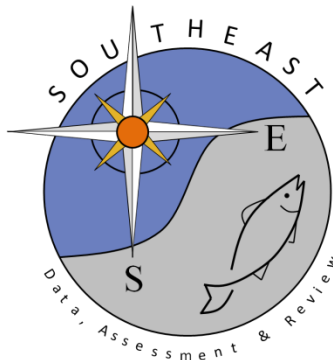# Bycatch estimates of scalloped and great hammerhead shark in the shark bottom longline fishery

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

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**Introduction**
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 hammerhead 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, etc.) and effort (e.g. number of hooks, gear characteristics, set and haul times).

**Methods**
Estimates of 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 discards were needed.

For vessels outside the shark research fishery (i.e. shark bottom longline fishery), observer-reported hammerhead shark discard rates from 2006-2018, 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 all areas. 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 hooks fished

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.

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.

Total discards were calculated as the product of observer reported yearly mean dead and live discard rates by hook and the yearly total fishing effort (bottom longline hooks) reported to the coastal logbook program. As the logbook data does not differentiate vessels in the research fishery, total fishing effort from 2008-2018 was estimated by subtracting the effort observed (100%) in the research fishery from the effort estimated in the logbooks.

To calculate discards for the years 1993-2005, when the Panama City observer program made no observer trips, the mean discard rate was used. In a year where no observations were made outside the shark research fishery or sample size was low (e.g., n≤5), the mean discard rate from 2006-2019 was used.

**Results and Discussion**
Calculated hammerhead shark dead and live discards (in numbers of sharks) from commercial shark bottom longline fishery and the shark research fishery are provided in Table 1- 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).

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

| Year | Number Observed Sets | Mean Discard Rate | Standard deviation | Total hooks | Total Dead Discards |
|------|------|------|------|------|------|
| 1993 |      | 0.00009 | 0.0002 | 1101380 | 96 |
| 1994 |      | 0.00009 | 0.0002 | 1941435 | 169 |
| 1995 |      | 0.00009 | 0.0002 | 2417653 | 211 |
| 1996 |      | 0.00009 | 0.0002 | 3435583 | 299 |
| 1997 |      | 0.00009 | 0.0002 | 1471463 | 128 |
| 1998 |      | 0.00009 | 0.0002 | 1579283 | 138 |
| 1999 |      | 0.00009 | 0.0002 | 1529138 | 133 |
| 2000 |      | 0.00009 | 0.0002 | 1387950 | 121 |
| 2001 |      | 0.00009 | 0.0002 | 1358879 | 118 |
| 2002 |      | 0.00009 | 0.0002 | 1662874 | 145 |
| 2003 |      | 0.00009 | 0.0002 | 1652615 | 144 |
| 2004 |      | 0.00009 | 0.0002 | 1227075 | 107 |
| 2005 | 93 | 0 | 0.0000 | 1388406 | 0 |
| 2006 | 89 | 0 | 0.0000 | 1579548 | 0 |
| 2007 | 94 | 0 | 0.0000 | 495758 | 0 |
| 2008 | 5 | 0 | 0.0000 | 258546 | 0 |
| 2009 | 9 | 0 | 0.0000 | 290442 | 0 |
| 2010 | 13 | 0 | 0.0000 | 230152 | 0 |
| 2011 | 13 | 0 | 0.0000 | 209477 | 0 |
| 2012 | 97 | 0 | 0.0000 | 193178 | 0 |
| 2013 | 20 | 0 | 0.0000 | 231876 | 0 |
| 2014 | 22 | 0 | 0.0000 | 329424 | 0 |
| 2015 | 17 | 0 | 0.0000 | 300820 | 0 |
| 2016 | 38 | 0 | 0.0000 | 187493 | 0 |
| 2017 | 48 | 0 | 0.0000 | 210155 | 0 |
| 2018 | 52 | 0.000856788 | 0.0033 | 196449 | 168 |
| 2019 | 39 | 0.0003626 | 0.0018 | 130975 | 47 |

Table 2.  Yearly observed dead discards of great hammerhead sharks from shark research fishery.  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 3.  Yearly calculated live discards of great hammerhead sharks for the shark bottom longline fishery.   Discards are reported as number.

| Year | Number Observed Sets | Mean Discard Rate | Standard deviation | Total hooks | Total Live Discards |
|------|------|------|------|------|------|
| 1993 |  | 0.00020 | 0.00037 | 373270 | 73 |
| 1994 |  | 0.00020 | 0.00037 | 767570 | 151 |
| 1995 |  | 0.00020 | 0.00037 | 293603 | 58 |
| 1996 |  | 0.00020 | 0.00037 | 853758 | 168 |
| 1997 |  | 0.00020 | 0.00037 | 393413 | 77 |
| 1998 |  | 0.00020 | 0.00037 | 458687 | 90 |
| 1999 |  | 0.00020 | 0.00037 | 420234 | 82 |
| 2000 |  | 0.00020 | 0.00037 | 398160 | 78 |
| 2001 |  | 0.00020 | 0.00037 | 432662 | 85 |
| 2002 |  | 0.00020 | 0.00037 | 583965 | 115 |
| 2003 |  | 0.00020 | 0.00037 | 586888 | 115 |
| 2004 |  | 0.00020 | 0.00037 | 455745 | 89 |
| 2005 | 93 | 0 | 0 | 386396 | 0 |
| 2006 | 89 | 3.76799E-05 | 0.000251731 | 386212 | 15 |
| 2007 | 94 | 0 | 0 | 207548 | 0 |
| 2008 | 5 | 0 | 0 | 112946 | 0 |
| 2009 | 9 | 0 | 0 | 252278 | 0 |
| 2010 | 13 | 0 | 0 | 209491 | 0 |
| 2011 | 13 | 0 | 0 | 150252 | 0 |
| 2012 | 97 | 0 | 0 | 88786 | 0 |
| 2013 | 20 | 0.00131579 | 0.005884389 | 126843 | 167 |
| 2014 | 22 | 0 | 0 | 173177 | 0 |
| 2015 | 17 | 0 | 0 | 155914 | 0 |
| 2016 | 38 | 0.000292398 | 0.00180246 | 92890 | 27 |
| 2017 | 48 | 0.000521695 | 0.001777477 | 97453 | 51 |
| 2018 | 52 | 0.000468004 | 0.001555691 | 71537 | 33 |
| 2019 | 39 | 0.000112461 | 0.000702317 | 71538 | 8 |

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

| Year | Number Observed Sets | Total Dead 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 5.  Yearly calculated dead discards of scalloped hammerhead sharks for the shark bottom longline fishery for all areas.   Discards are reported as number.

| Year | Number Observed Sets | Mean Discard Rate | Standard deviation | Total hooks | Total Dead Discards |
|------|------|------|------|------|------|
| 1993 |  | 0.0005 | 0.0008 | 1101380 | 555 |
| 1994 |  | 0.0005 | 0.0008 | 1941435 | 978 |
| 1995 |  | 0.0005 | 0.0008 | 2417653 | 1,218 |
| 1996 |  | 0.0005 | 0.0008 | 3435583 | 1,730 |
| 1997 |  | 0.0005 | 0.0008 | 1471463 | 741 |
| 1998 |  | 0.0005 | 0.0008 | 1579283 | 795 |
| 1999 |  | 0.0005 | 0.0008 | 1529138 | 770 |
| 2000 |  | 0.0005 | 0.0008 | 1387950 | 699 |
| 2001 |  | 0.0005 | 0.0008 | 1358879 | 684 |
| 2002 |  | 0.0005 | 0.0008 | 1662874 | 837 |
| 2003 |  | 0.0005 | 0.0008 | 1652615 | 832 |
| 2004 |  | 0.0005 | 0.0008 | 1227075 | 618 |
| 2005 | 93 | 0.0000 | 0.0000 | 1388406 | 0 |
| 2006 | 89 | 0.0000 | 0.0004 | 1579548 | 67 |
| 2007 | 94 | 0.0000 | 0.0003 | 495758 | 16 |
| 2008 | 5 | 0.0000 | 0.0000 | 258546 | 0 |
| 2009 | 9 | 0.0000 | 0.0000 | 290442 | 0 |
| 2010 | 13 | 0.0012 | 0.0022 | 230152 | 266 |
| 2011 | 13 | 0.0001 | 0.0004 | 209477 | 24 |
| 2012 | 97 | 0.0000 | 0.0003 | 193178 | 7 |
| 2013 | 20 | 0.0000 | 0.0000 | 231876 | 0 |
| 2014 | 22 | 0.0003 | 0.0008 | 329424 | 86 |
| 2015 | 17 | 0.0021 | 0.0077 | 300820 | 631 |
| 2016 | 38 | 0.0002 | 0.0010 | 187493 | 44 |
| 2017 | 48 | 0.0003 | 0.0012 | 210155 | 53 |
| 2018 | 52 | 0.0024 | 0.0082 | 196449 | 479 |
| 2019 | 39 | 0.0004 | 0.0024 | 130975 | 51 |

Table 6. Yearly observed dead discards of scalloped hammerhead sharks from shark research fishery from all areas. 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 7. Yearly calculated live discards of scalloped hammerhead sharks for the shark bottom longline fishery from all areas. Discards are reported as number.

| Year | Number Observed Sets | Mean Discard Rate | Standard deviation | Total hooks | Total Live Discards |
|---|---|---|---|---|---|
| 1993 | | 0.0003 | 0.0005 | 1101380 | 366 |
| 1994 | | 0.0003 | 0.0005 | 1941435 | 645 |
| 1995 | | 0.0003 | 0.0005 | 2417653 | 803 |
| 1996 | | 0.0003 | 0.0005 | 3435583 | 1,141 |
| 1997 | | 0.0003 | 0.0005 | 1471463 | 489 |
| 1998 | | 0.0003 | 0.0005 | 1579283 | 525 |
| 1999 | | 0.0003 | 0.0005 | 1529138 | 508 |
| 2000 | | 0.0003 | 0.0005 | 1387950 | 461 |
| 2001 | | 0.0003 | 0.0005 | 1358879 | 451 |
| 2002 | | 0.0003 | 0.0005 | 1662874 | 552 |
| 2003 | | 0.0003 | 0.0005 | 1652615 | 549 |
| 2004 | | 0.0003 | 0.0005 | 1227075 | 408 |
| 2005 | 93 | 0.0000 | 0.0005 | 1388406 | 65 |
| 2006 | 89 | 0.0001 | 0.0009 | 1579548 | 187 |
| 2007 | 94 | 0.0000 | 0.0001 | 495758 | 8 |
| 2008 | 5 | 0.0000 | 0.0000 | 258546 | 0 |
| 2009 | 9 | 0.0000 | 0.0000 | 290442 | 0 |
| 2010 | 13 | 0.0000 | 0.0000 | 230152 | 0 |
| 2011 | 13 | 0.0000 | 0.0000 | 209477 | 0 |
| 2012 | 97 | 0.0000 | 0.0000 | 193178 | 0 |
| 2013 | 20 | 0.0012 | 0.0053 | 231876 | 276 |
| 2014 | 22 | 0.0000 | 0.0000 | 329424 | 0 |
| 2015 | 17 | 0.0000 | 0.0000 | 300820 | 0 |
| 2016 | 38 | 0.0008 | 0.0037 | 187493 | 159 |
| 2017 | 48 | 0.0008 | 0.0029 | 210155 | 163 |
| 2018 | 52 | 0.0014 | 0.0055 | 196449 | 272 |
| 2019 | 39 | 0.0003 | 0.0020 | 130975 | 42 |

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

| Year | Number Observed Sets | Total Dead 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 9.  Yearly calculated dead discards of scalloped hammerhead sharks for the shark bottom longline fishery the Atlantic.   Discards are reported as number.

| Year | Number Observed Sets | Mean Discard Rate | Standard deviation | Total hooks | Total Dead Discards |
|---|---|---|---|---|---|
| 1993 | | 0.0007 | 0.0013 | 373270 | 248 |
| 1994 | | 0.0007 | 0.0013 | 767570 | 510 |
| 1995 | | 0.0007 | 0.0013 | 293603 | 195 |
| 1996 | | 0.0007 | 0.0013 | 853758 | 568 |
| 1997 | | 0.0007 | 0.0013 | 393413 | 262 |
| 1998 | | 0.0007 | 0.0013 | 458687 | 305 |
| 1999 | | 0.0007 | 0.0013 | 420234 | 279 |
| 2000 | | 0.0007 | 0.0013 | 398160 | 265 |
| 2001 | | 0.0007 | 0.0013 | 432662 | 288 |
| 2002 | | 0.0007 | 0.0013 | 586165 | 390 |
| 2003 | | 0.0007 | 0.0013 | 586888 | 390 |
| 2004 | | 0.0007 | 0.0013 | 455745 | 303 |
| 2005 | 41 | 0.0000 | 0.0000 | 386396 | 0 |
| 2006 | 36 | 0.0001 | 0.0006 | 386212 | 40 |
| 2007 | 35 | 0.0001 | 0.0005 | 207548 | 19 |
| 2008 | 5 | 0.0000 | 0.0000 | 112946 | 0 |
| 2009 | 2 | 0.0000 | 0.0000 | 252278 | 0 |
| 2010 | 2 | 0.0017 | 0.0024 | 209491 | 349 |
| 2011 | 12 | 0.0001 | 0.0004 | 150252 | 19 |
| 2012 | 21 | 0.0002 | 0.0007 | 88786 | 14 |
| 2013 | 20 | 0.0000 | 0.0000 | 126843 | 0 |
| 2014 | 22 | 0.0003 | 0.0008 | 173177 | 45 |
| 2015 | 8 | 0.0045 | 0.0111 | 155914 | 695 |
| 2016 | 14 | 0.0003 | 0.0010 | 92890 | 26 |
| 2017 | 13 | 0.0000 | 0.0000 | 97453 | 0 |
| 2018 | 0 | | | 72317 | 0 |
| 2019 | 10 | 0.0015 | 0.0048 | 22476 | 34 |

Table 10.  Yearly observed dead discards of scalloped hammerhead sharks from shark research fishery from 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 11.  Yearly calculated live discards of scalloped hammerhead sharks for the shark bottom longline fishery for the Atlantic.   Discards are reported as number.

| Year | Number Observed Sets | Mean Discard Rate | Standard deviation | Total hooks | Total Live Discards |
|---|---|---|---|---|---|
| 1993 | | 0.0004 | 0.0006 | 373270 | 134 |
| 1994 | | 0.0004 | 0.0006 | 767570 | 275 |
| 1995 | | 0.0004 | 0.0006 | 293603 | 105 |
| 1996 | | 0.0004 | 0.0006 | 853758 | 306 |
| 1997 | | 0.0004 | 0.0006 | 393413 | 141 |
| 1998 | | 0.0004 | 0.0006 | 458687 | 165 |
| 1999 | | 0.0004 | 0.0006 | 420234 | 151 |
| 2000 | | 0.0004 | 0.0006 | 398160 | 143 |
| 2001 | | 0.0004 | 0.0006 | 432662 | 155 |
| 2002 | | 0.0004 | 0.0006 | 586165 | 210 |
| 2003 | | 0.0004 | 0.0006 | 586888 | 211 |
| 2004 | | 0.0004 | 0.0006 | 455745 | 164 |
| 2005 | 41 | 0.0001 | 0.0007 | 386396 | 41 |
| 2006 | 36 | 0.0002 | 0.0014 | 386212 | 89 |
| 2007 | 35 | 0.0000 | 0.0002 | 207548 | 9 |
| 2008 | 5 | 0.0000 | 0.0000 | 112946 | 0 |
| 2009 | 2 | 0.0000 | 0.0000 | 252278 | 0 |
| 2010 | 2 | 0.0000 | 0.0000 | 209491 | 0 |
| 2011 | 12 | 0.0000 | 0.0000 | 150252 | 0 |
| 2012 | 21 | 0.0000 | 0.0000 | 88786 | 0 |
| 2013 | 20 | 0.0012 | 0.0053 | 126843 | 151 |
| 2014 | 22 | 0.0000 | 0.0000 | 173177 | 0 |
| 2015 | 8 | 0.0000 | 0.0000 | 155914 | 0 |
| 2016 | 14 | 0.0020 | 0.0059 | 92890 | 181 |
| 2017 | 13 | 0.0000 | 0.0000 | 97453 | 0 |
| 2018 | 0 | | | 72317 | 0 |
| 2019 | 10 | 0.0013 | 0.0040 | 22476 | 28 |

Table 12.  Yearly observed live discards of scalloped hammerhead sharks from 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 | 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 13.  Yearly calculated dead discards of scalloped hammerhead sharks for the shark bottom longline fishery the Gulf of Mexico.   Discards are reported as number.

| Year | Number Observed Sets | Mean Discard Rate | Standard deviation | Total hooks | Total Dead Discards |
|---|---|---|---|---|---|
| 1993 | | 0.0004 | 0.0008 | 728110 | 268 |
| 1994 | | 0.0004 | 0.0008 | 1173865 | 433 |
| 1995 | | 0.0004 | 0.0008 | 2124050 | 783 |
| 1996 | | 0.0004 | 0.0008 | 2581825 | 952 |
| 1997 | | 0.0004 | 0.0008 | 1078050 | 397 |
| 1998 | | 0.0004 | 0.0008 | 1120596 | 413 |
| 1999 | | 0.0004 | 0.0008 | 1108904 | 409 |
| 2000 | | 0.0004 | 0.0008 | 989790 | 365 |
| 2001 | | 0.0004 | 0.0008 | 926217 | 341 |
| 2002 | | 0.0004 | 0.0008 | 1076709 | 397 |
| 2003 | | 0.0004 | 0.0008 | 1065727 | 393 |
| 2004 | | 0.0004 | 0.0008 | 771330 | 284 |
| 2005 | 52 | 0.0000 | 0.0000 | 1002010 | 0 |
| 2006 | 53 | 0.0000 | 0.0000 | 1193336 | 0 |
| 2007 | 59 | 0.0000 | 0.0000 | 288210 | 0 |
| 2008 | 0 | | | 137903 | 0 |
| 2009 | 7 | 0.0000 | 0.0000 | 29846 | 0 |
| 2010 | 11 | 0.0011 | 0.0023 | 24177 | 26 |
| 2011 | 1 | 0.0000 | | 26370 | 0 |
| 2012 | 66 | 0.0000 | 0.0000 | 95264 | 0 |
| 2013 | 0 | | | 95401 | 0 |
| 2014 | 0 | | | 135732 | 0 |
| 2015 | 9 | 0.0000 | 0.0000 | 130594 | 0 |
| 2016 | 24 | 0.0002 | 0.0010 | 82828 | 17 |
| 2017 | 35 | 0.0003 | 0.0014 | 100869 | 35 |
| 2018 | 52 | 0.0024 | 0.0082 | 111142 | 271 |
| 2019 | 29 | 0.0000 | 0.0000 | 96685 | 0 |

Table 14. Yearly observed dead discards of scalloped hammerhead sharks from shark research fishery from 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 15.  Yearly calculated live discards of scalloped hammerhead sharks for the shark bottom longline fishery for the Gulf of Mexico.   Discards are reported as number.

| Year | Number Observed Sets | Mean Discard Rate | Standard deviation | Total hooks | Total Live Discards |
|------|------|------|------|------|------|
| 1993 |  | 0.0004 | 0.0008 | 728110 | 268 |
| 1994 |  | 0.0004 | 0.0008 | 1173865 | 433 |
| 1995 |  | 0.0004 | 0.0008 | 2124050 | 783 |
| 1996 |  | 0.0004 | 0.0008 | 2581825 | 952 |
| 1997 |  | 0.0004 | 0.0008 | 1078050 | 397 |
| 1998 |  | 0.0004 | 0.0008 | 1120596 | 413 |
| 1999 |  | 0.0004 | 0.0008 | 1108904 | 409 |
| 2000 |  | 0.0004 | 0.0008 | 989790 | 365 |
| 2001 |  | 0.0004 | 0.0008 | 926217 | 341 |
| 2002 |  | 0.0004 | 0.0008 | 1076709 | 397 |
| 2003 |  | 0.0004 | 0.0008 | 1065727 | 393 |
| 2004 |  | 0.0004 | 0.0008 | 771330 | 284 |
| 2005 | 52 | 0.0000 | 0.0000 | 1002010 | 0 |
| 2006 | 53 | 0.0000 | 0.0000 | 1193336 | 0 |
| 2007 | 59 | 0.0000 | 0.0000 | 288210 | 0 |
| 2008 | 0 |  |  | 137903 | 0 |
| 2009 | 7 | 0.0000 | 0.0000 | 29846 | 0 |
| 2010 | 11 | 0.0011 | 0.0023 | 24177 | 26 |
| 2011 | 1 | 0.0000 |  | 26370 | 0 |
| 2012 | 66 | 0.0000 | 0.0000 | 95264 | 0 |
| 2013 | 0 |  |  | 95401 | 0 |
| 2014 | 0 |  |  | 135732 | 0 |
| 2015 | 9 | 0.0000 | 0.0000 | 130594 | 0 |
| 2016 | 24 | 0.0002 | 0.0010 | 82828 | 17 |
| 2017 | 35 | 0.0003 | 0.0014 | 100869 | 35 |
| 2018 | 52 | 0.0024 | 0.0082 | 111142 | 0 |
| 2019 | 29 | 0.0000 | 0.0000 | 96685 | 0 |

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

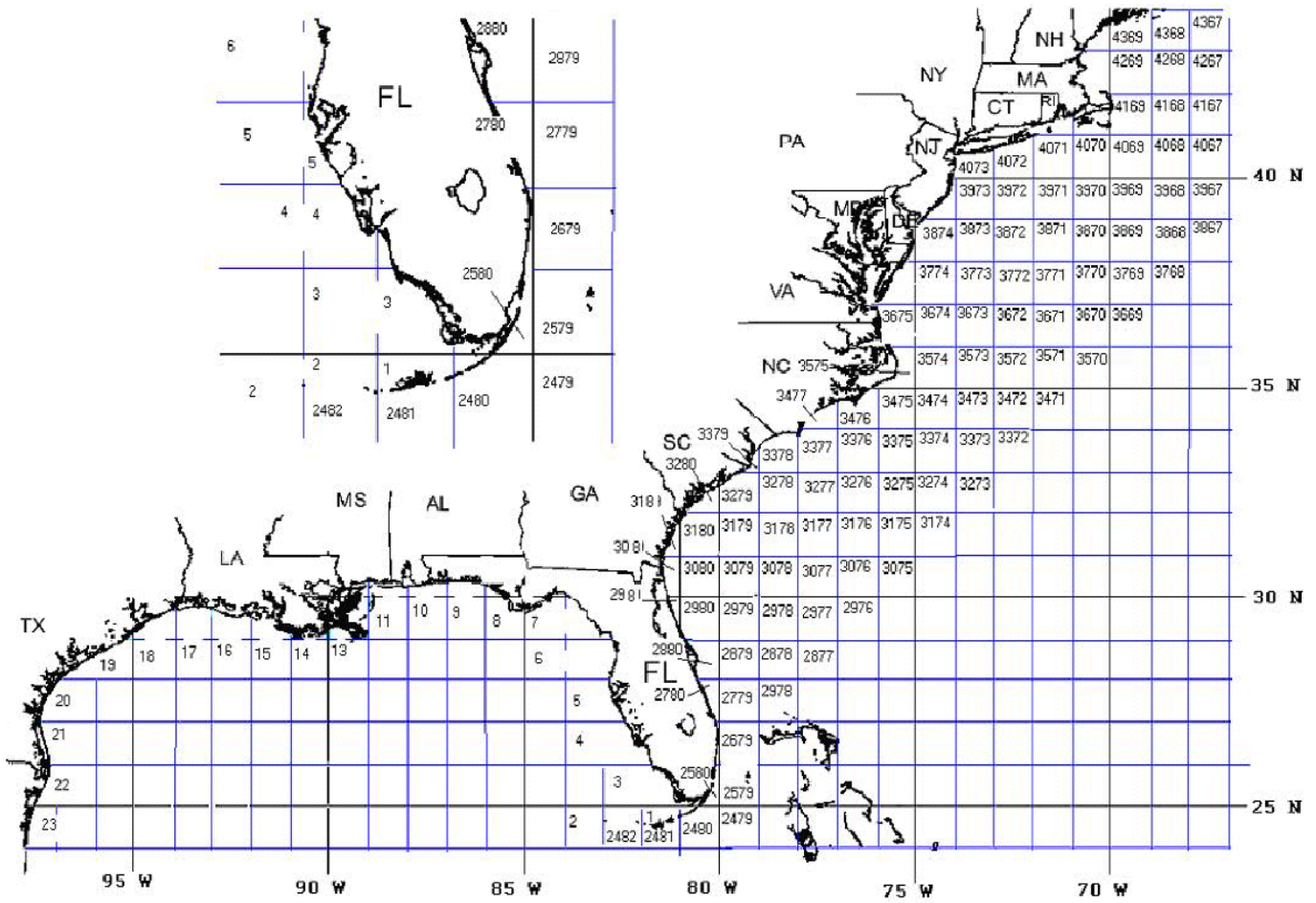| Year | Number Observed Sets | Total Dead Discards |
|------|----------------------|---------------------|
| 2008 | 41 | 2 |
| 2009 | 71 | 16 |
| 2010 | 58 | 4 |
| 2011 | 95 | 15 |
| 2012 | 27 | 5 |
| 2013 | 46 | 0 |
| 2014 | 16 | 3 |
| 2015 | 39 | 7 |
| 2016 | 29 | 6 |
| 2017 | 55 | 23 |
| 2018 | 49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

**Figure 1.** Coastal logbook statistical areas.