	9
2005-2019	649	6	249305	1327	12	0.093	0.045	0.490	2014	329424	31	76	13
2005-2019	649	6	249305	1327	12	0.093	0.045	0.490	2015	300820	28	69	11
2005-2019	649	6	249305	1327	12	0.093	0.045	0.490	2016	187493	17	42	7
2005-2019	649	6	249305	1327	12	0.093	0.045	0.490	2017	210155	20	49	8
2005-2019	649	6	249305	1327	12	0.093	0.045	0.490	2018	196449	18	44	7
2005-2019	649	6	249305	1327	12	0.093	0.045	0.490	2019	130975	12	30	5

Table 2. Yearly observed dead discards of great hammerhead sharks from the shark research fishery for the areas combined. Discards are reported as number.

Year	Number Observed Sets	Total Dead Discards
2008	62	3
2009	111	3
2010	185	27
2011	236	37
2012	85	2
2013	93	6
2014	104	1
2015	99	1
2016	81	1
2017	104	2
2018	108	0
2019	100	3

Table 3a. Yearly calculated live discards of great hammerhead sharks for the shark bottom longline fishery for the areas combined. Discards are reported as number.

Observed Year	Observed Sets	Positive Sets	Observed Hooks	Positive Hooks	Observed Animals	Mean CPUE (Per 1000 Hooks)	Standard Deviation	CV	Logbook Year	Logbook Hooks	Estimated Discards	Upper 95% CI	Lower 95% CI
1993									1993	1101380			
1994									1994	1941435			
1995									1995	2417653			
1996									1996	3435583			
1997									1997	1471463			
1998									1998	1579283			
1999									1999	1529138			
2000									2000	1387950			
2001									2001	1358879			
2002									2002	1662874			
2003									2003	1652615			
2004									2004	1227075			
2005	93	0	50394	0	0	0.000	0.000		2005	1388406	0		
2006	89	2	48652	1238	2	0.037	0.027	0.710	2006	1579548	59	207	17
2007	94	0	67645	0	0	0.000	0.000		2007	495758	0		
2008	5	0	2325	0	0	0.000	0.000		2008	258546	0		
2009	9	0	3305	0	0	0.000	0.000		2009	290442	0		
2010	13	0	5467	0	0	0.000	0.000		2010	230152	0		
2011	13	0	5035	0	0	0.000	0.000		2011	209477	0		
2012	97	0	11119	0	0	0.000	0.000		2012	193178	0		
2013	20	1	1996	76	2	1.316	1.316	1.000	2013	231876	305	1559	60
2014	22	0	6354	0	0	0.000	0.000		2014	329424	0		
2015	17	0	3652	0	0	0.000	0.000		2015	300820	0		
2016	38	1	9910	90	1	0.292	0.292	1.000	2016	187493	55	281	11
2017	48	5	14346	1474	7	0.517	0.249	0.480	2017	210155	109	267	44
2018	52	5	10888	1502	7	0.470	0.220	0.470	2018	196449	92	220	39
2019	39	1	8217	228	1	0.112	0.112	1.000	2019	130975	15	77	3

Table 3b. Yearly calculated live discards of great hammerhead sharks for the shark bottom longline fishery for the areas combined. Discards are reported as number. Due to small number of observed positive sets, all years of observed data are combined.

Observed Year	Observed Sets	Positive Sets	Observed Hooks	Positive Hooks	Observed Animals	Mean CPUE (Per 1000 Hooks)	Standard Deviation	CV	Logbook Year	Logbook Hooks	Estimated Discards	Upper 95% CI	Lower 95% CI
2005-2019	649	15	249305	4608	20	0.140	0.046	0.330	1993	1101380	155	289	83
2005-2019	649	15	249305	4608	20	0.140	0.046	0.330	1994	1941435	272	507	146
2005-2019	649	15	249305	4608	20	0.140	0.046	0.330	1995	2417653	339	631	182
2005-2019	649	15	249305	4608	20	0.140	0.046	0.330	1996	3435583	482	898	259
2005-2019	649	15	249305	4608	20	0.140	0.046	0.330	1997	1471463	206	384	111
2005-2019	649	15	249305	4608	20	0.140	0.046	0.330	1998	1579283	222	413	119
2005-2019	649	15	249305	4608	20	0.140	0.046	0.330	1999	1529138	215	400	115
2005-2019	649	15	249305	4608	20	0.140	0.046	0.330	2000	1387950	195	363	105
2005-2019	649	15	249305	4608	20	0.140	0.046	0.330	2001	1358879	191	356	103
2005-2019	649	15	249305	4608	20	0.140	0.046	0.330	2002	1662874	233	434	125
2005-2019	649	15	249305	4608	20	0.140	0.046	0.330	2003	1652615	232	432	125
2005-2019	649	15	249305	4608	20	0.140	0.046	0.330	2004	1227075	172	320	92
2005-2019	649	15	249305	4608	20	0.140	0.046	0.330	2005	1388406	195	363	105
2005-2019	649	15	249305	4608	20	0.140	0.046	0.330	2006	1579548	222	413	119
2005-2019	649	15	249305	4608	20	0.140	0.046	0.330	2007	495758	70	130	38
2005-2019	649	15	249305	4608	20	0.140	0.046	0.330	2008	258546	36	67	19
2005-2019	649	15	249305	4608	20	0.140	0.046	0.330	2009	290442	41	76	22
2005-2019	649	15	249305	4608	20	0.140	0.046	0.330	2010	230152	32	60	17
2005-2019	649	15	249305	4608	20	0.140	0.046	0.330	2011	209477	29	54	16
2005-2019	649	15	249305	4608	20	0.140	0.046	0.330	2012	193178	27	50	14
2005-2019	649	15	249305	4608	20	0.140	0.046	0.330	2013	231876	33	61	18
2005-2019	649	15	249305	4608	20	0.140	0.046	0.330	2014	329424	46	86	25
2005-2019	649	15	249305	4608	20	0.140	0.046	0.330	2015	300820	42	78	23
2005-2019	649	15	249305	4608	20	0.140	0.046	0.330	2016	187493	26	48	14
2005-2019	649	15	249305	4608	20	0.140	0.046	0.330	2017	210155	29	54	16
2005-2019	649	15	249305	4608	20	0.140	0.046	0.330	2018	196449	28	52	15
2005-2019	649	15	249305	4608	20	0.140	0.046	0.330	2019	130975	18	34	10

Table 4. Yearly observed live discards of great hammerhead sharks from the shark research fishery for the areas combined. Discards are reported as number.

Year	Number Observed Sets	Total Live Discards
2008	62	2
2009	111	4
2010	185	0
2011	236	8
2012	85	3
2013	93	15
2014	104	4
2015	99	12
2016	81	5
2017	104	26
2018	108	5
2019	100	14

Table 5a. Yearly calculated dead discards of scalloped hammerhead sharks for the shark bottom longline fishery for the areas combined. Discards are reported as number.

Observed Year	Observed Sets	Positive Sets	Observed Hooks	Positive Hooks	Observed Animals	Mean CPUE (Per 1000 Hooks)	Standard Deviation	CV	Logbook Year	Logbook Hooks	Estimated Discards	Upper 95% CI	Lower 95% CI
1993									1993	1101380			
1994									1994	1941435			
1995									1995	2417653			
1996									1996	3435583			
1997									1997	1471463			
1998									1998	1579283			
1999									1999	1529138			
2000									2000	1387950			
2001									2001	1358879			
2002									2002	1662874			
2003									2003	1652615			
2004									2004	1227075			
2005	93	0	50394	0	0	0.000	0.000		2005	1388406	0		
2006	89	1	48652	267	1	0.042	0.042	1.000	2006	1579548	66	337	13
2007	94	1	67645	320	1	0.033	0.033	1.000	2007	495758	16	82	3
2008	5	0	2325	0	0	0.000	0.000		2008	258546	0		
2009	9	0	3305	0	0	0.000	0.000		2009	290442	0		
2010	13	4	5467	1650	6	1.142	0.577	0.510	2010	230152	263	669	103
2011	13	1	5035	671	1	0.115	0.115	1.000	2011	209477	24	123	5
2012	97	1	11119	310	1	0.033	0.033	1.000	2012	193178	6	31	1
2013	20	0	1996	0	0	0.000	0.000		2013	231876	0		
2014	22	2	6354	711	2	0.260	0.181	0.700	2014	329424	86	295	25
2015	17	2	3652	816	12	2.097	1.862	0.890	2015	300820	631	2812	142
2016	38	2	9910	460	2	0.233	0.164	0.700	2016	187493	44	153	13
2017	48	2	14346	662	4	0.252	0.176	0.700	2017	210155	53	183	15
2018	52	8	10888	1270	13	2.339	1.026	0.440	2018	196449	460	1047	202
2019	39	1	8217	66	1	0.389	0.389	1.000	2019	130975	51	261	10

Table 5b. Yearly calculated dead discards of scalloped hammerhead sharks for the shark bottom longline fishery for the areas combined. Discards are reported as number. Due to small number of observed positive sets, all years of observed data are combined.

Observed Year	Observed Sets	Positive Sets	Observed Hooks	Positive Hooks	Observed Animals	Mean CPUE (Per 1000 Hooks)	Standard Deviation	CV	Logbook Year	Logbook Hooks	Estimated Discards	Upper 95% CI	Lower 95% CI
2005-2019	649	25	249305	7203	44	0.328	0.090	0.280	1993	1101380	362	615	213
2005-2019	649	25	249305	7203	44	0.328	0.090	0.280	1994	1941435	637	1083	375
2005-2019	649	25	249305	7203	44	0.328	0.090	0.280	1995	2417653	794	1349	467
2005-2019	649	25	249305	7203	44	0.328	0.090	0.280	1996	3435583	1128	1917	664
2005-2019	649	25	249305	7203	44	0.328	0.090	0.280	1997	1471463	483	821	284
2005-2019	649	25	249305	7203	44	0.328	0.090	0.280	1998	1579283	518	880	305
2005-2019	649	25	249305	7203	44	0.328	0.090	0.280	1999	1529138	502	853	295
2005-2019	649	25	249305	7203	44	0.328	0.090	0.280	2000	1387950	456	775	268
2005-2019	649	25	249305	7203	44	0.328	0.090	0.280	2001	1358879	446	758	262
2005-2019	649	25	249305	7203	44	0.328	0.090	0.280	2002	1662874	546	928	321
2005-2019	649	25	249305	7203	44	0.328	0.090	0.280	2003	1652615	543	923	320
2005-2019	649	25	249305	7203	44	0.328	0.090	0.280	2004	1227075	403	685	237
2005-2019	649	25	249305	7203	44	0.328	0.090	0.280	2005	1388406	456	775	268
2005-2019	649	25	249305	7203	44	0.328	0.090	0.280	2006	1579548	519	882	305
2005-2019	649	25	249305	7203	44	0.328	0.090	0.280	2007	495758	163	277	96
2005-2019	649	25	249305	7203	44	0.328	0.090	0.280	2008	258546	85	144	50
2005-2019	649	25	249305	7203	44	0.328	0.090	0.280	2009	290442	95	161	56
2005-2019	649	25	249305	7203	44	0.328	0.090	0.280	2010	230152	76	129	45
2005-2019	649	25	249305	7203	44	0.328	0.090	0.280	2011	209477	69	117	41
2005-2019	649	25	249305	7203	44	0.328	0.090	0.280	2012	193178	63	107	37
2005-2019	649	25	249305	7203	44	0.328	0.090	0.280	2013	231876	76	129	45
2005-2019	649	25	249305	7203	44	0.328	0.090	0.280	2014	329424	108	184	64
2005-2019	649	25	249305	7203	44	0.328	0.090	0.280	2015	300820	99	168	58
2005-2019	649	25	249305	7203	44	0.328	0.090	0.280	2016	187493	62	105	36
2005-2019	649	25	249305	7203	44	0.328	0.090	0.280	2017	210155	69	117	41
2005-2019	649	25	249305	7203	44	0.328	0.090	0.280	2018	196449	64	109	38
2005-2019	649	25	249305	7203	44	0.328	0.090	0.280	2019	130975	43	73	25

Table 6. Yearly observed dead discards of scalloped hammerhead sharks from the shark research fishery for the areas combined. Discards are reported as number.

Year	Number Observed Sets	Total Dead Discards
2008	62	1
2009	111	41
2010	185	23
2011	236	37
2012	85	6
2013	93	3
2014	104	4
2015	99	4
2016	81	6
2017	104	8
2018	108	4
2019	100	3

Table 7a. Yearly calculated live discards of scalloped hammerhead sharks for the shark bottom longline fishery for the areas combined. Discards are reported as number.

Observed Year	Observed Sets	Positive Sets	Observed Hooks	Positive Hooks	Observed Animals	Mean CPUE (Per 1000 Hooks)	Standard Deviation	CV	Logbook Year	Logbook Hooks	Estimated Discards	Upper 95% CI	Lower 95% CI
1993									1993	1101380			
1994									1994	1941435			
1995									1995	2417653			
1996									1996	3435583			
1997									1997	1471463			
1998									1998	1579283			
1999									1999	1529138			
2000									2000	1387950			
2001									2001	1358879			
2002									2002	1662874			
2003									2003	1652615			
2004									2004	1227075			
2005	93	1	50394	456	2	0.047	0.047	1.000	2005	1388406	65	332	13
2006	89	2	48652	604	2	0.117	0.096	0.820	2006	1579548	185	758	45
2007	94	1	67645	690	1	0.015	0.015	1.000	2007	495758	8	41	2
2008	5	0	2325	0	0	0.000	0.000		2008	258546	0		
2009	9	0	3305	0	0	0.000	0.000		2009	290442	0		
2010	13	0	5467	0	0	0.000	0.000		2010	230152	0		
2011	13	0	5035	0	0	0.000	0.000		2011	209477	0		
2012	97	0	11119	0	0	0.000	0.000		2012	193178	0		
2013	20	1	1996	42	1	1.190	1.190	1.000	2013	231876	276	1411	54
2014	22	0	6354	0	0	0.000	0.000		2014	329424	0		
2015	17	0	3652	0	0	0.000	0.000		2015	300820	0		
2016	38	4	9910	1079	5	0.782	0.496	0.630	2016	187493	147	459	47
2017	48	4	14346	954	7	0.812	0.479	0.590	2017	210155	171	499	59
2018	52	4	10888	1291	21	1.578	1.051	0.670	2018	196449	310	1016	95
2019	39	1	8217	80	1	0.321	0.321	1.000	2019	130975	42	215	8

Table 7b. Yearly calculated live discards of scalloped hammerhead sharks for the shark bottom longline fishery for the areas combined. Discards are reported as number. Due to small number of observed positive sets, all years of observed data are combined.

Observed Year	Observed Sets	Positive Sets	Observed Hooks	Positive Hooks	Observed Animals	Mean CPUE (Per 1000 Hooks)	Standard Deviation	CV	Logbook Year	Logbook Hooks	Estimated Discards	Upper 95% CI	Lower 95% CI
2005-2019	649	18	249305	5196	40	0.315	0.109	0.350	1993	1101380	347	670	180
2005-2019	649	18	249305	5196	40	0.315	0.109	0.350	1994	1941435	611	1179	317
2005-2019	649	18	249305	5196	40	0.315	0.109	0.350	1995	2417653	761	1468	394
2005-2019	649	18	249305	5196	40	0.315	0.109	0.350	1996	3435583	1081	2086	560
2005-2019	649	18	249305	5196	40	0.315	0.109	0.350	1997	1471463	463	893	240
2005-2019	649	18	249305	5196	40	0.315	0.109	0.350	1998	1579283	497	959	258
2005-2019	649	18	249305	5196	40	0.315	0.109	0.350	1999	1529138	481	928	249
2005-2019	649	18	249305	5196	40	0.315	0.109	0.350	2000	1387950	437	843	226
2005-2019	649	18	249305	5196	40	0.315	0.109	0.350	2001	1358879	428	826	222
2005-2019	649	18	249305	5196	40	0.315	0.109	0.350	2002	1662874	523	1009	271
2005-2019	649	18	249305	5196	40	0.315	0.109	0.350	2003	1652615	520	1003	269
2005-2019	649	18	249305	5196	40	0.315	0.109	0.350	2004	1227075	386	745	200
2005-2019	649	18	249305	5196	40	0.315	0.109	0.350	2005	1388406	437	843	226
2005-2019	649	18	249305	5196	40	0.315	0.109	0.350	2006	1579548	497	959	258
2005-2019	649	18	249305	5196	40	0.315	0.109	0.350	2007	495758	156	301	81
2005-2019	649	18	249305	5196	40	0.315	0.109	0.350	2008	258546	81	156	42
2005-2019	649	18	249305	5196	40	0.315	0.109	0.350	2009	290442	91	176	47
2005-2019	649	18	249305	5196	40	0.315	0.109	0.350	2010	230152	72	139	37
2005-2019	649	18	249305	5196	40	0.315	0.109	0.350	2011	209477	66	127	34
2005-2019	649	18	249305	5196	40	0.315	0.109	0.350	2012	193178	61	118	32
2005-2019	649	18	249305	5196	40	0.315	0.109	0.350	2013	231876	73	141	38
2005-2019	649	18	249305	5196	40	0.315	0.109	0.350	2014	329424	104	201	54
2005-2019	649	18	249305	5196	40	0.315	0.109	0.350	2015	300820	95	183	49
2005-2019	649	18	249305	5196	40	0.315	0.109	0.350	2016	187493	59	114	31
2005-2019	649	18	249305	5196	40	0.315	0.109	0.350	2017	210155	66	127	34
2005-2019	649	18	249305	5196	40	0.315	0.109	0.350	2018	196449	62	120	32
2005-2019	649	18	249305	5196	40	0.315	0.109	0.350	2019	130975	41	79	21

Table 8. Yearly observed live discards of scalloped hammerhead sharks from the shark research fishery for the areas combined. Discards are reported as number.

Year	Number Observed Sets	Total Live Discards
2008	62	2
2009	111	16
2010	185	13
2011	236	19
2012	85	5
2013	93	7
2014	104	10
2015	99	13
2016	81	23
2017	104	42
2018	108	14
2019	100	17

Table 9a. Yearly calculated dead discards of scalloped hammerhead sharks for the shark bottom longline fishery for the Atlantic. Discards are reported as number.

Observed Year	Observed Sets	Positive Sets	Observed Hooks	Positive Hooks	Observed Animals	Mean CPUE (Per 1000 Hooks)	Standard Deviation	CV	Logbook Year	Logbook Hooks	Estimated Discards	Upper 95% CI	Lower 95% CI
1993									1993	373270			
1994									1994	767570			
1995									1995	293603			
1996									1996	853758			
1997									1997	393413			
1998									1998	458687			
1999									1999	420234			
2000									2000	398160			
2001									2001	432662			
2002									2002	586165			
2003									2003	586888			
2004									2004	455745			
2005	41	0	25900	0	0	0.000	0.000		2005	386396	0		
2006	36	1	17700	267	1	0.104	0.104	1.000	2006	386212	40	205	8
2007	35	1	18839	320	1	0.089	0.089	1.000	2007	207548	19	97	4
2008	5	0	2325	0	0	0.000	0.000		2008	112946	0		
2009	2	0	429	0	0	0.000	0.000		2009	252278	0		
2010	2	1	900	300	1	1.667	1.667	1.000	2010	209491	349	1784	68
2011	12	1	4293	671	1	0.124	0.124	1.000	2011	150252	19	97	4
2012	31	1	4748	310	1	0.104	0.104	1.000	2012	88786	9	46	2
2013	20	0	1996	0	0	0.000	0.000		2013	126843	0		
2014	22	2	6354	711	2	0.260	0.181	0.700	2014	173177	45	154	13
2015	8	2	2729	816	12	4.456	3.916	0.880	2015	155914	695	3061	158
2016	14	1	2153	260	1	0.275	0.275	1.000	2016	92890	26	133	5
2017	13	0	5432	0	0	0.000	0.000		2017	97453	0		
2018									2018	72317			
2019	10	1	809	66	1	1.515	1.515	1.000	2019	22476	34	174	7

Table 9b. Yearly calculated dead discards of scalloped hammerhead sharks for the shark bottom longline fishery for the Atlantic. Discards are reported as number. Due to small number of observed positive sets, all years of observed data are combined.

Observed Year	Observed Sets	Positive Sets	Observed Hooks	Positive Hooks	Observed Animals	Mean CPUE (Per 1000 Hooks)	Standard Deviation	CV	Logbook Year	Logbook Hooks	Estimated Discards	Upper 95% CI	Lower 95% CI
2005-2019	251	11	94607	3721	21	0.265	0.104	0.39	1993	373270	99	208	47
2005-2019	251	11	94607	3721	21	0.265	0.104	0.39	1994	767570	204	429	97
2005-2019	251	11	94607	3721	21	0.265	0.104	0.39	1995	293603	78	164	37
2005-2019	251	11	94607	3721	21	0.265	0.104	0.39	1996	853758	226	475	108
2005-2019	251	11	94607	3721	21	0.265	0.104	0.39	1997	393413	104	219	49
2005-2019	251	11	94607	3721	21	0.265	0.104	0.39	1998	458687	122	256	58
2005-2019	251	11	94607	3721	21	0.265	0.104	0.39	1999	420234	111	233	53
2005-2019	251	11	94607	3721	21	0.265	0.104	0.39	2000	398160	106	223	50
2005-2019	251	11	94607	3721	21	0.265	0.104	0.39	2001	432662	115	242	55
2005-2019	251	11	94607	3721	21	0.265	0.104	0.39	2002	586165	155	326	74
2005-2019	251	11	94607	3721	21	0.265	0.104	0.39	2003	586888	156	328	74
2005-2019	251	11	94607	3721	21	0.265	0.104	0.39	2004	455745	121	254	58
2005-2019	251	11	94607	3721	21	0.265	0.104	0.39	2005	386396	103	217	49
2005-2019	251	11	94607	3721	21	0.265	0.104	0.39	2006	386212	102	214	49
2005-2019	251	11	94607	3721	21	0.265	0.104	0.39	2007	207548	55	116	26
2005-2019	251	11	94607	3721	21	0.265	0.104	0.39	2008	112946	30	63	14
2005-2019	251	11	94607	3721	21	0.265	0.104	0.39	2009	252278	67	141	32
2005-2019	251	11	94607	3721	21	0.265	0.104	0.39	2010	209491	56	118	27
2005-2019	251	11	94607	3721	21	0.265	0.104	0.39	2011	150252	40	84	19
2005-2019	251	11	94607	3721	21	0.265	0.104	0.39	2012	88786	24	50	11
2005-2019	251	11	94607	3721	21	0.265	0.104	0.39	2013	126843	34	71	16
2005-2019	251	11	94607	3721	21	0.265	0.104	0.39	2014	173177	46	97	22
2005-2019	251	11	94607	3721	21	0.265	0.104	0.39	2015	155914	41	86	20
2005-2019	251	11	94607	3721	21	0.265	0.104	0.39	2016	92890	25	53	12
2005-2019	251	11	94607	3721	21	0.265	0.104	0.39	2017	97453	26	55	12
2005-2019	251	11	94607	3721	21	0.265	0.104	0.39	2018	72317	19	40	9
2005-2019	251	11	94607	3721	21	0.265	0.104	0.39	2019	22476	6	13	3

Table 10. Yearly observed dead discards of scalloped hammerhead sharks from the shark research fishery for the Atlantic. Discards are reported as number.

Year	Number Observed Sets	Total Dead Discards
2008	21	0
2009	40	0
2010	127	10
2011	141	17
2012	58	3
2013	47	1
2014	88	2
2015	60	2
2016	52	1
2017	49	1
2018	57	4
2019	51	0

Table 11a. Yearly calculated live discards of scalloped hammerhead sharks for the shark bottom longline fishery for the Atlantic. Discards are reported as number.

Observed Year	Observed Sets	Positive Sets	Observed Hooks	Positive Hooks	Observed Animals	Mean CPUE (Per 1000 Hooks)	Standard Deviation	CV	Logbook Year	Logbook Hooks	Estimated Discards	Upper 95% CI	Lower 95% CI
1993									1993	373270			
1994									1994	767570			
1995									1995	293603			
1996									1996	853758			
1997									1997	393413			
1998									1998	458687			
1999									1999	420234			
2000									2000	398160			
2001									2001	432662			
2002									2002	586165			
2003									2003	586888			
2004									2004	455745			
2005	41	1	25900	456	2	0.107	0.107	1.000	2005	386396	41	210	8
2006	36	1	17700	120	1	0.231	0.231	1.000	2006	386212	89	455	17
2007	35	1	18839	690	1	0.041	0.041	1.000	2007	207548	9	46	2
2008	5	0	2325	0	0	0.000	0.000		2008	112946	0		
2009	2	0	429	0	0	0.000	0.000		2009	252278	0		
2010	2	0	900	0	0	0.000	0.000		2010	209491	0		
2011	12	0	4293	0	0	0.000	0.000		2011	150252	0		
2012	31	0	4748	0	0	0.000	0.000		2012	88786	0		
2013	20	1	1996	42	1	1.190	1.190	1.000	2013	126843	151	772	30
2014	22	0	6354	0	0	0.000	0.000		2014	173177	0		
2015	8	0	2729	0	0	0.000	0.000		2015	155914	0		
2016	14	3	2153	875	4	1.791	1.327	0.740	2016	92890	166	607	45
2017	13	0	5432	0	0	0.000	0.000		2017	97453	0		
2018									2018	72317			
2019	10	1	809	80	1	1.250	1.250	1.000	2019	22476	28	143	5

Table 11b. Yearly calculated live discards of scalloped hammerhead sharks for the shark bottom longline fishery for the Atlantic. Discards are reported as number. Due to small number of observed positive sets, all years of observed data are combined.

Observed Year	Observed Sets	Positive Sets	Observed Hooks	Positive Hooks	Observed Animals	Mean CPUE (Per 1000 Hooks)	Standard Deviation	CV	Logbook Year	Logbook Hooks	Estimated Discards	Upper 95% CI	Lower 95% CI
2005-2019	251	8	94607	2263	10	0.316	0.158	0.500	1993	373270	118	298	47
2005-2019	251	8	94607	2263	10	0.316	0.158	0.500	1994	767570	243	613	96
2005-2019	251	8	94607	2263	10	0.316	0.158	0.500	1995	293603	93	235	37
2005-2019	251	8	94607	2263	10	0.316	0.158	0.500	1996	853758	270	681	107
2005-2019	251	8	94607	2263	10	0.316	0.158	0.500	1997	393413	124	313	49
2005-2019	251	8	94607	2263	10	0.316	0.158	0.500	1998	458687	145	366	57
2005-2019	251	8	94607	2263	10	0.316	0.158	0.500	1999	420234	133	335	53
2005-2019	251	8	94607	2263	10	0.316	0.158	0.500	2000	398160	126	318	50
2005-2019	251	8	94607	2263	10	0.316	0.158	0.500	2001	432662	137	346	54
2005-2019	251	8	94607	2263	10	0.316	0.158	0.500	2002	586165	185	467	73
2005-2019	251	8	94607	2263	10	0.316	0.158	0.500	2003	586888	186	469	74
2005-2019	251	8	94607	2263	10	0.316	0.158	0.500	2004	455745	144	363	57
2005-2019	251	8	94607	2263	10	0.316	0.158	0.500	2005	386396	122	308	48
2005-2019	251	8	94607	2263	10	0.316	0.158	0.500	2006	386212	122	308	48
2005-2019	251	8	94607	2263	10	0.316	0.158	0.500	2007	207548	66	166	26
2005-2019	251	8	94607	2263	10	0.316	0.158	0.500	2008	112946	36	91	14
2005-2019	251	8	94607	2263	10	0.316	0.158	0.500	2009	252278	80	202	32
2005-2019	251	8	94607	2263	10	0.316	0.158	0.500	2010	209491	66	166	26
2005-2019	251	8	94607	2263	10	0.316	0.158	0.500	2011	150252	48	121	19
2005-2019	251	8	94607	2263	10	0.316	0.158	0.500	2012	88786	28	71	11
2005-2019	251	8	94607	2263	10	0.316	0.158	0.500	2013	126843	40	101	16
2005-2019	251	8	94607	2263	10	0.316	0.158	0.500	2014	173177	55	139	22
2005-2019	251	8	94607	2263	10	0.316	0.158	0.500	2015	155914	49	124	19
2005-2019	251	8	94607	2263	10	0.316	0.158	0.500	2016	92890	29	73	11
2005-2019	251	8	94607	2263	10	0.316	0.158	0.500	2017	97453	31	78	12
2005-2019	251	8	94607	2263	10	0.316	0.158	0.500	2018	72317	23	58	9
2005-2019	251	8	94607	2263	10	0.316	0.158	0.500	2019	22476	7	18	3

Table 12. Yearly observed live discards of scalloped hammerhead sharks from the shark research fishery for the Atlantic. Discards are reported as number.

Year	Number Observed Sets	Total Live Discards
2008	21	0
2009	40	0
2010	127	9
2011	141	4
2012	58	0
2013	47	7
2014	88	7
2015	60	6
2016	52	17
2017	49	19
2018	57	9
2019	51	1

Table 13a. Yearly calculated dead discards of scalloped hammerhead sharks for the shark bottom longline fishery for the Gulf of Mexico. Discards are reported as number.

Observed Year	Observed Sets	Positive Sets	Observed Hooks	Positive Hooks	Observed Animals	Mean CPUE (Per 1000 Hooks)	Standard Deviation	CV	Logbook Year	Logbook Hooks	Estimated Discards	Upper 95% CI	Lower 95% CI
1993									1993	728110			
1994									1994	1173865			
1995									1995	2124050			
1996									1996	2581825			
1997									1997	1078050			
1998									1998	1120596			
1999									1999	1108904			
2000									2000	989790			
2001									2001	926217			
2002									2002	1076709			
2003									2003	1065727			
2004									2004	771330			
2005	52	0	24494	0	0	0.000	0.000		2005	1002010	0		
2006	53	0	30952	0	0	0.000	0.000		2006	1193336	0		
2007	59	0	48806	0	0	0.000	0.000		2007	288210	0		
2008									2008	137903			
2009	7	0	2876	0	0	0.000	0.000		2009	29846	0		
2010	11	3	4567	1350	5	1.047	0.645	0.620	2010	24177	25	76	8
2011	1	0	742	0	0	0.000	0.000		2011	26370	0		
2012	66	0	6371	0	0	0.000	0.000		2012	95264	0		
2013									2013	95401			
2014									2014	135732			
2015	9	0	923	0	0	0.000	0.000		2015	130594	0		
2016	24	1	7757	200	1	0.208	0.208	1.000	2016	82828	17	87	3
2017	35	2	8914	662	4	0.346	0.241	0.700	2017	100869	35	120	10
2018	52	8	10888	1270	13	2.339	1.026	0.440	2018	111142	260	592	114
2019	29	0	7408	0	0	0.000	0.000		2019	96685	0		

Table 13b. Yearly calculated dead discards of scalloped hammerhead sharks for the shark bottom longline fishery for the Gulf of Mexico. Discards are reported as number. Due to small number of observed positive sets, all years of observed data are combined.

Observed Year	Observed Sets	Positive Sets	Observed Hooks	Positive Hooks	Observed Animals	Mean CPUE (Per 1000 Hooks)	Standard Deviation	CV	Logbook Year	Logbook Hooks	Estimated Discards	Upper 95% CI	Lower 95% CI
2005-2019	398	14	154698	3482	23	0.367	0.131	0.360	1993	728110	267	525	136
2005-2019	398	14	154698	3482	23	0.367	0.131	0.360	1994	1173865	431	848	219
2005-2019	398	14	154698	3482	23	0.367	0.131	0.360	1995	2124050	780	1534	397
2005-2019	398	14	154698	3482	23	0.367	0.131	0.360	1996	2581825	948	1864	482
2005-2019	398	14	154698	3482	23	0.367	0.131	0.360	1997	1078050	396	779	201
2005-2019	398	14	154698	3482	23	0.367	0.131	0.360	1998	1120596	411	808	209
2005-2019	398	14	154698	3482	23	0.367	0.131	0.360	1999	1108904	407	800	207
2005-2019	398	14	154698	3482	23	0.367	0.131	0.360	2000	989790	363	714	185
2005-2019	398	14	154698	3482	23	0.367	0.131	0.360	2001	926217	340	669	173
2005-2019	398	14	154698	3482	23	0.367	0.131	0.360	2002	1076709	395	777	201
2005-2019	398	14	154698	3482	23	0.367	0.131	0.360	2003	1065727	391	769	199
2005-2019	398	14	154698	3482	23	0.367	0.131	0.360	2004	771330	283	557	144
2005-2019	398	14	154698	3482	23	0.367	0.131	0.360	2005	1002010	368	724	187
2005-2019	398	14	154698	3482	23	0.367	0.131	0.360	2006	1193336	438	861	223
2005-2019	398	14	154698	3482	23	0.367	0.131	0.360	2007	288210	106	208	54
2005-2019	398	14	154698	3482	23	0.367	0.131	0.360	2008	137903	51	100	26
2005-2019	398	14	154698	3482	23	0.367	0.131	0.360	2009	29846	11	22	6
2005-2019	398	14	154698	3482	23	0.367	0.131	0.360	2010	24177	9	18	5
2005-2019	398	14	154698	3482	23	0.367	0.131	0.360	2011	26370	10	20	5
2005-2019	398	14	154698	3482	23	0.367	0.131	0.360	2012	95264	35	69	18
2005-2019	398	14	154698	3482	23	0.367	0.131	0.360	2013	95401	35	69	18
2005-2019	398	14	154698	3482	23	0.367	0.131	0.360	2014	135732	50	98	25
2005-2019	398	14	154698	3482	23	0.367	0.131	0.360	2015	130594	48	94	24
2005-2019	398	14	154698	3482	23	0.367	0.131	0.360	2016	82828	30	59	15
2005-2019	398	14	154698	3482	23	0.367	0.131	0.360	2017	100869	37	73	19
2005-2019	398	14	154698	3482	23	0.367	0.131	0.360	2018	111142	41	81	21
2005-2019	398	14	154698	3482	23	0.367	0.131	0.360	2019	96685	35	69	18

Table 14. Yearly observed dead discards of scalloped hammerhead sharks from the shark research fishery for the Gulf of Mexico. Discards are reported as number.

Year	Number Observed Sets	Total Dead Discards
2008	41	1
2009	71	41
2010	58	13
2011	95	20
2012	27	3
2013	46	2
2014	16	2
2015	39	2
2016	29	5
2017	55	7
2018	49	0
2019	49	3

Table 15a. Yearly calculated live discards of scalloped hammerhead sharks for the shark bottom longline fishery for the Gulf of Mexico. Discards are reported as number.

Observed Year	Observed Sets	Positive Sets	Observed Hooks	Positive Hooks	Observed Animals	Mean CPUE (Per 1000 Hooks)	Standard Deviation	CV	Logbook Year	Logbook Hooks	Estimated Discards	Upper 95% CI	Lower 95% CI
1993									1993	728110			
1994									1994	1173865			
1995									1995	2124050			
1996									1996	2581825			
1997									1997	1078050			
1998									1998	1120596			
1999									1999	1108904			
2000									2000	989790			
2001									2001	926217			
2002									2002	1076709			
2003									2003	1065727			
2004									2004	771330			
2005	52	0	24494	0	0	0.000	0.000		2005	1002010	0		
2006	53	1	30952	484	1	0.039	0.039	1.000	2006	1193336	47	240	9
2007	59	0	48806	0	0	0.000	0.000		2007	288210	0		
2008									2008	137903			
2009	7	0	2876	0	0	0.000	0.000		2009	29846	0		
2010	11	0	4567	0	0	0.000	0.000		2010	24177	0		
2011	1	0	742	0	0	0.000	0.000		2011	26370	0		
2012	66	0	6371	0	0	0.000	0.000		2012	95264	0		
2013									2013	95401			
2014									2014	135732			
2015	9	0	923	0	0	0.000	0.000		2015	130594	0		
2016	24	1	7757	204	1	0.204	0.204	1.000	2016	82828	17	87	3
2017	35	4	8914	954	7	1.114	0.652	0.580	2017	100869	112	324	39
2018	52	4	10888	1291	21	1.578	1.051	0.670	2018	111142	175	574	53
2019	29	0	7408	0	0	0.000	0.000		2019	96685	0		

Table 15b. Yearly calculated live discards of scalloped hammerhead sharks for the shark bottom longline fishery for the Gulf of Mexico. Discards are reported as number. Due to small number of observed positive sets, all years of observed data are combined.

Observed Year	Observed Sets	Positive Sets	Observed Hooks	Positive Hooks	Observed Animals	Mean CPUE (Per 1000 Hooks)	Standard Deviation	CV	Logbook Year	Logbook Hooks	Estimated Discards	Upper 95% CI	Lower 95% CI
2005-2019	398	10	154698	2933	30	0.308	0.137	0.440	1993	728110	224	514	98
2005-2019	398	10	154698	2933	30	0.308	0.137	0.440	1994	1173865	362	830	158
2005-2019	398	10	154698	2933	30	0.308	0.137	0.440	1995	2124050	655	1502	286
2005-2019	398	10	154698	2933	30	0.308	0.137	0.440	1996	2581825	796	1825	347
2005-2019	398	10	154698	2933	30	0.308	0.137	0.440	1997	1078050	332	761	145
2005-2019	398	10	154698	2933	30	0.308	0.137	0.440	1998	1120596	345	791	150
2005-2019	398	10	154698	2933	30	0.308	0.137	0.440	1999	1108904	342	784	149
2005-2019	398	10	154698	2933	30	0.308	0.137	0.440	2000	989790	305	699	133
2005-2019	398	10	154698	2933	30	0.308	0.137	0.440	2001	926217	285	653	124
2005-2019	398	10	154698	2933	30	0.308	0.137	0.440	2002	1076709	332	761	145
2005-2019	398	10	154698	2933	30	0.308	0.137	0.440	2003	1065727	328	752	143
2005-2019	398	10	154698	2933	30	0.308	0.137	0.440	2004	771330	238	546	104
2005-2019	398	10	154698	2933	30	0.308	0.137	0.440	2005	1002010	309	708	135
2005-2019	398	10	154698	2933	30	0.308	0.137	0.440	2006	1193336	368	844	161
2005-2019	398	10	154698	2933	30	0.308	0.137	0.440	2007	288210	89	204	39
2005-2019	398	10	154698	2933	30	0.308	0.137	0.440	2008	137903	42	96	18
2005-2019	398	10	154698	2933	30	0.308	0.137	0.440	2009	29846	9	21	4
2005-2019	398	10	154698	2933	30	0.308	0.137	0.440	2010	24177	7	16	3
2005-2019	398	10	154698	2933	30	0.308	0.137	0.440	2011	26370	8	18	3
2005-2019	398	10	154698	2933	30	0.308	0.137	0.440	2012	95264	29	66	13
2005-2019	398	10	154698	2933	30	0.308	0.137	0.440	2013	95401	29	66	13
2005-2019	398	10	154698	2933	30	0.308	0.137	0.440	2014	135732	42	96	18
2005-2019	398	10	154698	2933	30	0.308	0.137	0.440	2015	130594	40	92	17
2005-2019	398	10	154698	2933	30	0.308	0.137	0.440	2016	82828	26	60	11
2005-2019	398	10	154698	2933	30	0.308	0.137	0.440	2017	100869	31	71	14
2005-2019	398	10	154698	2933	30	0.308	0.137	0.440	2018	111142	34	78	15
2005-2019	398	10	154698	2933	30	0.308	0.137	0.440	2019	96685	30	69	13

Table 16. Yearly observed live discards of scalloped hammerhead sharks from the shark research fishery for the Gulf of Mexico. Discards are reported as number.

Year	Number Observed Sets	Total Live Discards
2008	41	2
2009	71	16
2010	58	4
2011	95	15
2012	27	5
2013	46	0
2014	16	3
2015	39	7
2016	29	6
2017	55	23
2018	49	5
2019	49	16

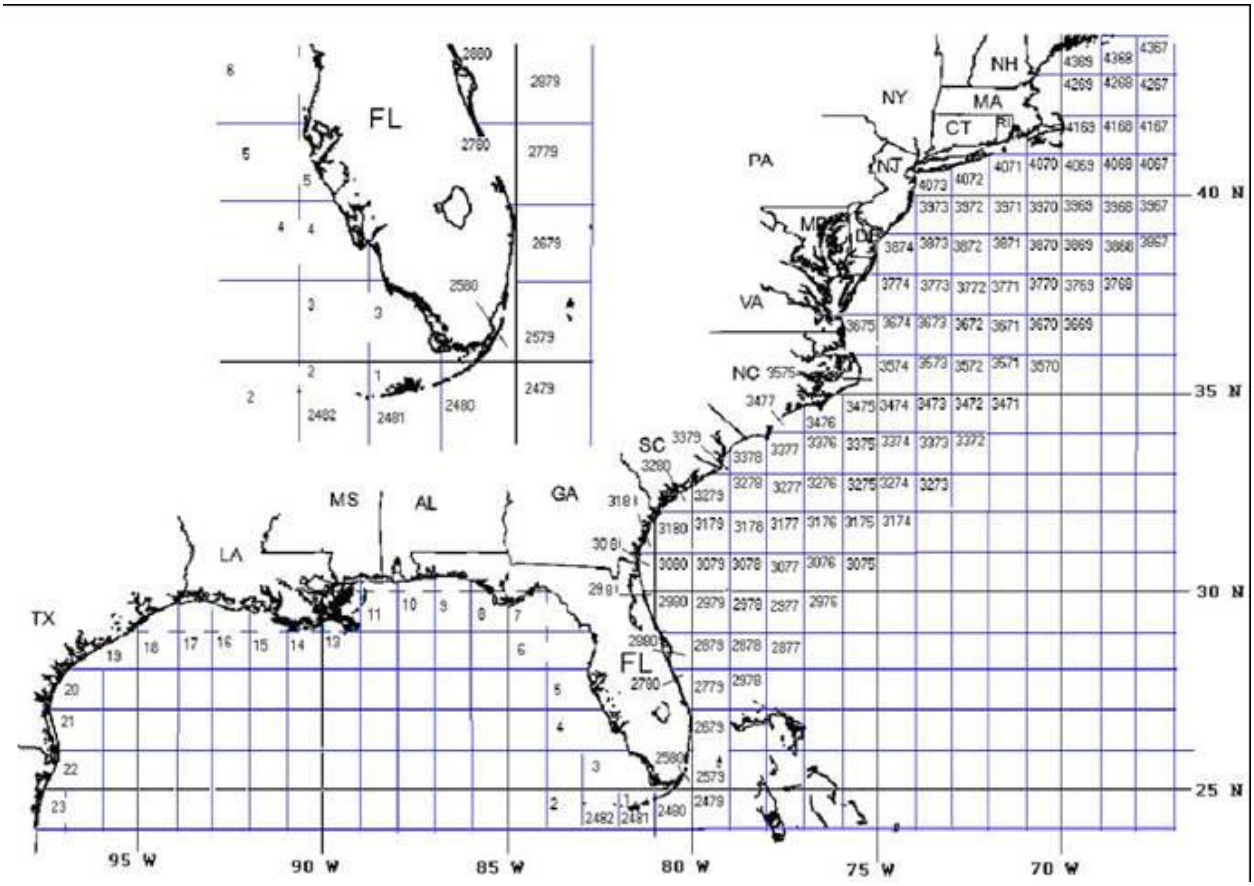

Figure 1. Coastal logbook statistical areas.